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Research in Farm Management

--Scope and Method--

Prepared under the direction of
**The Advisory Committee on Social
and Economic Research in
Agriculture**

JOHN D. BLACK, Editor

**H. R. TOLLEY, Executive Secretary
of Special Advisory Committee
on Farm Management**

SOCIAL SCIENCE RESEARCH COUNCIL

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ACKNOWLEDGMENTS

This report represents the joint effort of a large number of the experienced research workers in Farm Management in the United States. Many who have not contributed to its preparation failed to avail themselves of an opportunity to do so for lack of time or other reasons. A special advisory committee was designated by the Advisory Committee on Social and Economic Research in Agriculture to decide upon the general outline of this report and to approve it for publication.

In the preparation of the outline a considerable number of research workers in addition to the members of the Special Advisory Committee were consulted. The Chairman and Executive Secretary of this Special Advisory Committee solicited the assistance of the various workers who have contributed to the report, and performed the task of fitting together their contributions and filling in the gaps. The name of the principal contributor is indicated at the beginning of each section of the report.

Among the Farm Management workers in the United States are some conflicting points of view with respect to the organization of research in the field and the research technique best suited to specific projects. These points of view are not all discussed fully in this report, largely owing to the fact that some workers did not avail themselves of the opportunity to present their points of view.

At various places in the report the Chairman and the Executive Secretary have endeavored by footnotes and otherwise to indicate points on which there are conflicting views and to refer to articles and publications containing discussions of or exemplifying points of view and methods of attack differing from those presented herein.

The final manuscript of this report has been submitted for criticism and comment to all members of the Committee, but some have not found time to read and comment on all of the projects. Dr. Holmes would no doubt have indicated definite disagreement with more of the projects could he have found time to do so. Dr. Myers has indicated this by stating that "he is in hearty disagreement with the point of view and many of the details of a considerable number of the proj-

ects". In some cases, this disagreement is indicated in footnotes attached to individual projects.

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USES OF THIS REPORT

This report is No. 13 in a series on "Scope and Method" of research in the various sub-fields of agricultural economics and rural sociology. This series of reports is part of a program of assistance to research in these fields, upon which the Advisory Committee on Social and Economic Research in Agriculture set forth in 1925 under instruction from the Social Science Research Council. Each report will undertake to outline the research of some sub-field of agricultural economics or rural sociology and then discuss the problems in methodology that are peculiar to it. The outline of any sub-field will be in large part in terms of a listing and discussion of specific research projects that have been undertaken or might be undertaken. Hence the discussion of methodology will be largely in terms of specific projects.

It is expected that these reports will be useful in the following ways: First, directors of experiment stations and chiefs of divisions of agricultural economics and of rural sociology in land-grant institutions in the United States, and persons similarly responsible for direction of the research in agricultural economics and rural sociology in other types of institutions, will find the outlines of the various sub-fields of much help in laying out continuing programs of research for their institutions. Second, individual research workers, graduate students looking for thesis subjects, and teachers conducting research seminars, as well as the agencies above named, will find the listing and discussions of projects helpful in choosing suitable research projects. Third, the descriptions of research already done will save research workers from duplicating other work and help them to find a way of building upon it successfully. Fourth, the discussion of the nature of a project and the qualitative background will reveal the body of the subject-matter which needs to be mastered for its intelligent prosecution, and the difficulties involved, and thus save many research workers from launching forth upon projects for which they have not yet qualified themselves, or which may be too difficult for all but the chosen few. Fifth, the analysis of methodology will furnish a basis for a more intelligent decision as to the procedures and methods which will lead to valid and usable results. Sixth, the discussion of methodology will also suggest helpful devices in technique and details of procedure that might not otherwise be brought to the attention of the research workers. Seventh, the discussions of both scope and methods will make clear to those organizing research in any field the contributions which workers on different subjects have to offer to it, and point the way to the form of collaboration needed.

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Research Relating to Farm Management --Scope and Method

Research in farm management was developed in the United States at an earlier date than research in other parts of the field of agricultural economics. The principal centers of early development were the United States Department of Agriculture, the University of Minnesota, Cornell University, and the University of Wisconsin. Under the leadership of these institutions, research in farm management was soon introduced into the program of many of the state agricultural experiment stations, and it continues to occupy a leading place in the agricultural economic research program in the United States. In 1931 more than two hundred research projects in farm management were being carried on in the agricultural experiment stations and in the United States Department of Agriculture. The early development of research in farm management has been discussed at length in a number of articles and books, among which are:

- Bennett, M. K., *Farm Cost Studies in the United States*. Stanford University Press, 1928.
- Carlsaw, R. McG., *Farm Management Research Technique*. London, College of Estate Management, 1931.
- Frauendorfer, S. V., "Development Methods and Results of Agricultural Economic Research in the United States," *Journal of Farm Economics*, July 1928.
- Warren, G. F., "The Origin and Development of Farm Economics in the United States," *Journal of Farm Economics*, January 1932.

Reading these discussions and the project analyses following will show how changes in points of view in research technique have accompanied the development of this field. As research has developed in other parts of the field of agricultural economics, there has also come a clearer conception of the scope of farm management as a research subject and of the relationship between research in farm management and research in other parts of the field of agricultural economics.

OBJECTIVES

The purposes of this report are: To outline this subdivision of the field of research in agricultural economics; to indicate its relationship to other parts of the field; to describe briefly the present status and recent trends in research in farm management; to outline a considerable number of projects representative of those now under way or needed to round out the program of farm manage-

ment research; and to suggest methods and procedures which are being used or which may be used to advantage in different types of projects.

It is hoped that this report, representing as it does the viewpoints and judgments of a large number of workers, many of whom have had considerable experience in research in other parts of the field of agricultural economics as well as in farm management, will be of assistance to those engaged in farm management research and to those responsible for its conduct, in choosing projects to be undertaken and in deciding upon methods to be employed and procedures to be followed.

DEFINITION OF THE FIELD

(By H. R. Tolley)

In the early stages of development of research in farm management, any project with an *economic* objective was likely to be classified as a farm management project, because most of the economic research pertaining to agriculture was being carried on by men whose primary interest was in farm management, and because the other parts of the field had not been developed and their content was not well understood. At the same time, many projects which pertained almost entirely to the natural science phases of agriculture were likely to be classified as farm management and carried on by farm management workers if they were conceived to involve a consideration of the "entire farm business." Studies of the relation of crop rotations to yields is a case in point. But the development of research in the other parts of the field of agricultural economics has led to a considerable modification of the earlier points of view concerning the scope of research in farm management in its relations to subjects such as land utilization, agricultural credit, agricultural incomes, marketing and prices. Likewise the research workers in both farm management and the physical and biological sciences have come to understand that research designed to study and determine physical and biological relationships will yield the most dependable results when conducted by one trained primarily in the natural sciences.¹

(1) "I doubt whether the first sentence is strictly true. Farm management as a body of subject matter was developed first of all by technical people who disclaimed for it any relationship with economic ideas as such. I think, therefore, it would be very hard to find any studies in prices and related fields of economics which in an earlier period, or at any time, were pursued under the label of farm management. Likewise, I do not believe that there was any period when farm management workers were claiming portions of fields which really belong to the natural science phases of agriculture. It is true that crop rotation is a subject considered within the realm of farm management in certain aspects from the beginning but it was always recognized that soil scientists and agronomists also had interests in certain phases of the problem of crop rotations. In general, I think the earlier period was marked by more extravagant claims by technical workers than by farm management workers."

—C. L. Holmes.

But the agricultural economist, especially the research worker in farm management, frequently must use the results of physical and biological research in his work. Many projects needed in a well-rounded program of research in farm management involve the consideration of so many natural-science factors and relationships that they should be conducted jointly by farm management workers and workers in the physical and biological sciences. Much the same situation is found when the relationship between farm management projects and projects in other parts of the field of agricultural economics is considered. Many projects needed to round out the program of farm management research involve the study of factors and relationships which are ordinarily classified in some part of the field of agricultural economics other than farm management. In such cases the projects should be carried on jointly by farm management workers and workers in other phases of agricultural economics. A large number of the studies of the Division of Farm Management of the Bureau of Agricultural Economics are conducted in cooperation with other divisions of that Bureau or with the appropriate divisions of the Bureaus of Plant Industry, Animal Industry, Dairy Industry and Agricultural Engineering.

Relationships to particular fields—economics of agricultural production.

The closest of all relationships of farm management is that to the division of "pure" economics² that relates to production, and particularly to the economics of agricultural production. Studies in the economics of production relate to general principles such as those of comparative advantage and specialization, and to the specialized forms of these principles that refer to production in particular fields, such as in agriculture or in mining. In their specialized form, these principles largely explain the kind of production that is found in any area, or on any one farm, at any given time, or the changes that have occurred or are occurring there. Research devoted to such ends explains in large part why some farms make better incomes than others, and lays the foundations for understanding what is good farm management; *but it does not indicate how any particular farm should be organized or operated, which is the task of the applied science, farm management.* Similarly any project designed to determine the most advantageous combination of products for the farms of an area, or to formulate the most desirable farming program for an area, is of the applied-science or farm-management type.

As explained above, the projects outlined in the later pages of this report are not all applied science only. Many of them include in addition a considerable amount of specialization of the principles

(2) The writer is following conventional usage in using the term "pure" here. This has the unfortunate effect of stigmatizing the applied sciences as "impure", which they are only in the sense that they commonly combine several pure sciences.

of the pure science of production economics. The same is true of most of the research projects in farm management now being carried on in the experiment stations and the U. S. Department of Agriculture. (See the discussion of recent trends and present status of farm management research.) While there is constant pressure to reduce such projects more and more to the basis of applied science only, it nevertheless is true that these cannot contribute much to the testing and extension of the principles of production economics.

Relation to agricultural policy.

Another phase of the applied science of agricultural production relates to the question of what the nation, or society, shall produce. This differs from farm management in that the objective is to maximize the well-being (defined in whatever way one prefers) of some group, such as the nation, as distinguished from the income of the individual farm. The former is just as much applied science as farm management, although it is difficult for some of our professors of old fashioned "political economy" to understand this. The pure science of agricultural production economics is something different from either of these. This report does not include projects dealing with the national or social economy of agricultural production. These are reserved for the report on Agricultural Policy. But obviously the point of view of the individual farm and that of the society or the nation are closely related in many research undertakings, and there is not only economy in considering many problems from both points of view, but greater clarity of thinking. European agricultural economists commonly separate farm management and agrarian policy from each other widely, even placing them in separate departments with separate personnel. In the United States, the common practice is the reverse of this; and most Americans are satisfied that their plan is the better because it is less likely on the one hand to produce specialists in agricultural policy who have little conception of the economy of the individual farm, and on the other hand to produce specialists in analyzing the internal farm economy who are unable to relate farm production programs to developments in the outside world.

Relation to agricultural income.

Research in agricultural income is concerned with the distribution of income from agriculture among the various factors of production, the variations in the agricultural income of the nation from year to year and the reasons therefor, and the development of methods for estimating the agricultural income of an area, a state or the nation, and as an incident to the foregoing, the income of the individual farm and farm family. Such research is described in the report in this series on Agricultural Income. Research in farm management concerns itself only with incomes from individual farms, and with comparisons between incomes from individual farms. More-

over, the income series so compared must be constructed so as to serve as criteria of economic success in farm management, not as measures of relative well-being. Measures designed for use in determining the best utilization of the farm resources may be entirely unsuited to the purposes of research relating to incomes as such. For example, the farm management worker who is studying the returns that have been received, or may be expected, from a particular combination of the factors of production may not find it necessary or desirable to attempt to place a value on the use of land, since he is interested in the income accruing from the *combined* use of this with the other resources of the farmer. If these data are complete enough and properly handled, they can also be assembled into income figures that will serve the purposes of income study as such, and perhaps be used to build up historical and geographical series of agricultural incomes; but most of the income measures devised for farm management purposes thus far are not suited for use as measures of incomes as such, and much evil has resulted from attempts of outsiders so to use them. This raises the question as to whether income compiled to serve as criteria of farm management should ever be called incomes. One cannot expect journalists and their kind to look beneath the surface of the name. Also often a very serious problem of sampling appears when efforts are made to use data from farm management studies in constructing income series.

Relation to land utilization.

The relation between the fields of farm management and land utilization is fully developed in the report on Agricultural Land Utilization (pp. 6-7). The most essential feature of this relation is that land utilization is concerned primarily with competition between major uses of land, and hence with land in the margin of agricultural use, whereas farm management concerns itself largely with competition between different agricultural uses on land mostly above the agricultural margin. It follows from the foregoing that research in land utilization is likely to have a somewhat broader scope than that in farm management, and to have more of the social or collective point of view in it. Land utilization studies in areas where farming constitutes one of the major alternative uses for the land should usually be planned and carried on jointly with farm management workers; and similarly farm management studies in marginal areas should commonly be conducted jointly with land utilization workers.

Relation to agricultural credit.

Problems in agricultural credit may be looked upon from two points of view: (1) that of the agencies which provide credit, and (2) that of the users of credit. (See the report in this series on Research in Agricultural Credit, page 7.) The credit problem of

the farmer, in so far as production is concerned, is to determine whether or not to borrow money with which to obtain control of resources for farming—land, livestock, equipment, labor, etc., and likewise how much to borrow. This assumes that credit will be available if it is wanted. In general, the farmer will consider the use of credit advisable if he thinks it will increase his net returns, i. e., if by using the credit the farm income will be increased more than enough to pay the interest and any other costs connected with its use. This same principle will determine how much he will borrow. Thus any research worker endeavoring to determine the best utilization of the farm resources must take into consideration all the possibilities of the use of borrowed capital to supplement that owned by the farmer. Farm management studies in areas where the use of borrowed capital is important, or where the study is likely to show that readjustments in organization and operation requiring large additional amounts of capital are advisable, might well be undertaken in cooperation with research workers in the field of agricultural credit.

Relation to land tenure, farm labor, etc.

Farm management analysis must of course take account of the circumstance that farms are operated under leases as well as under ownership; and under leases of various descriptions with numerous and varied detailed provisions with respect to division of responsibilities, expenditures and receipts. These circumstances also have significance from the standpoint of the tenure of the land, that is, of people's rights of use of it, and all that goes with such rights of use. A number of projects in these two fields therefore overlap somewhat. In general, farm management research with rented farms confines itself to the details of their operation as farms, and the relation of the leasing arrangements to such operation; and to the landlord's administration of his functions with respect to his farms. There is a similar overlapping in the case of farm labor and farm management, with a similar boundary zone between them. Special reports are planned for both land tenure and farm labor.

Relation to prices of farm products.

The research projects whose objective is to explain price differences and price changes are to be discussed in the report on Prices of Farm Products, even though they may need to go back to farm organization factors for the conditions affecting the elasticity of supply. In this latter case, however, they may be listed as "joint with farm management." Projects involving the adjustment of farm organization to changing prices or to local differences in prices, on the other hand, are listed under farm management. Should a farm management project require data as to local prices that are not yet available, the normal procedure would be to call upon the price researchers to provide them, indicating the form in which

they are needed, and arranging for joint control and support of the project if need be.

Relation to psychology and rural social psychology.

An increasing number of problems in farm management are calling for analysis of differences in intellectual equipment among farmers, and of responses of farmers to price and other stimuli. One project of this nature is listed below. Such research calls for special techniques understood only by trained psychologists; but farm management workers need to work with such persons very closely.

Relation to farm family living.

Since certain important items consumed by farm families are produced on the farms where they are consumed, and often are produced only to be thus consumed, studies in farm living will frequently need to take into account the economy of such production. The real incomes of farmers in an area may be either increased or decreased if a greater proportion of their efforts is devoted to producing for home use. Hence projects designed to determine the best utilization of the farm resources must take into account the whole family economy of using some of these resources in production for family use.

Relation to physical and biological sciences.

Farm management studies are dependent upon the physical and biological sciences for many kinds of basic data. In a great many of the projects outlined in the later pages of this report, information is needed on such points as the yield of crops under different conditions, the relation between animal production and the kinds and quantities of feed consumed, and the output of various machines and their adaptability to different farm operations. Often the farm management investigator finds that information on such points *in the form in which he needs it* has not been made available by his co-workers in the other fields. Hence we find that in many farm management projects a considerable amount of attention is given to obtaining and analyzing physical and biological data.

To illustrate, a study of the relation between the amount and kind of fertilizer used on a particular soil and the yield of a crop is clearly not a study in farm management as the field is here outlined; yet a rather complete knowledge of those relationships is necessary in many of the projects outlined in this report. Similarly a study of the relation between the amounts and kinds of feed consumed by a dairy herd and the quantity of milk produced is clearly outside the scope of farm management; but these and many other input-output relationships must be known in detail by the farm management worker who is endeavoring to determine the most advantageous organizations and methods of operation for dairy farms.

Where such information applicable to the conditions being studied

in the farm management project is not already available, the farm management research worker has the alternatives of arranging with his co-workers in the biological sciences to conduct the projects necessary to obtain it, or of arranging to obtain the information as part of the farm management project (in such cases the project should be carried on in cooperation with the appropriate biological department if possible). It would be helpful both to workers in farm management and to those in the other agricultural sciences if more thought were given to these points when research programs are being formulated.

Relation to engineering.

In those areas and for those types of farming where machines form a large part of the farmer's capital, it is particularly important that accurate and reliable information concerning the output of different machines, and the inputs of power and labor, be available to farm management workers. The introduction of mechanical power on farms in all parts of the country has emphasized this need. Any study with the objective of determining advisable changes or readjustments in farm organization and operation must now take into account the possibility of the use of mechanical power. The possibility of using each of many sizes and types of mechanical power units must also be considered. Much of the information needed to determine the economy of using a tractor as a source of power can best be obtained through engineering studies. This refers especially to items such as fuel and oil consumption, repairs, depreciation, and the technique of using a tractor with different implements on various operations.

With the introduction of tractors there have appeared especially designed tillage, planting and harvesting implements and machines which are more efficient when used with a tractor than were the implements and machines designed for use with animal power. Just as is true of tractors, the economy of using such machines must be studied in many farm management projects; and engineering data pertaining to them are needed as one of the bases of the study. The lack of engineering data needed in farm management research has been responsible for a growing number of cooperative engineering and farm management projects in the experiment stations and in the United States Department of Agriculture. While no definite line of demarcation between engineering research and farm management research is drawn in these projects, it is realized that the primary function of the engineering research is to study the physical input-output relations of the machines, and the primary function of the farm management research to use the resulting data together with information on prices of products, of the machines, of fuel, of labor, and many other items, to determine the conditions under which a farm proprietor will find the use of a particular machine economical.

The introduction of these new and expensive machines has brought to the foreground the question of readjustments in the proportional combination of the factors of production. The introduction of a tractor usually means the use of proportionally more capital and less labor. And since a tractor supplemented with the proper implements and machines usually makes it possible for a farmer to use more land advantageously than he was able to use without the tractor, the question of readjustments in the size of farms assumes major importance.

On the basis of the foregoing exposition, it will be seen that farm management is a coordinating science. It brings together the results of research and knowledge from the other sciences and studies them with the end in view of determining how to organize his resources (or combine the factors of production over which he has control) so as to obtain the maximum economic return, broadly interpreted, from their use.

FARM MANAGEMENT AS APPLIED SCIENCE

(By J. D. Black.)

Farm management as now conceived in the United States is both a pure and an applied science. As a pure science, it seeks to extend a growing body of principles relating to the way in which agricultural resources are used; as an applied science, it endeavors to apply such of these principles as seem to be useful as a guide in the task of setting up and operating individual farms.

This dual nature of farm management is clearly indicated by the current discussion of the subject. There is constant reference to the need of developing the *principles* of farm management. Professor G. F. Warren in his textbook published in 1913 speaks of farm management as "the study of the business principles of farming." This may mean having students learn such principles as have been developed; or it may mean the developing of principles. It probably was intended to include both. Professor H. C. M. Case in Illinois Bulletin 329 speaks of "certain definite principles that need to be observed in the organization and operation of a farm if it is to be financially successful" and lists eleven such principles, which are then "illustrated with facts obtained from detailed records of farms in east-central Illinois." Obviously the implication of these statements is that the research described has assisted in developing these principles. In his paper in the *Journal of Farm Economics* in July 1928, Professor Case says that "The objective of farm organization research undoubtedly is to aid in improving the organization of individual farms." No doubt he conceives of developing principles as means to the attainment of this objective. The type-of-farming studies being conducted in a considerable number of states and

regions which seek to classify the farms of an area into types, to discover the forces—economic and other—which have been responsible for the development of these types-of-farming in the area, and to explain the changes which have occurred in them (see Projects 1, 2, 3 and 4 in this report), are obviously conceived in the spirit of pure science, that is, of accounting for existing phenomena and change. But the ultimate aim of such projects is to provide a basis and background for determining what changes in farm organization and management will result in better utilization of the farm resources. For example, in North Dakota Bulletin 212, *Type-of-farming Areas in North Dakota* (by Rex Willard and O. M. Fuller, published in 1927), the opening sentence is: "The first and most important consideration in the preparation of this report has been to find a basis for more profitable farming in the various sections of the state." Here again the developing of relationships or principles is the means to the end of better farming.

The conception of farm management as in part comprising pure science objectives is not plausible, however, unless one holds to a different notion of pure science than is altogether common, a notion, namely, of pure science as being both general and specific. The economic principles pertaining to value may be narrowed down successively to land, to farm land, to farm land in different uses in a farming system, and to farm land in a given area. These are as definitely principles, and as surely pure science, in their restricted connections as in their larger ones. But they are highly specialized principles, and they constitute highly specialized pure science. Farm management as a pure science is obviously a form of specialized pure science, very frequently very much narrowed. This is illustrated by the first sentence in the summary of Cornell Bulletin 483, *Economic Studies of Dairy Farming in New York IX*, published in June 1929: "This study was made to bring out some underlying principles of farm management on dairy farms in the Chenango area."

In practice, the applied scientists commonly find that the pure scientists have stated their principles only in very general terms—as in the usual statements of the Principle of Diminishing Returns, and of the Principle of Comparative Advantage; and that in this form they usually cannot be applied directly to the highly concrete and specific situations with which they as applied scientists have to deal. It therefore becomes necessary that these principles be refined¹ and narrowed down before they can be put to work. Many pure scientists at present are impatient with such details. This is very much true of those economists who call themselves "theorists".

(1) To speak of "refining" of principles, as in this discussion, is not very satisfactory; neither is the sense properly conveyed if one speaks of "specializing" them or making them "specific", as also throughout the discussion. Professor I. G. Davis has attempted to indicate more exactly the meaning intended in the following:

(Continued on page 13)

In practice, therefore, the applied scientist may find himself not only applying principles, but attempting to develop his own. Frequently, however, his background of experience is such that he is not really familiar with the body of general principles pertinent to his narrow field; and in such circumstances he may attempt to develop a set of specialized principles without associating them in any way to the related general principles. He may in his innocence think that he is developing a whole new science. The principles he enumerates may be considerably at variance with the commonly accepted general principles. Thus several principles have in the past been stated for farm management that are more or less in discord with the general Principle of Diminishing Returns. There is, of course, no reason why by such procedure the general principle may not be discovered to be in error as commonly stated. This has happened time and again in all sciences. But in most cases, the defect is found in the supposed specialized principle, the supporting data either being not sufficiently representative or inadequately analyzed, or the results improperly interpreted.

As time goes on, however, the general scientists will refine their principles so that they refer to more specialized subjects—as the principles relating to value have recently been refined to refer to farm land value; and more of the applied scientists will be made familiar with these principles; and the two groups will reinforce each other's efforts constantly. But seldom in any field do the pure scientists reduce their principles to narrow enough terms so that they serve all the needs of the applied scientists, with the result that the applied scientists are compelled to collect data and generalize from them as well as to apply the existing body of principles refined as may be. Hence applied science commonly includes, besides the

(Continued)

"It seems to me that what we must mean by 'refinement of principles' involves a process about as follows:

(a) Verification with relation to the existence in the particular situation, of the hypotheses or assumptions employed in arriving at the general principle. For example, the classical distribution theory involved certain assumptions as to population growth, rate of progress in the arts, etc. Certain so-called principles followed. These principles hold in the Orient but not in the Occident. The assumptions of the theory are changed in the latter. The theory still holds and the principle as a general statement is as good as ever within the range of the implied assumptions.

(b) The operation of other forces or factors modifying or conditioning the application of the given principles in the given situation needs to be explored at length. A good example of this can be found in the fluid milk industry. It has been claimed that the demand price of different portions of a given homogeneous product at a given moment on a given market are the same. Yet dealers with no coercion whatever will pay more for the nearby product. Why? They fear the competition of producers and dealers on their market. Is this a refinement of the principle? No. The same principle applies. It represents a closer analysis of the forces and factors conditioning the application of the principle.

(c) Testing the fundamental principle in its application to a particular situation, due consideration having been given to the above—(1) and (2); seeking new principles or new manifestations of the general principle in its more universal application."

mere application of known principles, the final stages in the refinement of these principles to fit the narrow sets of conditions with which the applied scientist has to deal. How many stages will be left for the applied scientists will vary with the age of the science and the amount of attention it has received.

It follows from the foregoing that the important consideration is not to what stage of refinement the pure scientist of the economics of agricultural production carries his analysis, and at what stage of refinement the scientist of farm management begins; but that *one connects with the other*, with no breaks or inconsistencies between. In a field of work as new as this, one can expect that the general scientists have not carried their refinements very far, and that the applied scientists are forced to include in their work a very considerable part of the refinement operations. It thus follows that the field conceived in this report includes many projects in which the refinement of principle is more important than the determination of the facts and conditions needed as the basis for application of principles. If history repeats itself, at a later period in the development of the field of agricultural production economics, considerable of the research outlined in this report will be thought of as refined pure economic science and not farm management as such.

Never, however, is the refining of principles carried by the pure scientist of economics to the point of taking account of the conditions peculiar to any one area, or to any one system of farming. It stops with statements of principles that are significant for particular types of areas, or particular classes of farming systems. The last stage of refining beyond this will always fall to the lot of the applied scientist.

It is entirely proper that this should be the case, for at this point generalization and application merge into each other. The conclusions from such local studies are specifically true only for the actual farms covered in the study, and others in the particular universe from which the sample has been taken; and they can be directly applied only to these two groups of farms in efforts to improve their management. Relationships more general in their statement than these would not be closely enough applicable to these particular farms to be altogether useful in solving their management problems. Application of principles to a particular case or situation always calls for rather detailed information concerning it. Many of these same details are needed to refine the principles as narrowly as need be. Hence one project collects the data needed for both; and following the collection of the data come analytical procedures developing the relationships that specifically maintain in this universe; and following this comes the reading of the meaning of these relationships for the farms in the universe.

Some may question whether farm management or any other field conceived of as applied science only as above defined can be con-

sidered as science at all. This is a highly proper question and entitled to an answer. It is science because: (1) the application of the principles to the solution of the individual problem or situation or case in hand is an analytical procedure calling for collecting and proving of facts concerning the individual case and relating these to the principle in question; (2) such application constitutes a highly needed testing of the validity of the principle; and (3) out of such testing come suggestions as to hypotheses in the nature of modifications or refinements of the principle.

It is of course possible to apply principles to solutions in such a way as to contribute little or nothing whatever to the furthering of the process of developing valid principles. No doubt much of such application is constantly in process in the field of farm management as in other so-called applied fields. But this is not the fault of applied science as such; but rather is due to the inadequate scientific background and experience of the workers. The system rather common in the United States of having extension work in farm management done by a special personnel is open to serious criticism in this respect. It is entirely possible to have the necessary types of personnel, and to tie together the activities of the research and extension workers in farm management, so that the development of principles and testing of them supplement each other almost as well as though done by the same personnel; but it is unusual to find this to be the fact.

Comments (C. L. Holmes.)

I should like to speak for a different focus or emphasis from that obtaining in Dr. Black's section entitled "Farm Management as Applied Science". In his first paragraph he distinguishes between pure and applied science, referring to the first as "a growing body of principles" and to the second as the application of these principles to the task of setting up and operating individual farms. There is some doubt here as to whether in the reference to the application phase he has in mind the farmer's actual vocation as farm proprietor or the determination by means of research of the best forms of organization and methods of operation under a limited set of conditions, thus limiting the application phase as such in the realm of research and education so far as the scientific process is concerned. Presumably he means the latter.

This point of view implies that one important object of research in farm management—probably the most important—is to develop principles. The principles which Dr. Black has in mind are evidently generalizations of truth about the forces and conditions concerned in farm organization and operation rather than the primary forces themselves. His discussion implies, further, that as progress in farm management research is made, the body of principles will grow and the need of applied science, that is, the specific study of concrete

special situations, will diminish; for, he says, "How many stages will be left for the applied scientists will vary with the age of the science and the amount of attention it has received." The logical implication is that it is possible through research aimed at the development of the "pure science" of farm management to refine generalizations to such a degree as to have a principle, or set of principles, to apply to every conceivable set of circumstances—or at least a close approximation to that condition—and thus preclude the necessity for detailed study of special situations by substituting the use of the principles which are adequate and ready to hand.²

The phenomena with which farm management research has to do are not simple but exceedingly complex. Effort to reduce them to simple categories leads to unreality and is futile. Hence attempts at generalizations can go but a little way before the formulations cease to be principles because they contain no essential truth of adequately broad application. For this reason it would seem that farm management research must always be primarily concerned with the study of the elements in a given concrete situation that creates the problem, the measurement and evaluation of these elements, and the true interpretation of their relations to the problem and its solution.

This view of the thing does not negative in any measure the importance of principles in the process of research. An adequate understanding of them on the part of research workers is indispensable to correct analysis and accurate formation of judgments in the interpretation of research results. It may be added that an understanding of them is equally desirable on the part of those who are following the vocation of farm management. Neither does it follow that refinement and amplification of principles will not result from research motivated by the immediate objective of solving concrete problems. Indeed, such research is likely to be more fruitful in that direction than that which has as its chief objective the enrichment of the body of economic doctrine. Such results, however, will come as a by-product.

It would seem that in the introduction to the handbook of research in Farm Management, prefacing, as it is intended to do, a series of research projects, the emphasis should be on research as an attack on economic problems rather than as an enterprise in the development of economic principles.

RECENT TRENDS IN FARM MANAGEMENT RESEARCH (By Walter J. Roth and H. R. Tolley.)

For the purpose of portraying some of the major trends in farm management research in recent years, a comparison is here made

(2) No such extreme position is implied in my statement or intended. The sole issue involved is as to how much territory a generalization must cover in order to be a principle. (J. D. Black.)

between an analysis of the farm management projects in progress in the United States in 1931 and a similar analysis of projects in progress in 1927, which was made by Professor W. E. Grimes under the direction of the Advisory Committee on Social and Economic Research in Agriculture.¹ The information for the 1931 analysis was obtained from reports of economic research in the state experiment stations which have been collected by Dr. B. Youngblood of the Office of Experiment Stations at the request of the Advisory Committee, and from the records of the Division of Farm Management and Costs which were made available by Dr. C. L. Holmes. Professor Grimes classified farm management research projects into four major groups: (1) type-of-farming studies, (2) studies of farm practices, (3) studies of farm enterprises,² and (4) studies of the entire farm business. It will not be possible to make comparison with this earlier report unless this same classification is followed, even though this procedure fails to reveal the most important trends. It has been possible, however, to go back to the earlier data collected and classify the last two groups of projects, Farm Enterprise Studies and Studies of the Entire Farm Business, in greater detail than in the earlier report, and thus to get closer to the changes that have occurred. The classification adopted by Grimes has purposely not been followed in the presentation of the projects which are outlined in detail in the later pages of this report.

Of importance in this connection is the caution laid down by Grimes when he called attention to the difficulties of classifying the projects reported. Although ordinarily studies in Types of Farming and Farm Practices are readily recognized as such, those dealing with Farm Enterprises are not always clearly distinguished from those dealing with the Entire Farm Business, and vice versa. This is due in part to the fact that in some regions a single enterprise represents essentially the "entire farm business". Furthermore, the names of projects are often only partly indicative of their content. Again in some states, a study may be reported as a single unit while in others a similar study may be broken up into several separate and distinct projects.

In the survey of 1927, projects in farm management were reported by 41 states; in 1931, by 46 states. For 1927 only 5 states reported Type-of-Farming studies, and 11 Farm Practice studies, as compared with 18 for Farm Enterprise studies and 31 for studies of the Entire Farm Business. The change in distribution by 1931 is indicated on the following page:

(1) A preliminary report of a "Survey of Economic Research in Agriculture in the United States during the year July 1, 1926-June 30, 1927", Volume II, *Research in Farm Management*, by Waldo E. Grimes, Kansas Agricultural College. Published by the Social Science Research Council.

(2) In this report, the term "enterprise" will be used to indicate the part of a farm business concerned with producing one farm product, following the practice common in farm management literature in the United States.

STATES REPORTING
(Absolute Numbers)

	Type of Farming	Farm Practices	Farm Enterprise	Entire Farm Business	Total
	Number	Number	Number	Number	Number
1927	5	11	18	31	41
1931	11	23	25	43	46
Increase	6	12	7	12	5

The percentages of states reporting Type-of-Farming and Farm Practices studies have been more than doubled, whereas the percentages reporting the other two types of studies have increased less than a half. By number of projects, the changes have been as follows:

PROJECTS REPORTED

	Type of Farming	Farm Practices	Farm Enterprise	Entire Farm Business	Total
	Number	Number	Number	Number	Number
1927	7	19	34	65	125
1931	11	36	64	94	205
Increase	4	17	30	29	80

In 1927 the total number of projects was 125; in 1931, 205, an increase of 64 percent. The Farm Practices and Farm Enterprise groups show the greatest proportional increase. The increase for Type of Farming is greater than as first appears because in 1931 each state had only one project so classified, whereas in 1927 the type-of-farming work was split into two projects in two of the states. In addition, a number of states have made definite plans to inaugurate such projects, most of them in cooperation with the Division of Farm Management and Costs, as soon as the tabulations of the 1930 Census of Agriculture become available. The decline in proportion of Entire Farm Business studies may be in part due to a more careful statement of the project title and objective of such studies.

The increased interest in Farm Practices studies indicates a growing realization that efficiency within the enterprise offers considerable opportunity for worth while study and improvement. It may readily "pay" to make changes in practices, particularly in view of changing price relations for labor, power, equipment, etc. For similar reasons, Farm Enterprise studies are growing in relative importance and attention.

Farm enterprise studies.

The closer examination of the 34 Farm Enterprise projects listed in the 1927 report suggests a subclassification of them into 3 sub-groups, as follows:

I. Projects designed primarily to determine for an area the monetary expression of the cost of production of a commodity.

Some typical statements of objectives of projects which have been placed in this group are:

1. To determine the cost of producing potatoes in New York.
2. To assist growers in determining the cost of production of potatoes in Idaho.
3. To determine the cost and variations in cost in sheep and wool production in southeastern Ohio.
4. To determine the total costs, variations in costs and major factors affecting variations in costs in lamb feeding in Michigan.

The complete statements of objectives of the projects which have been placed in this group indicate that in some cases somewhat broader objectives than the mere determination of production costs were in mind. This is much more true of the projects in 1931 than in 1927. For example, one project had as an additional objective to discover the more effective practices for the areas in which the studies were made. Another had as an additional objective to determine the methods by which costs might be reduced. Doubtless all workers who are engaged on the projects in this group have had in mind broader ultimate objectives than the mere estimation of costs in money terms. But the procedure of analysis outlined in them usually does not proceed beyond this point—little if anything is indicated as to how the cost data are to be analyzed to find out just why the total cost is high or low on particular farms. The procedure most likely to be indicated, especially in these projects as outlined in 1927, is to calculate composite unit costs on each farm, and combine these into arrays of unit costs.

The change from the foregoing which is most obvious in the later studies is proceeding directly to the details of costs without calculating the totals. The cost of producing milk is looked at directly as made up of feed costs, labor costs, shelter costs, etc. How do each of these vary from farm to farm, and how can each be reduced on the high-cost farms? Feed costs vary according to the amount of feed used in producing a hundred-weight of milk and according to the price for the feed. There will be differences in both these items on the different farms. Hence each of these can be analyzed, and analyzed by itself. Then the variations in each of these can be analyzed and reasons for them discovered, these furnishing a basis for reducing costs. If the labor is not hired, there is nothing on the wage-rate side to study—it is only the economizing of the time and energy of the proprietor and his family that is desired, and this is analyzed when the data on labor per hundred-weight of milk are analyzed. The matter of utilization throughout the year of proprietor labor and family labor is another item for separate analysis on a purely physical basis without applying any wage-rates.

Variations in physical inputs of feed, labor, fertilizers, etc., per unit of product, have been made matters of special study in a number of projects. Such projects are included in the Farm Practices group in this classification. There is a similar relationship for labor and the other items of cost. Given cost-rates for the feed, labor, etc.,

and a price for the milk, a particular combination of inputs can be determined which will produce milk at lowest unit cost, and ordinarily another which will produce it at the highest profit to the business. Studies of this kind are obviously fundamental to all programs of reducing costs. They should ordinarily be made in co-operation with the natural science departments.

II. Projects designed to explain the trends in the production and consumption of a commodity in an area, a state or the nation.

Typical statements of objectives are:

1. To determine the status of the peach industry in New Jersey.
2. To study production, price and marketing factors as they relate to Utah's poultry industry.
3. To study the factors affecting the production, marketing and consumption of poultry and poultry products produced in Kansas.
4. To assemble, analyze, and interpret all facts available relating to the present situation and outlook for the cherry industry in Oregon.

These statements of objectives indicate that the studies in this group are not entirely within the scope of farm management research as outlined in the preceding pages of this report. Many of them are partly in the field of prices and partly in the field of marketing. They are quite similar to the "commodity studies" sponsored by the Division of Farm Management and Costs. (See statements on "Commodity Studies" by M. R. Cooper and R. D. Jennings in the later pages of this report.) These studies cover many of the points that would be covered in a study of the economics of production of a commodity as outlined in Project 6 of this report.

The Advisory Committee in its classification of projects in 1927 grouped as studies of Commodity Production and Marketing, outside of the Farm Management groupings, a total of 21 projects which had objectives somewhat similar to the above. Interest in studies of this type has been increasing since that time, and it is probable that there has been an increase in the number of projects. In 1927, only those projects in which primary emphasis was being given to the farm-management phases were classified in the Farm Management group. The same is true of the 1931 projects.

III. Projects designed primarily to determine the relations between one enterprise and other enterprises in the organization of the farms of an area.

Typical statements of objectives are:

1. To ascertain the economic possibilities of soy beans in Iowa farming.
2. To find out how the poultry enterprise, under varying conditions, fits into the whole farm business in West Virginia.
3. To study the relation of the swine enterprise to the organization, the returns and the permanent productiveness of the farm in Illinois.
4. To determine the factors affecting the production of hogs and the conditions under which hogs are included profitably in the farming systems of the peanut area of Alabama.

The number of states with projects in each of the three foregoing groups in 1927 and 1931, and the number of projects in each group, are shown in the following tables:

NUMBER OF STATES REPORTING FARM ENTERPRISE PROJECTS

	I Cost of Production	II Production and Consumption	III Relation between Enterprises	Total
1927	9	8	6	18
1931	12	10	14	25
Increase	3	2	8	7

NUMBER OF PROJECTS REPORTED IN FARM ENTERPRISE STUDIES

	I Cost of Production	II Production and Consumption	III Relation between Enterprises	Total
1927	18	8	8	34
1931	26	14	24	54
Increase	8	6	16	30

By states, the upswing in interest is definitely in the group involving the relation of one enterprise to other enterprises in the farm business. Although there is still a greater number of projects in the first group than in either of the other two, the percentage increases in Groups II and III have been much larger. As above indicated, also the nature of the cost projects has been considerably modified. Costs are still recognized as vitally important in determining the most economical methods of production and the most advantageous combination of enterprises, but the cost of producing a unit of a commodity expressed in monetary terms is being increasingly recognized as not of great help in studies which are designed to determine what methods of production and what combination of enterprises will yield the maximum return to the resources of family-type farms.

Studies of the entire farm business.

In manner similar to the foregoing, the studies of the Entire Farm Business may be put into three sub-groups as follows:

I. Cost-of-production studies: Projects designed primarily to determine by the cost-accounting method, or otherwise, the unit costs of each of the commodities produced on the farm.

Typical objectives are as follows:

1. To determine the labor and material requirements and costs of production for different enterprises.
2. To determine the cost of producing farm products and the influence of various factors on the cost of production in Illinois.
3. To determine the cost of producing the major farm products in North Carolina; to study the factors that influence production costs; to study the relationships between costs on different farms with reference to practices followed; to point out how information on costs may be of value to farms and for public purposes.

II. Farm analysis studies: Projects designed primarily to analyze and determine the relations between differences in the organization of the farms of an area and differences in incomes.

Typical objectives are as follows:

1. To determine the fundamental causes that contribute to success or failure in dairy farming in New Hampshire.

2. To determine the factors of organization and operation associated with farm income and labor earnings on small sugar cane farms in Louisiana.
3. To study farm management and farm practices in central Pennsylvania with a view to determining the relation between certain types of farming and certain management practices and the returns to farmers for their effort.

III. Reorganization studies: Projects designed primarily to develop forward-looking plans and indicate desirable readjustments on farms with specified resources.

Typical objectives are as follows:

1. To obtain basic data on dairying and other enterprises which can be used in planning the most profitable farm organization under varying economic conditions.
2. To obtain information that will enable us to determine through farm budgets the more profitable systems of farming. To obtain data that may be used in making profitable long- and short-time adjustments the better to meet changes in economic conditions. (Michigan)
3. To determine the unit quantities of labor, feeds and the other factors of production used in producing crops and livestock commonly grown in specific areas in Minnesota, to determine the most profitable method of growing these crops and of feeding and handling these classes of livestock under the conditions prevailing in the specific area, and to determine the kinds and amounts of the several crops and classes of livestock to combine for the profitable operation of farms.

The significant trend shown by this grouping, as indicated in the tables below, is the same as for the Farm Enterprise studies, that is, a very definite shift away from cost-of-production studies toward studies designed to develop forward-looking plans directly and determine desirable adjustments in farm organization. The only difference is that the shift is much more pronounced than in the case of Farm Enterprise studies.

NUMBER OF STATES REPORTING ENTIRE FARM BUSINESS STUDIES

	Cost of Production	Farm Analysis	Reorganization	Total
1927	20	19	9	31
1931	19	21	23	43
Increase	-1	2	14	12

NUMBER OF PROJECTS REPORTED IN ENTIRE FARM BUSINESS STUDIES

	Cost of Production	Farm Analysis	Reorganization	Total
1927	27	27	11	65
1931	23	35	36	94
Increase	-4	8	25	29

The trend indicated by the tables is further accentuated by the fact that, as was the case with some of the Farm Enterprise studies which have cost-of-production objectives, among the 23 projects in the first column which according to the statement of objectives were designed primarily to determine by the cost-accounting method or otherwise the production costs of each of the commodities produced

on the farm or in the area studied, were a number which had additional objectives representing a more direct attack on the effective utilization of the farmers' resources.

Finally, the rather intimate acquaintance of the writers with the status of farm management research in most of the state experiment stations and in the Division of Farm Management and Costs leads them to believe even that the foregoing analysis by project in terms of stated objectives and procedures over-emphasizes the place which studies designed primarily to obtain money costs occupy in the farm management research program of the country.

SUGGESTED PROCEDURES FOR SPECIFIC PROJECTS

(By J. D. Black)

The principal purpose of this report is to present a list of projects which are important in farm management research and to discuss method and procedure for them. The methodology applicable to some of the projects is discussed in considerable detail; the methodology for others, only in its general outline, and for a few others, not at all.

The list is not intended to include all possible projects that might have a place in a program of farm management research. Instead, it is a list of those projects which most of the members of the Special Advisory Committee on this report thought worth while discussing at this time. The principal criteria in deciding whether or not a project should be included for discussion were as follows:

- a. *Does it have significance from the standpoint of the needs of agriculture and the development of the science of farm management?* The projects of most importance from one or both of these standpoints have been relatively favored in the selection.
- b. *Does it need further discussion at this time?* Certain types of projects in farm management have been so widely used and frequently presented, and so little can be said concerning them that has not already been said many times, that it was not considered worth while to bring them up for discussion further than to cite references to literature upon them. Or if they have been taken up, it has been only for the purpose of presenting some new or less familiar phase of them.
- c. *Does it seem to be in line with developing trends in research in this field?* No important new or relatively unfamiliar type of project has been omitted because seemingly out of line with such trends. On the other hand, as between less important projects, some definitely in the path of current trends and some not, the preference has been given to the former; likewise for projects that the Committee might have been disposed to omit because already very familiar.

- d. *Does it stand out from other projects as a type, or does it closely resemble other projects?* An effort has been made to have all the different types of farm management research problems or of approaches to such problems represented by at least one project, rather than to include several projects much resembling each other.
- e. In addition to the projects satisfying the foregoing criteria, certain others have been included because they represent *new ventures in farm management research worthy of being given a trial.*

There will not be complete agreement among the farm management research workers of the country as to the relative merits of the projects that are presented. There is not complete agreement even among the members of the Special Advisory Committee. Some feel that the list of projects here presented does not represent all parts of the field, or does not represent them in the right proportions. Some feel that too many new and relatively untried projects are included. Others believe that some of the projects are too narrow in scope to warrant their consideration as separate projects and should have been included only as parts of broader projects. The selection of projects does, however, come as near as the Chairman and the Executive Secretary of the Special Advisory Committee could come to representing the majority views of this Committee.

Members of the Committee have differed in opinion most as to the desirable scope of a project. A large part of the research thus far done in farm management has been general in purpose and in type, covering many of the aspects of the farm business all in one project. In some of these projects, only the more general aspects have been included and these in a rather superficial, purely empirical way. This description fits especially the conventional farm business surveys that were so generally made in the period just before the World War.¹ One would expect this type of study to be made in the early stages of development of the science of farm management in a country. It represents a first look at the farm management of a region. It provides facts and descriptions that are very much needed when the first courses in farm management are being developed in the agricultural colleges of the region; and a first approach to stating a few relationships. For another part of these general-purpose projects, more detailed data have been collected for the whole farm business, sometimes by means of surveys, sometimes by means of records kept with varying degrees of supervision or assistance from visiting "route men." These have provided considerably more detailed facts and description of farm organization

(1) For summary of these, see p. 1285 of the 1925 Yearbook of the U. S. Department of Agriculture; also "Income Data from Farm Business Surveys" in the *Harvard Review of Economic Statistics*, November 1928.

and farm practices, which have been put to good use in teaching and in planning farm organizations in the region, and have contributed something further to the stating of relationships.

The argument most frequently advanced in favor of this general-purpose type of project is that they bring out all the facts and relationships that are really worth while. A much stronger and more valid argument, however, is that the farm business is an organic whole, and cannot be carved into parts and studied piecemeal.² The Committee recognizes the entire validity of this point of view, and has met it in various ways. In the first place, it has included a considerable list of projects which are comprehensive in scope. It has, however, tried to get away from making even these too general and indefinite as to purpose. (See Projects 1 to 6, 8 to 15, 21, 37 and 38.)

Most of the members of the Committee, however, hold to the view that when the whole farm business is studied at one time, it commonly proves feasible to include only its broader features, at least if the statistical method of analysis is to be followed. In practice, at any rate, the results obtained are only of broad general implication. The projects endeavoring to obtain detailed data for the whole farm business commonly prove in testing not to have provided enough detail really to answer the scores of specific questions for which a farm operator needs an answer; or to make possible the careful analysis required to reduce statements of relationship to definite quantitative terms. The Committee has therefore included a considerable list of projects which concentrate on some part, or group of related parts of the farm business, or on specific questions which need answers, or on particular relationships needing further testing and refinement, these projects including all possible of the particular data needed for analyzing these parts of the farm business, or questions, or relationships. (See Projects 16 to 20, 22 to 36.) The difficulty of needing facts as to the whole farm business in order to get a true picture of relationships is overcome in most of the projects by including the pertinent general aspects of the whole farm business as a background. Such projects therefore become a combination of comprehensive (but not general-purpose) studies, to provide the needed background, and of careful studies of a specific part or phase, or group of closely related parts or phases of the farm business, in order to get clear-cut answers to vital questions.³

(2) This point of view is widely held in Germany, and was well expressed by Dr. Immanuel Fauser of Berlin in the *Journal of Farm Economics*, Vol. VIII (1926), pp. 289-97.

(3) Compare U. S. D. A. Bulletins 341 and 1400, both of Chester County, Pennsylvania, one published in 1916, (Spillman et al) and the other in 1926 (Ezekiel), in order to observe the difference between the older general-purpose type of farm business study, and the newer type which includes the farm business as a whole only to furnish a background of analysis of particular questions, noting particularly Dr. Ezekiel's analysis of the dairy enterprise in the later study.

Provision is made, however, for detailed study of the farm business as a whole; but it is frankly recognized that the method of research appropriate thereto is the case method and not the statistical. One can, of course, unless the farming is too varied, as probably in most parts of the East, collect sufficiently detailed data on all aspects of enough entire farm businesses in order to make statistical procedure valid in analyzing them; but the expense would be very great, and probably not warranted in most cases.

The Committee has been particularly insistent that each project as presented shall have a clearly stated objective or set of related objectives; that is, that it shall be planned with the view to answering definitely conceived questions; that the objective of the project shall not be merely "to study" or "to survey" some area. Such questions may be stated in abstract general terms such as students of farm management as a science are wont to ask, such as the following, for regional studies of farm management:

What is the relation between system of farming and distance from market in this kind of an area? between soil types and systems of farming? between supply of family labor and systems of farming?

What rate of using fertilizer is most common in this type of area, and what are the reasons for this? Why the variations?

What factors account for the increasing use of tractors in this type of an area?

What are the trends in size of farm in such an area? and what are the reasons?

Can this type of region compete with Minnesota in producing butter?

Or such questions may be stated in their more definitely applied terms, such as these which an individual farmer who was contemplating going into dairying might ask:

What types of land are best to buy for one going into the dairy business? How located? What price should one pay?

What type of market should one seek?

Should one in the future buy milch cows or raise them? If one buys them, at what age?

What type of ration would prove most economical in the area, and at what rate should it be fed?

What parts of the ration should be produced on any farm? and what parts bought?

What rotation system would prove most advantageous in this type of land?

What other products and sources of income should be combined with dairying? In what proportion?

What hired labor would be needed, if any?

How many horses would be needed?

For farmers already in the dairy production in the area, the form of these questions will change somewhat, but not their nature.

The Committee also inclines toward the *analytical* as distinguished from the merely *empirical* type of project; toward projects that attempt to trace relationships back to their prior causes, or "antecedent probabilities", as Karl Pearson would say, as distinguished from projects that stop with merely finding that certain things occur together or are associated.⁴

Consideration of different methods of collecting data, e.g., the account book method, the survey method, and the mailed questionnaire method, and their relative merits, occupies only a small portion of the discussion of the different projects. This phase of farm management research has been covered at length in the report on *Research Method and Procedure in Agricultural Economics*, in numerous articles in the *Journal of Farm Economics* and in various recent books. In most of the project outlines, the emphasis is placed on methods of analysis and interpretation of results.

The projects are not arranged into the groups used in the discussion of recent trends on the pages just preceding. Some of them could hardly have been classified into the groupings used there. A different basis of classification would have to be used in order to provide a place for a project to determine the most desirable farm layout, or to devise the systems of records and accounts for use by farmers, or to determine the most economical use of the family labor supply, or to measure the influence of human factors on success in farming, or to study the economy of large-scale farming. Yet projects such as these have a place in a complete farm-management research program; and are listed and discussed in this report.

The users of this report must not look upon it as outlining a program of research for any institution. Such programs must be adapted to each particular situation. Some institutions may be just beginning their farm management research; others may already have mapped out their type-of-farming areas and have made comprehensive studies of the important types of farming. The needs of the time should figure in an important way in choice of projects; the type of personnel available to conduct them; and the funds available.⁵

This report must to a considerable extent reflect the viewpoints of the Committee, and of those most immediately responsible for it.

(4) See discussion of this difference in *Research Method and Procedure in Agricultural Economics*, or in Pearson, *Grammar of Science*.

(5) "There is one point of view which I do not find developed anywhere in the outline and that is that applied farm management research must necessarily be a continuous rather than an intermittent or sporadic process. Once those areas or sets of homogeneous conditions have been determined which give rise to fairly homogeneous types of farming, then continuous farm management series must be maintained with relation to the dominant types appearing under these conditions. This idea has not permeated the minds of extension or research administrators, and only a few agricultural economists have thoroughly grasped the notion." (I. G. Davis.)

However, an effort has been made by comments and footnotes to indicate the differences of opinion that exist with regard to various points in several of the project statements. Even if they serve no other purpose, the statements on controversial points may stimulate discussion and thus help to clarify them.

PROJECT 1. Type-of-Farming Area¹

OBJECTIVE: To determine the boundaries or limits of the type-of-farming areas in a state or region.

(By F. F. Elliott and H. R. Tolley.)

In formulating a specific statement of the objectives and the procedure in this project, it is essential at the outset to have clearly in mind the meaning of the terms "type of farming" and "type-of-farming area".

Type of farming. As used in this discussion "type of farming" is a term descriptive of the system of farming found on a group of farms having a high degree of uniformity in the kinds, amounts and proportions of the crops and livestock handled and in the methods and practices followed in production. The members in this group can be rather widely scattered geographically; all that is necessary is that they closely resemble each other so as to constitute a distinct type. From this definition it is apparent that a particular type of farming will be identified by the form which the farm business takes with respect to size, productive factors used, lines of production carried on, and the general policy adopted in conducting the business. (See *Economics of Farm Organization and Management* by C. L. Holmes, 1928, Chapter IV, "Types of Farming".)

Type-of-farming area. When a type of farming is fairly well concentrated in one area, so that it is the prevailing or dominant type in that area, usually associated with a set of reasonably homogeneous natural and economic conditions occurring throughout a definable geographic area, the area so characterized may be called a type-of-farming area.

With these concepts of *type of farming* and *type-of-farming area* in mind, we may say that the objective in this project is to subdivide a state or region or the nation into a number of areas, in each of which there is a considerable degree of uniformity in the types of farming.²

The size of such an area, and hence its boundaries, will depend to a considerable extent upon the precision in the measure of the "type

(1) One needs to read Projects 2 and 3 along with this project, because these discussions contain analysis that is also important for this project, and because in a type-of-farming research program all three projects must be closely integrated. They will frequently be combined.

(2) In this discussion, a "system of farming" is not called a "type of farming" unless it is repeated enough times, with sufficiently close resemblance, within an

of farming" adopted in the project. Using a very broad classification, Dr. O. E. Baker has divided the United States into twelve regions which he calls "agricultural regions", but which he might have called type-of-farming regions. "The East is divided into eight areas (excluding the forest and hay region) on the basis of the dominance of a certain crop or kind of farming which is the result largely of latitude and temperature conditions. The West is divided into four regions on the basis of the use of the land for grazing or crops, which is determined largely by altitude and rainfall.³ Dr. Baker conceives the dividing line between the East and West to be approximately at longitude 103. The agricultural regions in the East are:

1. The hay and dairy region.
2. The corn belt.
3. The corn and winter wheat belt.
4. The Middle Atlantic trucking region.
5. The cotton belt.
6. The humid subtropical crop belt.
7. The hard winter wheat region.
8. The spring wheat region.

The four agricultural regions of the West are:

1. The grazing and irrigated crops region.

area not too extended, so that it can be said to occur as a *type* in that area. Of course, it may be, and commonly will be, only one of a number of *types* that are found in this area. If the area has no one type which stands out as dominant, obviously it could not be part of any type-of-farming area as this latter term is here defined, if the definition were vigorously applied. In practice, when such studies are made and the foregoing definitions are followed, the whole territory is likely to be put in one type-of-farming area or another, the choice falling to the type which has the most representatives whether it is really dominant or not. Such definitions as these cannot be applied with any precision—the degree of dominance of type of farming required is uncertain; likewise the degree of resemblance and the number of times the system of farming must be repeated to make a type of farming; and the extent of the area within which the repetitions occur. But in practice in any given situation, some reasonable interpretation of the definitions is possible.

There is also another definition of type-of-farming area, probably not so commonly accepted as the foregoing, which does not make dominance of one type of farming a necessary criterion of a type-of-farming area, but instead merely a reasonable amount of continuity in the *pattern* of types of farming. This concept follows that of the anthropologist's concept of a "cultural pattern". This is easier to apply to an area such as parts of New England where the most characteristic feature of the agriculture is a mixture of several types of farming, perhaps even a prevalence of farming systems so heterogeneous that farming types as above defined are difficult to establish. Nevertheless, a *pattern* is there. Dr. J. D. Black prefers this concept of a type-of-farming area. One does not need to do violence to such a concept in order to apply it to such areas and still include all of them in one type-of-farming area or another. For some purposes, it is not necessary or desirable to put all of a region into some type-of-farming area, but instead only those portions of it which are clearly dominated by one type-of-farming, or type-pattern, leaving the remainder as nondescript or intermediate or twilight zone area. (EDITORS.)

(3) Baker, O. E., *Graphic Summary of American Agriculture*, Miscellaneous Publication 105, United State Department of Agriculture, Page 4, Fig. 1.

2. Columbia Plateau wheat region.
3. Pacific subtropical crops region.
4. North Pacific forest, hay and pasture region.

In addition to these agricultural regions, Dr. Baker has designated two small regions, one in the northwestern part of the country and the other in the northeastern part, as Forest and Hay regions. In these regions there is so little farming that they can scarcely be called agricultural regions.

As an example of the results obtained when a finer classification of type of farming is used, the study conducted in Nebraska by Hedges and Elliott may be cited (see Project 4-b),⁴ in which the state of Nebraska is divided into nine type-of-farming areas as follows:

1. Northeastern intensive wheat producing area.
2. Southeastern general farming area.
3. Southern cash grain and livestock area.
4. Central corn and livestock area.
5. Central hay and livestock area.
6. Sand hill cattle ranching area.
7. Southwestern wheat area.
8. High plains small grain and grazing area.
9. Irrigated area.

Obviously a *considerably higher* degree of uniformity prevails in one of these areas than in Dr. Baker's regions. This shows that the type-of-farming areas which will emerge from a type-of-farming study will be determined by the degree of uniformity desired within the area as well as by the precision used in classifying the types of farming prevailing. The finer the classification of type and the greater the degree of uniformity within an area demanded by the investigator, the smaller will be the resulting type-of-farming areas, and the greater the number. Inasmuch as no two farms in the country are exactly alike, the classification could be made so fine and so high a degree of uniformity of type within an area could be insisted upon, that the investigator would come to the conclusion that no dominant type existed in any area, and hence that the type-of-farming areas are never definable. But such refinement would serve no purpose. It is doubtless true, on the other hand, that in some parts of the country, as for example, where soil types vary greatly, underlying conditions will be so heterogeneous that many large differences will be found, in even a very limited area, and no single type will be dominant; and under such conditions and for such regions, it is not worth while to attempt to carry this sort of a project very far.

(4) Hedges, Harold and Elliott, F. F., *Types of Farming in Nebraska*, Nebraska Bulletin 244.

Value and uses of project.

This project is logically a first step in farm management research. It gives a bird's-eye view of the field and provides a background of information essential to a correct understanding and interpretation of the economic problems of the farmer. It furthermore affords the researcher a means of orienting himself in the agricultural problems of his state or region and of studying them in their local setting.

One of the first problems which the research man has to face is that of selecting the area of study and of defining its limits. He should and does attempt to free it, in so far as possible, of unrelated and extraneous factors, thus narrowing the field of study to its essential and related elements. The differentiation of the agriculture of a state or region into type-of-farming areas within which there is a high degree of uniformity in the enterprise combinations and practices and in the conditions of production, obviously is an important step in this direction.

It not only provides the research man a basis for defining his universe, and hence for sampling, but affords the extension man a better idea of the limits within which specific recommendations may apply. Broad generalizations are usually dangerous, and just how questionable they may be when made for the agriculture of a state or region as a whole is emphasized in the variations disclosed by a project of this kind.

Our basic statistics, in the main, relate to political units such as counties or townships or combinations of the same. In many respects these data would be of more significance if they related to type-of-farming areas. This is particularly true for much of our crop and livestock estimate data. These data not only would be more accurate but would be more usable and of more significance to research workers in geographic and other problems, if they pertained to type-of-farming areas.

Similarly, studies made with the view of obtaining methods and practices from which general standards are to be derived are likely to be more representative if they are confined to type-of-farming areas. The same is true of elasticity of supply and income studies. The significant price-supply relationships are likely to be more realistic and trustworthy if determined for local areas. Income studies showing returns to farms of the same or different types also would be more representative and indicative of the actual situation than would be true if all types were thrown together into a composite group.

The factors influencing types of farms, and defining type-of-farming area are of course well recognized. What is not clearly understood is the way in which the natural science factors—physical and biological—and the social science factors—economic no doubt predominating—interact upon each other. The boundary lines of many of the type-of-farming areas follow sharply certain lines of

natural differences—such as differences in topography and vegetation in the Red River Valley of Minnesota and the Dakotas; but others ignore such lines to a greater or less extent; or the types of farming within such lines of sectional difference shift from decade to decade. These interactions of natural and social factors will be clarified by research following the lines of this and several succeeding projects.

Procedure.

The type of analysis called for in arriving at conclusions as to the boundaries of type-of-farming areas is essentially that of "qualitative description" described by Dr. E. G. Nourse in *Research Method and Procedure in Agricultural Economics*. Dr. Nourse says "two general orders of qualitative description in the investigational field may be differentiated. The first may be called factual description and the second analytical description." Both are used in a project of this type—factual description in portraying the facts concerning the various items by means of maps, charts, and otherwise, and analytical description in studying the relationships between the various items and formulating a judgment as to the location of the boundaries between type-of-farming areas.

But it is qualitative description of the geographic type as discussed by Dr. C. L. Holmes in the same report. Dr. Holmes suggests that geographical description has three phases—descriptive, graphic and synthetic. Work on all three phases is called for in this project. The last phase is represented by the drawing of boundaries of areas. In Project No. 3, this description is followed by analysis of the reasons for the existence of the types of farming in the area and for the historical changes that have occurred.

In determining the type-of-farming areas in a region, the approach has been from the general to the specific situation. The agriculture is first studied by the major enterprises from the standpoint of their geographical distribution. The unit used, whether county, township, or other, will be determined by the character of the data available. Data by units as small as townships should be used if available. By means of hachure maps and dot maps, the centers of production of each product can be indicated, and its relative importance in each part of the region with respect to other competing, complementary or supplementary enterprises determined.

In determining these relationships it is necessary to relate each enterprise to some base which is reasonably stable from area to area, and which will give coefficients that are comparable. (See discussion of the comparability of such coefficients in *Research Method and Procedure in Agricultural Economics*.) Various bases may be used, including acres in farms, acres in crops, acres in crops and pasture, and acres in land area, and the acreage or number of each enterprise may then be expressed as a percentage of this base. The base should show the exact situation obtaining on the farms as a whole

in so far as possible, and at the same time should indicate the relative importance of each enterprise in different parts of the region under study. In an area where there exists a high degree of uniformity in the physical and biological conditions, township or county coefficients will be strictly comparable and the relative importance of the different enterprises will be clearly indicated. In regions where such homogeneity does not obtain, however, the problem is more difficult. If crop area is used as a base, for example, the importance of a particular crop or class of livestock is over-emphasized in those counties or areas in which the crop acreage makes up only a small portion of the farm area, especially where a large part of the farm area is in pasture. The same difficulty arises under certain conditions if farm area is used, particularly in a range country where the area in farms is considerably short of the total land area. Under such conditions it may be well to shift from the farm-area basis and use crop area plus pasture or total land area instead. However, total land area is not a reliable base under most conditions, since it includes land in cities, roads, streams, swamps, bluffs, etc. There obviously is no point in including land used for such purposes in determining the relative importance of different lines of agricultural production.

Hence the base used must be selected in the light of the conditions existing in different parts of the state. If the difference in type is one of degree rather than of kind, the same base probably can be used throughout; but if the other way around, it may be well to use more than one base. Furthermore, under conditions where both field and truck crops are grown in varying amounts, it may be necessary for comparability to use some unit other than area as a base if the relative importance of each enterprise is to be shown. The relative importance of tobacco and corn, for example, either from the standpoint of labor inputs or from the standpoint of income, will not be shown by relative acre-to-acre comparison. There is a further discussion of this point under "Measures of Farm Type" in Project 2.

Having reduced the various enterprises in each county or township to comparable units or coefficients and shown their geographical distribution in this way, the next step is to group the townships or counties which have about the same kind, quantity, and proportion of the different crops and livestock. This is usually accomplished graphically by means of bar charts, each bar representing the relative importance of each enterprise in the particular township or county. (See, for example, Figures 15 and 16, Minnesota Experiment Station Bulletin 257, *Types of Farming in Minnesota*, by L. F. Garey.) This grouping gives the first approximation to the type-of-farming areas. Inasmuch as several enterprises are usually found in the same area, it is not possible to group on just one enterprise, but all of them have to be taken into

consideration. In actual practice the counties or townships are thrown together which appear to be alike in the major portion of their enterprises. Thus type-of-farming areas established in this way are based on the particular combination of enterprises which is dominant in the areas as shown by the county or township totals. This fails to indicate other combinations of enterprises found in the area, and to that extent fails to identify all the types of farming prevailing. These are taken care of, as shall be shown presently, in the analysis of the internal organization of the farms in each area.

Instead of the collective approach using the data showing acreages and livestock numbers by counties or townships, an alternative method would be to start with the individual farm as the point of departure. The farms in a county, state or region under this procedure would first be classified by type as suggested in Project 2. Areas or regions would then be delimited on the basis of the proportion of the total farms which were of a given type. The number of areas which would result under such a scheme obviously would be determined by the amount of dispersion in type which would be permitted within a type-of-farming area.

If a type-of-farming area is defined in the extreme sense of including only one type of farming, then the classification will be practically impossible to make, since there are but few areas of any appreciable size in the United States which have only one type of farming. If a type area is defined, however, as one in which 75, 50 or 40 percent of the farms are of one type, then it should be possible to indicate fairly easily the important type-of-farming areas in most states or regions. This method of approach is being tested out in a study now under way. The schedules of the 1930 Census of Agriculture are being used as the basis of classification.

In most states where data are available only by counties, there frequently will be found certain counties in which the farming types are so mixed that it is difficult to classify them with any particular group. This variation within the county is reflected in the county totals which fail to correspond to the totals of counties contiguous to them. Upon examination it usually will be found that a fairly distinct break in the soil type, topography, or other physical conditions exists within these particular counties. Where such is the case there seems ample justification for cutting across county lines and letting the line of demarcation between areas follow the line determined by the nature of the physical factor even though data are available only by county totals. It cannot be assumed, however, that just because the county averages for a group of counties are very similar that the basic physical and economic conditions determining these averages are uniform through this group of counties. It may be that each of these counties has so wide a range in its physical and economic conditions that many small type-of-farming areas might be outlined if township data were available. Further,

these type areas may repeat themselves in each county in such a fashion that the county averages are very similar.⁵ In any event, the lines of demarcation may not be so sharp and distinct as shown on a map. There is more likely to be a gradual shading from one area into another.

In states where these studies have been conducted, there has been found to exist a rather close correspondence between the physical conditions and the resulting types of farming. Certain crops, because of their physiological make-up and growing habits, manifest marked preference for certain soil types and climatic conditions. For this reason such crops usually will be found associated with these physical conditions. Since the effects of these physical factors are reflected in the relative yields and variability in yields of crops, these probably most of the time largely determine on the physical side which crops are given the preference.

The nature of the cropping system in turn is likely profoundly to influence the livestock enterprises associated with it. Cropping systems producing large quantities of concentrated, fat-producing feeds, for example, are likely to include livestock of the meat producing type—whereas those having more hay, small grain, and pasture are more likely to include more dairy cows. Likewise, a large amount of non-tillable pasture land may force a type of farming in which livestock plays a greater part than would be true were there less permanent pasture to utilize.

The analysis of physical factors that is needed for correctly locating the boundaries and limits of type-of-farming areas is related in many respects to the analysis called for in Projects 1 to 10 in the report in this series on research in Agricultural Land Utilization. The principal difference in approach is that in the land utilization projects the aim would usually be to explain the relationship between the natural factors such as soil type and precipitation and the utilization of land as between major uses, such as crops, pasture and timber, while in a type-of-farming study the aim would be to use the analysis of physical factors as an aid in determining the boundaries of an area within which a particular type of farming is dominant and within which a particular type is likely to remain dominant for some time.

In addition to the existing physical and biological factors, trend movements or historical sequences in systems of farming must be considered in determining type-of-farming areas. Two areas at a particular time may have the same proportion of their farm area in the same crops and livestock, yet be moving in the opposite direction. On the other hand, the two groups may be moving in the same direction, yet one group be lagging considerably behind the other. By charting and determining the trends taking place in the different

(5) *Cropping Systems in Iowa, Past and Present*, Edgar B. Hurd, Iowa Experiment Station, No. 268, p. 152.

crops and livestock in each county or township, a measure of the situation in each area is obtained. Two areas having the same physical conditions are likely to have the same historical sequence of systems of farming. Hence these two approaches supplement each other. (See Project 3 for further discussion of this. Some of the methodology there presented may need to be used in this project.)

The effect of economic factors is more difficult to determine. Within the confines of a single state, the variations in economic factors are not likely to be very pronounced, except as influenced by production of perishables for local markets. This is particularly true as between contiguous areas. The growth of urban centers, improved transportation facilities, development of new machines and technique and the like, however, may affect the types of farming in different parts of an individual state in a different way, and the extent to which this is true must be given weight when determining type-of-farming areas.

To recapitulate, type areas are first approximated by grouping counties or townships in which there is a marked similarity in the dominant crop and livestock enterprises. These areas are then refined and tested in the light of the physical, biological, and economic conditions prevailing in each area and in the light of the historical shifts which have taken place in the various crop and livestock enterprises. Thus each area when its boundaries and limits are finally determined will be an area within which the physical and biological factors influencing type of farming are more or less homogeneous, and within which trends of production will have been similar, and a single type of farming is dominant.

PROJECT 2. Classifying Farming Types.

OBJECTIVE: To classify and describe the types of farming in an area or region at a particular time.

(By I. G. Davis and F. F. Elliott.)

Stated in more detail, the objectives in a project of this type are (1) to classify the enterprise organizations of all the farms in the area into type-of-farming categories, (2) to describe the enterprise organization of each category and (3) to determine the proportion of the farms of the area belonging in each category.

Scope of project.

This project, limited to the classification and description of types of farming, would be a logical sequel to Project 1 in many areas, and Project 3, designed to account for the changes which have occurred in the types of farming in an area in the past and for the existence of the types found at a particular time, may be looked upon as a

logical sequel to this project in many areas. However, this project, while closely related to Projects 1 and 3, is distinct from them and can be carried on separately. Project 1 is concerned with finding the boundaries and limits of areas, and Project 3 is concerned with accounting for changes that have occurred in the areas.

This project can be limited to a type-of-farming area, or it can be expanded to cover an entire state or a broader region containing many dissimilar types of farming. The project, if repeated from time to time in a given area, would furnish an excellent basis for studies of the kind outlined under Project 3. In fact, the historical changes which have occurred in the types of farming in an area can be portrayed and measured accurately only when this project has been repeated for two or more different periods of time.

Measures of type of farming.

One of the most essential features of this project is the development of the measure of type of farming to be used. No single measure of type that will be satisfactory in all areas and regions has yet been developed, or is likely to be developed. The measure to be used must be chosen with careful consideration of the character of the enterprise combinations found within the scope of a particular study. It should if possible fulfill the following requirements:

1. It should be of such a character as not to include in the description of the type the element of efficiency of management of capital, of land, or of labor. The concept of type is distinct from the concept of efficiency.

2. The bases or criteria of classification should be entirely independent of the characteristics of the natural and economic environment. That is, the classification should be based on internal characteristics of the farm business organization. If this rule is followed, the association between types of farming, or farm-type classes, and the characteristics of the environment, such as soil type or location, can be studied without falling into the fallacy of circular reasoning.

3. Its use should give a result that is roughly representative of the extent of the gross income from each enterprise or source of income and of the size of the farm business. (Income as here used includes not only cash receipts, but also the value of the farm goods consumed by the farm family. It may be desirable for certain purposes, however, to utilize the same data for classifying farms in accordance with the sources of the cash income rather than of the gross income.)

4. It should be capable of application to any important combination of enterprises likely to be found within the universe of farms to which it applies.

5. The measure of type should, if possible, be of such a nature that it is capable of statistical treatment. The data should be easily

and inexpensively attainable and the statistical procedure simple and easily applied.*

In areas such as parts of the Great Plains, where the business consists principally of producing staple crops of similar intensity with relation to proportional acreage distribution, size of the farm in acres and the acres devoted to each crop together with the number of livestock are a satisfactory basis for type determination and classification.

On the other hand, in an area where crops of varying intensity of labor and capital input per acre are produced, accompanied by a diversity of non-crop enterprises, the use of proportional farm acreage distribution and number of livestock may prove an awkward, or even unreliable, measure of type. In some parts of the country, particularly in regions not too distant from the industrial centers of the northeastern United States, many enterprises enter into the farm business for which neither acreage nor number of livestock is an accurate measure of relative size, either in comparison with other enterprises on the same farm, or with similar enterprises on other farms.

A comparison of the measure of type which has been utilized in studies in the Corn Belt and the Great Plains with the measure which is being used in a study in Connecticut, illustrates the need for this adaptation of measures of type to the area or region being studied.

Corn Belt and Great Plains.

In a type-of-farming area in southeastern Kansas (See *Types of Farming in Kansas* by J. A. Hodges, F. F. Elliott and W. E. Grimes, Kansas Experiment Station Bulletin 251), the size of farm in acres and the proportion of the total farm acreage in corn—the dominant crop—were used as the primary measures of farm type. For example, one type of farming (or “typical farming system,” the designation used in the bulletin) in the area is classified as: 80-acre farm with 10 to 29 acres of corn. Another is: 160-acre farm with 23-35 acres of corn. Another is: 240-acre farm with 40 to 75 acres of corn. For the more common sizes of farms in the area, several types of farming (or typical farming systems) are identified and described. Below is a table showing the typical farming systems identified on the 160-acre farms of the area, and the relative frequency of each type, together with the modal cropping system and livestock system for each type.

*“I do not agree with the authors on Point 1. I do not see how the element of efficiency can be kept out entirely from a study of farm type. Type may be significantly influenced by present technique or future changes in technique and technique itself is intimately related to efficiency of production.

Points 4 and 5 referring to Davis' measure of type are difficult of realization. It seems to me that gross farm income comes closest to these requirements but of course is not perfect. However, I think it is much superior to the standard labor requirement which he has developed. It seems to have worked fairly well in Elliott's census analysis and I can personally see no adequate reason for the rather highly artificial measure which Davis recommends for use in the North-eastern States.” (C. L. Holmes.)

**TYPICAL FARMING SYSTEMS ON 160-ACRE FARMS IN AN AREA
IN SOUTHEASTERN KANSAS IN 1925**

(Adapted from table on p. 59 of Kansas Experiment Station Bulletin 251)

	Typical farming systems			
	8-20 acres corn	23-35 acres corn	36-47 acres corn	50-70 acres corn
Relative frequency of type	Percent 13	Percent 37	Percent 24	Percent 18
Cropping systems :	Acres	Acres	Acres	Acres
Corn	16	30	40	60
Oats	0-20	10	10	0-25
Barley				
Wheat				
Flax		0-15		
Sorghum	15	10	10	0-25
Tame hay (1)	10	10	25	20
Wild hay	25	15		
Other crops				
Pasture	80	70	65	50
Other land	5	10	10	10
Livestock system:	Number	Number	Number	Number
Horses	5	6	6	6
Cows	5-10	5-12	5-10	5-11
Cows milked	5-9	5-10	4-9	3-9
Other cattle	5-10	5-12	5-10	5-11
Sows	0-3	0-4	0-4	0-5
Sheep				
Poultry	75-150	100-150	100-175	75-150

(1) About 40 percent of the hay is tame; of this, probably three fourths is timothy and clover. Alfalfa is found on some farms ranging usually from 2 to 5 acres.

Connecticut

The conditions in eastern Connecticut make the problem of classification more complex and make it most desirable that some common denominator be found for the various farm activities and enterprises, not only as a basis for classification, but also to make the data descriptive of the various farms capable of easy statistical manipulation, in a form where all farm enterprises may be measured in terms of the same unit of measure. Some of these conditions are enumerated below:

1. Outside labor constitutes an important part of the business on many farms, and certain economic patterns are preeminently non-agricultural.

2. Forest products are a secondary source of income on practically all farms and the extent of the activity and the income associated with it are largely unrelated to acreage or to any other easily measurable factor.

3. A variety of intensively cultivated cash crops is produced in the region, the income from which in some cases is unrelated to the acreage involved.

4. A number of kinds of hay are produced, with greatly varying yields and significance in the farm business.

The man-labor requirements of the various enterprises constituting the organization have proved to be the most promising of the measures which have been considered. In applying this measure, the average man-labor input per unit of each enterprise has been computed on the basis of the best data available for the area, and then the number of units of this enterprise on each farm multiplied by the average man-labor input per unit (productive man-work unit.)¹ The following shows a farm business which has been reduced to a basis of productive man-work units thus computed:

DAIRY					Acres and No.	M.W.U.	Percent of Total
Grass Hay Bought.....	Sold.....	Rented.....			11	11	
Clover, Alfalfa.....					0.0		
Millet, Grain Hay.....					2.5	21	
Corn for Silage.....					0		
Corn for Grain.....					1	36	
Dairy Cows.....					9	126	
Other Dairy Stock.....					2	8	
TOTAL						202	55
POULTRY							
Hens.....					75	19	
Other Poultry.....							
Chicks Raised.....						6	
Eggs Incubated.....							
TOTAL						25	7
VEGETABLES							
Potatoes.....					$\frac{1}{2}$	6	
Sweet Corn.....					$\frac{1}{2}$	10	
TOTAL						16	4
Apples—Bearing.....					1 (10)	10	3
Non-Bearing.....							
FOREST PRODUCTS							
Cords of Wood Cut.....					50	75	
1000 ft. Timber Cut.....					1	1	
TOTAL						76	21
LABOR RECORD—MONTH'S WORK							
	On Farm	Off Farm	Kind of Work	Eqpt. Used			
Operator	10 $\frac{1}{2}$	1 $\frac{1}{2}$	Team			38	
Wife	0						
Children under 16	0						
Boys over 16	0						
Father (1)	12						
(2)							
TOTAL OFF FARM						38	10
Labor used in Marketing Products				Hours per day	Length Period		
Method of Marketing Milk.....							
Forest Products.....							
Vegetables.....							
Poultry.....							
TOTAL						0	0
GRAND TOTAL						367	100

(1) See, *Farm Management* by G. F. Warren, pp. 350-353; and *Storrs Experiment Station Bulletin No. 127*, pp. 59 and 60.

Total man-work units become the measure of size of business and the man-work units per enterprise and the percentage which they are of the total, together with any other significant facts of the business, become the measure of type to be used in classification.

This measure in type may be considered as simply a refinement of the measures described above which have been used in the Corn Belt and Great Plains. It takes the additional step of multiplying acres, number of livestock, days of outside labor, cords of wood cut, etc., by a series of conversion factors which represent average labor inputs per acre, per head of livestock, etc. In testing the validity of this classification, an attempt was made to establish the relationship between these representative labor inputs and the extent of the gross receipts from each source. If conditions are normal, that is, if they represent long-time conditions for the average farmer, labor inputs would theoretically be representative of net income provided the conditions of labor and technology among the several enterprises are fairly similar.*

A high correlation between labor inputs in a particular enterprise and gross income from that enterprise on a number of farms may be expected to appear and does appear, the deviations from the line of regression being accounted for by the differences in efficiency in the operations and management of the several farmers.²

If further study substantiates the hypothesis that a certain level of efficiency tends to characterize the operation of each of the several enterprises of a given farm, then two conclusions follow from this and the foregoing paragraphs:

*I do not agree with this statement. (C. L. Holmes.)

(2) Comments by F. F. Elliott:

These deviations will also be due in part to the degree of mechanization practiced and by the extent to which actual labor inputs on the individual farm vary from the group average input used. To the extent that mechanical power is substituted for manual labor, productive man-work units will not measure accurately the size of business; nor will man-work units per enterprise in relation to total man-work units on all enterprises measure accurately the type of farming. Furthermore, this measure has an element of efficiency in it. The man-work units for the same enterprise will vary widely on different farms in the same area and even on the same farm in different years. The standard error of any average of man-labor inputs per acre, per head of livestock, etc., consequently will be high. Although the same average is applied to the various farms as a constant conversion factor in computing total man-work units per enterprise or per farm, this in itself does not eliminate the element of efficiency which will remain in the average; that is, the average is high or low depending upon the relative efficiency with which the bulk of farmers conduct each particular enterprise.

Another difficulty with the use of the measure has to do with the question whether or not the same farmer will be equally efficient in conducting the various enterprises on his farm. If, for example, he is a very efficient dairyman and is a decidedly less efficient poultryman or tobacco grower his total man-work units per dairy cows handled will be low; whereas his man-work units per hundred hen or acres of tobacco handled will be high, that is, above the standard or average derived from a study of surrounding farms. Obviously the classification of this farm based on the average for the group may be in error to the extent that this is true.

1. Average labor inputs under the conditions assumed above, are a good measure of the relative size of the same enterprise on each of a large number of farms.
2. A schedule of the labor inputs of each of the enterprises in a farm business and of their percentage relationships to each other and to the total may be used as a basis for farm classification.

This gives us a basis of classification (1) related in an approximate quantitative way to sources of gross farm income, (2) from which the factor of efficiency has been eliminated, (3) which is capable of statistical treatment, and (4) which is capable of adaptation to the great variety of enterprise combination found in Eastern Connecticut.

On the basis of an intensive study of a sample of 100 farms for which complete income data were available in an area in eastern Connecticut and from a type-of-farming study in the town of Woodstock, a definite classification has been set up which it is expected will be applicable to farms in the eastern Connecticut area from which the sample was drawn. It is, of course, possible that other types not included in this classification will appear as the organization of more and more farms is examined. The schedule follows:

I. A specialized dairy farm is one in which dairying is the major enterprise with no secondary enterprise of significance from the standpoint of cash receipts.

Secondary enterprises have been found to lack commercial significance under the following conditions:³

1. When comprising less than 25% of a total business of 151-200 productive man-work units.
2. When comprising less than 20% of a total business of 201-300 productive man-work units.
3. When comprising less than 15% of a total business of 301-500 productive man-work units.
4. When comprising less than 10% of a total business of over 500 productive man-work units.

II. A dairy-combination farm is one which has a larger percentage of productive man-work units in dairy than in any one other enterprise, with one or more secondary enterprises comprising percentages of the total farm business above the limits set for the specialized dairy farm. There may be any number of dairy-combination types, such as dairy-poultry, dairy-vegetables, dairy-apple, or dairy-mixed (dairy-poultry, dairy-vegetables-outside labor, etc.).

III. A combination-dairy farm is similar to a dairy-combination farm, but with dairying as the secondary or one of the secondary, rather than the major farm enterprise. There may be any number of combinations just as in the case of the dairy-combination type.

(3) This schedule is drawn to eliminate from consideration as secondary enterprises those enterprises which produce products for family use only or which produce a small volume for sale to neighbors. The secondary classification is therefore based on commercial product rather than gross product.

To determine when the secondary enterprises should or should not be included in the type description, a study was made to determine approximately what the size of the enterprise, as measured in productive man-work units, should be before it would be of significance as a source of cash receipts to the farm. The effect of setting different percentage limits for secondary enterprises in businesses of different sizes is to include the secondary enterprise in the type description only when it is large enough to be an essential part of the commercial farm operation.

IV. A non-dairy farm is one on which dairying constitutes a portion of the farm business falling within the limits set for other enterprises in respect to the specialized dairy type. A few farms such as specialized apple, vegetable and poultry farms and combinations between these types are found in the Eastern Highland section, although this study included farms of the dairy types only, and classified the farms by the method outlined for dairy farms.

In addition to the above classifications two other important primary types were identified.

V. Residential farms—farms having less than 50 productive man-work units of business, no significant attempt at farm operation for any productive purpose being attempted.

VI. Part-time farms—farms having between 50 and 150 productive man-work units of farm enterprises. Frequency distributions of productive man-work units on eastern Connecticut farms give a very distinctly bimodal curve. Between 50 and 150 productive man-work units are found large numbers of places in which the dominant source of income is outside the farms which carry on some farming for sale or family maintenance.

Classification of size of business:

1. One-man farm—less than 1.3 men per farm.
2. One- and one-half man farm—1.3 to 1.8 men per farm.
3. Two-man farm—1.8 to 2.2 men per farm (Includes both 1.8 and 2.2).
4. Over two-man farm—farms having more than 2.2 men per farm.

Whatever measure of type is used in a study, great care should be exercised to avoid classifying as of the same type, farms which may appear similar as a result of superficial analysis, but which are essentially of different type. For example, in areas where both butter and market milk are produced, a measure of type based on number of dairy cattle may show the farms to be of the same type, whereas from the standpoint of income and interrelationships between enterprises these farms may be essentially different. Likewise farms which specialize in the production of certified seed will be different from farms producing the same product for feed, although on an acreage basis they may appear the same. Thus various specialized methods of production or marketing may seem to indicate the desirability of sub-division of type. The extent to which this is carried must be left to the judgment of the investigator. In general, it should be recognized that a simple classification is to be preferred to a complex one.

As indicated above, the use of the productive man-work unit as a measure of type must be limited to enterprises throughout which the conditions of the use of labor are fairly similar. If, for instance, a portion of the farms of a given type are highly mechanized and others not at all, or if some employ considerable amounts of gang labor while others do not, it is apparent that labor input may be dissimilarly related to gross income on these farms apart from any elements of efficiency involved.

If it is desired to use the productive man-work unit under these conditions, the problem may be met by sub-classification by degree of mechanization or by introducing a factor to take account of the degree of mechanization. Farm type classification, however, cannot usually be profitably carried to a degree of refinement which warrants any great extension of this procedure.

Sources of data.

Where farms are not laid out by townships, ranges, and sections, as is the case in eastern United States, it is impossible to use individual census schedules and to find the location of the farm being studied. With the diversity of environmental conditions occurring in the East, practically any study of farm classifications involves the association of the different classes with the characteristics of the environment. In order to use individual census records it would be necessary to secure the names of the farmers associated with each record and the location of each farm on the base map. Census regulations up to the present time do not permit such a procedure.

The classification of farms, then, under Eastern conditions must be based on primary data secured directly by the research worker or his agent. This involves the formulation of a field schedule, visiting of farms to secure the requisite data as to acreages, number of head of livestock, outside labor, etc., and the problem of sampling.

It is sufficient for the purposes of a study of this character to take the farmers' estimates as to acres of crops and number of head of various kinds of livestock. The records can be roughly verified by checking acres of crops and plowable pasture against total tillable acreage and by checking total roughage against number and kind of animals fed. Care must be taken to get complete estimates of time spent in marketing farm products and in outside labor. The schedule required is usually a very simple one dealing with matters most familiar to the farmer or any mature member of his family.

Field work can be done by intelligent educated young farmers or mature college students after a period of training and under proper supervision. Where soil observations are made by the same workers, as was done in the eastern Connecticut study, much more intensive training and more careful and continuous checking by soil specialists is necessary.⁴

Before the field schedule is prepared, the system of classification to be employed must be carefully worked out by reconnaissance studies in trial areas, and a careful analysis of the data with a view to determining the most serviceable and realistic system of classification. The field record schedule should be based on the experience acquired by such a study. In making up the record the researcher should have in mind the statistical treatment to which the data are to be subject as well as the system of classification. He should also have in mind the peculiarities of the various enterprises appearing within the area.

Where productive man-work units are used for converting acreages and the number of head of livestock into comparable measures of size of enterprises, it is important to use productive man-work unit tables which as far as possible are up-to-date and representative

(4) See Project No. 5, Bulletin No. 2 in this series, *Research in Agricultural Land Utilization*.

of the area being studied. It is not necessary that the data from which the productive man-work units are computed be drawn from the area being studied provided it can be shown that the areas from which they are drawn are approximately similar.

Sampling.

Two considerations dominate the problem of sampling in this project:

1. The desirability of securing a valid and adequate sample upon which to base generalizations for the entire area being studied.
2. The desirability of keeping down the cost of collecting data and making the study at reasonable expense.

The random sample involves high costs in the collection of data. It does not afford opportunity to study the sequence of type changes as one set of physical or economical conditions merge into another. The same criticisms apply to stratified sampling.

Where township census totals or averages are available, an excellent method is to select townships that as far as can be judged are representative of the entire area. These selections should be verified or modified by checking with soil, topographic, road, and population maps.

Care should be taken to see that the various soil types, topographic and economic situations appearing in the entire area, occur within the range of the sample in some approximate proportion to their appearance in the entire area. It is important also to get a good geographic distribution of the selected townships. A sample thus selected should serve the purposes of a classification study and be useful for further research.

Analysis of data from census schedules to determine typical farming systems.

Following is a statement of a procedure using census schedules which was followed in a number of projects in the Corn Belt and Great Plains, and can be used with the 1930 census schedules as soon as they are available for such use, over a considerable part of the United States. Each of these particular projects was a part of or a sequel to a study of the kind described under Project 1, and the object was to classify and describe the types of farming existing in an already defined type-of-farming area.

Although conditions within an area as a whole are fairly homogeneous, considerable variation is likely to be found in specific localities and on individual farms. For this reason, areas determined on the basis of organizations which are dominant are almost certain to have other farming systems within them which vary sometimes quite widely from the dominant system. This is due not alone to variations in physical conditions, but to differences in aptitudes among farmers, to their likes and dislikes, to variations in family

labor supply, availability of capital, conditions of tenure, degree of encumbrance and the like.

In order to determine to what extent such variations exist in each of the type areas under study, a careful examination was made of conditions in each area. Sub-areas (townships) were selected which represented the range in conditions found. In selecting these sub-areas, particular regard was given to their location and to their representativeness. Detailed soil surveys, farm management surveys and the like, as well as knowledge of people familiar with local conditions, were drawn upon in selecting them.

In highly uniform areas, it usually was not necessary to select more than one sub-area. In other areas where there was less uniformity the representative townships were selected at scattered points in the area so as to show the complete range in conditions in so far as possible. The number of sub-areas selected depended upon the size of the type area and upon its uniformity. A sample of from three to five percent of all the farms in each area was usually taken. In most cases a sample of around 300 farms was taken for each sub-area, varying from as low as 200 to as high as 600.

Through a cooperative arrangement with the U. S. Bureau of the Census, permission was given to use the original schedules of the 1925 Census of Agriculture in obtaining the organization of each of the individual farms in these representative townships. Cards were first prepared on which was included the information essential to disclose the size and organization of each of the farms. The complete organization of every farm in these representative townships was then transferred to these cards, each card representing one farm. The cards (or farms) were then sorted into size groups. This gets the farms of the same size together and further indicates the relative frequency of each size of farm.

With the farms sorted into size-groups the next problem is to determine what the prevailing organizations are on the farms in each size group and to see if there is any tendency for the organizations to vary on the different sizes of farms; in other words, to see if the same crops and livestock are found in the same proportions on the large farms as on the small farms. In order to show this a frequency distribution is made of the farms in each size group according to some enterprise or combination of enterprises which satisfactorily portrays the organization of the farms.

The final problem has involved pushing the analysis a step further and analyzing the farms of a particular size to determine what the variations in organizations are and to see if there is any tendency for the farms to center into clearly defined groups. To show this, the farms of the same size are first arrayed on the basis of the dominant product grown on the farms and then sub-arrayed on one or more other enterprises depending upon the variability existing.

By this method of sorting, arraying and sub-arraying, the farms

of the same size and organization are brought together and any central tendency in grouping can be noted. In the Corn Belt and Great Plains states where these studies have been conducted, farms sorted and arrayed in this way have exhibited a rather pronounced tendency to settle into fairly distinct groups.

In the case of livestock it frequently happens that there are two or more livestock combinations with the same crop combination. Such a situation, of course, would be expected in an area where there was a mixture of cash grain and livestock farming, but it is found even in areas where either one or the other is dominant. While in some cases this can be explained by the variations in the kind and quality of a pasture available, in others it probably can be explained only on the grounds of incomplete utilization of resources on the part of some farmers.

Although the array of farms of the same size in most areas will show a rather wide range in organizations, closer inspection will show that the farms in the array usually can be broken into a few distinct groups within each of which the organizations are quite similar. Making use of this tendency of farming systems to exhibit common group characteristics affords the basis for setting up what have been termed "typical farming systems" (types of farming) in each area. The classification and description of typical farming systems on 160-acre farms in an area in southeastern Kansas shown on a preceding page illustrates the results that can be obtained from this analysis.

These typical farming systems are simply modal averages of these distinct groups as obtained by arraying and sub-arraying the farms of the same size and general organization. Thus there will be as many typical farming systems on the farms of the same size as there are distinct groups. As a usual thing it is not practicable to attempt to isolate more than two or three typical farming systems for each size farm; but of course the number will be determined by the refinement in classification desired.

By arraying farms into groups and determining the cropping system and livestock system representative of each group, the types of farming prevailing in each area are finally identified, classified and described. The farms instead of being grouped together regardless of size to obtain a so-called "average farm," are divided into groups each of which is distinctive enough to represent a typical farming system. An average of each of these groups will be really representative of each of the farms in the group. In practice, instead of an arithmetic mean of the crop acreages and livestock numbers in each group, a mode or median is taken. This can be determined quite accurately by inspection.

PROJECT 3. Accounting for Changes in Farming Types.

OBJECTIVE: To account for the systems of farming in an area and for the historical changes in these systems.

(By J. D. Black and Edgar B. Hurd.)¹

Explaining variations in systems of farming now found in an area, and explaining changes that have taken place in such systems in the past, may be undertaken in separate projects; and no doubt many research workers will want to undertake them separately. The writer has preferred to put both in one project because the paramount final objective of the historical type of project is the same as for the cross-section type of project, namely, to show why the systems of farming now in an area are there. There are two ways of accounting for a thing as it is: one, to show what other things are associated with it and presumably are responsible for making it what it is, or keeping it that way; and the other to show how it came to be as it is—how it grew or evolved into what it now is. The latter is the genetic or historical way of accounting for things.

Certain groups of scholars incline strongly toward the first type of explanation; others toward the second; and sometimes there is dispute between them as to which is the better method. (Debate of this type occupied many sessions of the former Committee on Scientific Method of the Social Science Research Council.) The writer takes the commonly accepted position that these two methods are valuable supplements to each other and in fact should be combined for a full explanation. Merely to trace the historical changes that have led up to a present arrangement is like fitting a trend line to a set of historical data. The only way one can forecast from it is to project the trend line into the future. We all know the inadequacy of this form of forecasting. If the method is inadequate for indicating what is likely to happen in the next few years, it is then also inadequate for accounting for what we find now, and for the same reasons.

On the other hand, merely to show what factors are associated with the present set-up, and in as far as possible, by reasoning to deduce the existing cause-and-effect relationships present in these associations, fails in many cases to reveal much explanation of primary importance; for frequently about the only reason for a current practice is that it prevailed in the period preceding, and not enough time has elapsed for it to have been abandoned in favor of a new practice suited to the now prevailing conditions. Consequently it is nearly always very helpful to turn back the pages and see things as they were especially in the period just preceding, and also, though in less detail, in the earlier periods.

(1) Mr. Hurd contributed mostly to the discussion of Method B under "Methods of Analysis".

When the two methods are used in combination, a succession of cross-sections is taken at different cut-offs beginning with the present and continuing backward at yearly, or five- or ten-year intervals, ordinarily as determined by the availability of the data, and an effort is made to explain the content of each cross-section in terms of the accompanying circumstances that may have causative values, and also in terms of what may have held over from the period before although no longer having survival value on its own account. At some earlier period, if not in the one under study, the various items in the content of each later cross-section must have had a reason for being in terms of accompanying conditions. A thorough study would trace each item back until such reason is found and then follow its history down to the present, or to its point of disappearance, in order to observe how the forces of custom and tradition cause farm practices to persist after their time, although eventually always dying out, sometimes quickly, sometimes very gradually. (See Chapter XXII, *Introduction to Production Economics*, John D. Black, for discussion of the dynamics of production changes.) Having made such an analysis as the foregoing we are able to forecast, and to explain what now is, not merely by projecting the trend line, but in addition by showing how certain factors have influenced the direction of the trend line in the past, are influencing the present situation, and probably will influence future developments.

Value and use of project.

The most important value in such projects is that they lay the foundations for future production programs for the particular areas studied. Such planning is not a part of this project as here outlined (See Project 12 for this); but this project must be so conducted as to make its results contribute as much as possible to such planning. The cross-section analysis (sometimes called geographic) and the historical analysis should be thought of primarily as contributing to such an end.

The second value in importance in such studies is that out of many such projects will gradually develop a body of generalizations as to how systems of farming are determined, as to how particular factors affect systems of farming acting either as separate forces or jointly with other factors, and as to how changes in systems of farming work themselves out.

Geographers will no doubt see some purely geographic values in such projects; and historians some purely historical values; but these are of no concern to the project as here outlined.

Scope of project.

This project assumes that the type-of-farming areas in the region have been delimited (as in Project 1) and that the systems of farming now in the area have been classified (as in Project 2). The area selected for study will ordinarily be one type-of-farming area

or several contiguous type-of-farming areas, depending upon the degree of refinement in the mapping areas. The limits of such an area may be clearly enough recognized in advance so that no special analysis of this phase of it may have been needed; but the systems of farming will always need to have been described and classified. Project No. 4 may include No. 3 as one of its phases. Project No. 6 will be greatly simplified if No. 3 has already been done in all the competing areas.

Studies of this general sort have in the past most commonly been in terms of one commodity. For example, they have attempted to account for the distribution of the cow population of a region; or for the shifts in wheat growing. These no doubt reveal certain major associations especially of a physical and biological nature, and have contributed considerably to our understanding in the past. Their defect is that they do not take account of those relationships between different products that are of such great importance especially in economic analysis. In this project, therefore, particular stress is given to the need for taking *the system of farming as the unit rather than the single product*. It may be outlined with the county or township as the unit of area; or it may go to the extreme detail of explaining the system of farming on each farm in the area covered. This extreme would involve locating the farms on a soil map such as published in connection with soil surveys; and likewise for topography; and for climate when it varies considerably within an area, as it does when variations in elevation are considerable. (See Projects 2, 3 and 5 in Bulletin No. 2, *Research in Agricultural Land Utilization*, in this series.) In the Connecticut land utilization studies, intensity of analysis is carried to the point of mapping the soil types on each farm and relating them to the system of farming. An intermediate degree of intensity of analysis might be illustrated in the case of soils by mapping the soils in much less detail, grouping together under five to ten heads the types or classes of soils that are significant from the standpoint of land use, and determining the prevalence of the different systems of farming on each soil type, or combination of soil types, possibly by sampling the farms in each soil-type area, or by using township data for townships selected because the land in them is very largely of a definite type. Differences in topography and climate can be combined with differences in soil in such analysis.

For the historical parts of such studies, the unit of an area will ordinarily be the county, since the needed data are not available for smaller units before 1930. This means that the boundaries for the areas taken for study will follow county or township lines. For the cross-section parts of such studies, the boundaries can be chosen according to the methods outlined in Project 1.

The explanation which this sort of project undertakes is in terms of types of farming; but this includes inescapably considerable

reference to type-of-farming areas. The boundary lines between type-of-farming areas are significant measures of the changes in location in type of farming and hence become things to explain in themselves by relating them particularly to differences in natural conditions. Differences in natural conditions are commonly indicated by lines on maps; hence the task of explanation in its more elementary phases, represented by Method A below, takes the form largely of observing the relation between lines on maps. But one must not be led into thinking that this is all that is involved in the project. *Not just one type of farming, the dominant one, must be accounted for in any area, but all the important types found in it. The variations from the prevailing type are as important to explain as the existence of the prevailing type.*

The scope of the project may also be varied with respect to intensity. It may (1) be restricted merely to discovering what factors contribute to the differences, or have contributed to the changes, in a purely qualitative analysis; (2) include in addition an attempt at rough rating of the relative importance of the various factors; (3) attempt a more careful quantitative measurement of the co-variation of the various factors. If outlined on the more extensive of these bases, it is feasible to expand it to include more territory, even the whole United States.

Methods of analysis:

A. Visual correlation.

The method of analysis of the current cross-section that will first occur to one is the common procedure of mapping the various physical and economic factors that are supposed to determine farming systems—soil, topography, rainfall, growing season, price at the farm of the various products, wages of hired labor, etc.—in so far as these vary within the area; then of mapping the variation in the occurrence of the different systems of farming in the area, including proportions of the different types; then of placing these side by side, or one over the other, and observing the co-occurrences (see discussion of this method in *Research Method and Procedure in Agricultural Economics* under the head of “Cross-section—Geographical”; also Projects 2 to 6 in Bulletin No. 2 in this series dealing with research in Land Utilization). This simple procedure may suffice to indicate with satisfactory conclusiveness a number of important relationships. The soil and topography differences may be so clearly marked—as at the boundaries of the Yazoo Delta area, of the Connecticut Valley in New England—that one can hardly escape attributing changes in types and proportions of types to these factors. In most areas the farming systems change gradually, and one cannot be certain how much the natural factors contribute to the changes. The natural factors themselves are sometimes woven into intricate patterns of soil type, topography and climate. The effect of rainfall will not be so easy to determine as would at first

appear. One cannot safely attribute to the decline in rainfall all of the decline in corn acreage in the farming systems in Kansas and Nebraska as one goes westward; some of it may be due to price or population factors; or local variations in the rate of decline may be due to soil factors.

As suggested above, at first glance it would appear that this method of analysis explains only type-of-farming areas and the boundaries between them. It could of course be used in such a way as not to go beyond this. As here presented, it is intended to include all the important systems of farming in an area, and the proportions between them. But these will need to be reduced to form so that they can be represented on maps, for the most part by lines on maps. Devices for this are discussed below.

Such simple visual methods of correlation may be considerably reinforced by combining with them a study of the agronomic bases of crop growth. A fairly definite rainfall requirement may establish clearly on the map the western or northern limit of a given system of the farming; or a definite summer temperature or growing season requirement; or a combination of requirements, such as rainfall, temperature and relative humidity. These requirements may have been established experimentally; or perhaps by observations of cropping experience in a sufficient number of other parts of the earth to give them validity.

Economic factors such as prices may arrange themselves in more or less concentric zones about or out from a market; and by comparing the prices of the competing products in each zone, one may discover why types of farming or proportions of them, change from zone to zone. By going back to relative transportation costs of different types of products from the different zones to the market center, one may discover the reason for the schedules of prices for the different products in each zone. The Russian students of agricultural geography have given particular attention to the relation of transportation and prices to zoning of production around a market. In this case also, the method employed is visual correlation reinforced by knowledge of basic conditions.

In many cases, the co-occurrence observed cannot be offered as an established relationship. It may be only a matter of chance, and not repeated in any other area. Such, for example, may be the co-occurrence between the line of equal yields per acre of corn and oats in Iowa and the line for a growing season of 150 days (observed by Hurd); or that between cheese production in Wisconsin and a certain summer isotherm (observed by Dr. O. E. Baker). No doubt these natural factors are producing effects of the sort in question; but that the particular length of growing season observed is the critical point for the crop would require additional evidence, including that of repetition in other areas.

In a similar way, the co-occurrence of certain factors and farming systems in a certain zone or sector of an area, and the reverse of

this in others, must not be taken as proof of a relationship. But chance co-occurrence is not likely to be repeated several times.

The method of visual correlation calls imperatively for devices for representing systems of farming and the various factors supposed to be associated with systems of farming on maps in such a way that the eye is able to perceive the relations existing without too much painful effort and without introducing the various forms of optical illusion which figure so largely in graphic presentation. The methods of reporting systems of farming on maps which are in common use do not fulfill these requirements. For example, the device of reporting the proportion of the crop land in different crops by bar diagrams by counties, as used by Dr. Spillman in his studies, and by Hedges and Elliott in the Nebraska study described in Project 4B, has the difficulty of not being graphic enough—the eye is not able to catch at a glance the parts of the whole area which have the same combination of systems of farming and proportions between them. One can of course supplement these bar diagram presentations by drawing a line around the contiguous counties having the same combinations and proportions of systems of farming. These lines, however, as pointed out in Project 1, will have to be located rather arbitrarily and this will tend to obscure the important gradations between proportions of type of farming in various parts of the type-of-farming area which are so significant for the purposes of this sort of a study. If the bar diagrams can be left on the map, and the lines separating the subdivisions of the type-of-farming areas can be superposed on these in such a way as to produce the grouping effect desired while still preserving the gradations indicated by the bar diagrams, the resulting map may serve the purposes of this project fairly well.

Two other types of graphic presentation should, however, be considered as probably more suited to the problem in hand. One gives to each major system of farming in a type-of-farming area a distinctive symbol that the eye can catch readily on the map, the proportions of the various systems of farming in any county being indicated by proportions between the numbers of the various symbols shown in the map. The most effective symbols to use in this way would be dots or small disks of different colors. If black and white symbols are to be used, the following set has been found to be fairly distinctive: dots or disks, crosses, squares, circles (the various symbols should all have about the same area of black surface).

The other device is that of isopleth lines drawn in according to the ratios between the two dominant systems of farming or on some other basis, the space between isopleth lines being shaded from light to dark according to the degree of dominance of the major system of farming. Maps of this type are shown on pages 28 to 34 of U. S. Department of Agriculture Circular No. 160, *Economic Aspects of Land Settlement in the Cut-Over Region of the Great Lakes States*

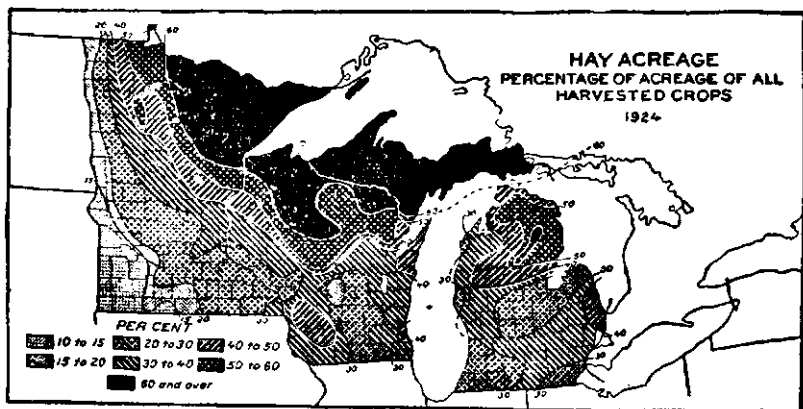


FIGURE 29.—In the newest counties farthest north, hay is almost the only crop grown, and much of it is cut with the scythe between stumps and in small patches of clearing. (Based on the census)

by W. A. Hartman and J. D. Black. Figure 29 from this bulletin is shown here as an example. The difficulty with this device is that it does not lend itself very well to situations in which several systems of farming occur in an area. The related variables—temperature, rainfall, growing season, prices, transportation costs, land values, and rents—can be represented by similar isopleths. The same difficulty will arise with respect to prices as with respect to combinations of systems of farming—the ratios between prices of several products may need to be shown.

The soil variable also introduces complications. If the study is made on an intensive basis, the actual soil survey maps may be used, as indicated above, and the symbols for the different systems of farming located on them. Of course one would not ordinarily want to publish such maps. They would serve as work sheets upon which the desired relationships could be determined, the results being presented in tables and text. If the study is carried out on the somewhat more extensive basis also indicated above, the soil types being grouped into some five or ten classes, a system of cross-hatching can be worked out which varies from white, let us say, for the most productive soil, to black for the waste-land types. To indicate the possibilities of this procedure, the state of Massachusetts can be shown on a single page by reducing the soil survey maps to one-twentieth their present scale and if the soils are reduced to five classes. Less reduction in scale and in soil classes than this is desirable, but this will require the use of an insert map in a bulletin or book of the ordinary size.²

(2) These problems have been encountered in presenting the soils in New England in the study bearing the title, *The Land and Agriculture of New England*, being prepared for publication by John D. Black and Henry I. Richards. One has to choose between grouping the soils on the basis of soil "series", such as the Charlton series and the Gloucester series, or upon soil "classes" such as clay, silt loam, sandy loam, etc. Both systems of grouping

The actual process of visual correlation can be facilitated considerably if the mapping is done on semi-transparent drafting paper and the maps are superposed one over another on a light table according to the relationships which one wishes to examine. Mr. J. Pryse Howell has presented the data for England and Wales in form so that the reader can do this for himself in his *An Agricultural Atlas of England and Wales*.

At this point, reference should be made to the common procedure of showing the different crops and forms of livestock on separate maps, and likewise the physical and other factors, and then trying to discover the relationships between systems of farming and these factors. This amounts in effect to presenting the dependent variable *systems of farming*, or proportions of them, in several parts, which makes it very difficult at times for one to assemble into proper complexes the particular sets of variables needing to be considered. The method, however, is capable of yielding significant results, especially if some one product such as corn is the major determinant of the system of farming in the area.

To use the method of visual correlation with the historical phases of this project, one needs to map the systems of farming for the area at each of the census periods included in the study, and likewise any of the independent variables that may change from period to period—for example, prices, transportation costs, and land values. One can then examine the maps for each census cut-off and see whether the same relationships are found in each, and if not, what changes have occurred. If changes in types of farming have occurred, one should ordinarily expect to find some changes in the social environment that have been responsible for them. If one does not find them, the explanation may be that of lag in readjustments. To observe the presence of lag, one ordinarily needs to have data for the intervening years so as to note at what particular point the shift to meet changing conditions began to appear. The changing variables can be expressed in the form of historigrams to which secular trends can be fitted. These trend lines and deviations therefrom can be studied in relation to each other in the usual manner of such visual analysis. One must not be too disappointed if he is not able to account for all the difference in census periods by the method of visual correlation. It is one of the limitations of this method that it is not able to explain certain types of relationships of considerable significance.

In summary, it may be said that the method of visual correlation is simple and easily understood. It therefore lends itself to the are illustrated in this study. The map of soils for the state of Vermont published in the study of rural Vermont directed by Dr. H. C. Taylor, bearing the title *Rural Vermont*, is an example of grouping soils on the basis of soil series. Perhaps neither series alone, nor classes alone will be adequate, but particular soil types, or combinations of series and class, such as Gloucester sandy loam, may need to be mapped separately to show the relationship desired.

preliminary stages of any study attempting to account for systems of farming in an area. Ordinarily this step should be taken as the first stage in any research project of this type. It does not appear at first glance to need any special statistical training or technique. It is commonly used by geographers and economic historians with very little statistical background. This, however, points to one of the shortcomings of the method. Those using it have been too much inclined to accept a limited degree or a single instance of co-occurrence as establishing a relationship. A knowledge of statistical theory, particularly that part of it relating to inference, would protect one from too ready inferences from such data. The application of the theory of inference to geographical data is not very well developed at the best (see *Research Method and Procedure in Agricultural Economics* for a discussion of this under the heading of "Correlation as Description of Geographic Data").

A grasp of the related aspects of economic theory may also be needed to enable one to sense the underlying relationships more clearly. An example of this is the fallacy that high land values and rents are causes of intensive systems of farming. The proper understanding of the problem would make one conscious that other and more fundamental factors combine to produce both high rents and intensive agriculture in many areas but not in others. Similarly, a thorough understanding of production economics theory will reveal the relationships between enterprises and the related application of systems of farming, and furnish the research worker with a rational basis for the systems of farming that he finds or fails to find in the area. At the best, the particular relationships that one finds between systems of farming and other factors in a project of this kind should be looked upon as hypotheses with varying degrees of promise of validity. A rational basis in economic theory will lend strength to any of them.

B. *Mathematical associations and correlations.*

This method differs from the former in that the variables are reduced to more definite quantitative terms. The actual form of mathematical analysis may be either *association* or *correlation* as these terms are used by Yule (see discussion under the head of "Association Analysis" by Dorothea Kittredge in *Research Method and Procedure in Agricultural Economics*, or the fuller and more difficult discussion in Yule's *Introduction to the Theory of Statistics*). The correlation analysis may be of the elementary type commonly called cross-tabulation, or may take the form of formal correlation analysis, possibly carried to the point of working with several variables at a time. (For a discussion of cross-tabulation as a form of correlation, also see *Research Method and Procedure in Agricultural Economics*).³

(3) The writer has found that relatively few people understand the essential idea of cross-tabulation analysis. The method to most people apparently means

The correlation may also take the form of construction of tables in which the average percentages of the crop land which is devoted to different systems of farming are computed for the different soil classes or types, for different kinds of topography, for various distances from market, for various ratios between prices of different farm products, for different land values or rents, etc. Tables of this sort have been presented in some of the Iowa studies by Mr. Hurd and others¹ (also see Mr. Hurd's discussion under the heading of "Cross-section Analysis—Geographic" in *Research Method and Procedure in Agricultural Economics*). The advantage of this method, according to Mr. Hurd's point of view, is that the effects of certain variables which are not likely to be correlated with natural and economic factors, particularly the variable of personal differences between farmers, will cancel out, making the average figures very close to actual net correlation results. One has to be very careful, however, with this procedure, as is pointed out under the heading of "Elementary Analysis" in *Research Method and Procedure in Agricultural Economics*. It has been used very extensively in the past in such a way as to indicate a much higher degree of correlation than actually exists, and also to attribute to the variable under study the influence of other variables with which it was significantly correlated. There may well be other factors associated with soil type or distance from market that are in considerable part responsible for the apparent correlation and contribute a considerable part of the apparent regression. It is commonly recognized that differences in capacity and efficiency of farmers are definitely correlated with soil types and grades of land and with systems of farming. If, therefore, the simple procedure of working out group averages is resorted to, the research worker must study his area very carefully to make sure that none of these significant intercorrelations enters into the results.

In general the better procedure would be to test out the data thoroughly by the method of association analysis above referred to, or by cross-tabulation. If these methods point in the direction of definite relationships, they can be tested more carefully by formal correlation methods and the results expressed in the usual coefficients. If such analysis indicates significant intercorrelation between the independent variables, there may be object in using the multiple correlation technique. One must, however, be on guard against the dangers of too high a degree of intercorrelation between independent variables.

nothing more than a two-way sorting of the data without any recognition of the possibility in it of separating from each other the effects of two or more independent variables. To be sure, the separation obtained is crude unless there is a large number of observations, but it may be refined enough for the purposes of many studies, at least in their preliminary stages. (J. D. BLACK.)

(4) *Cropping Systems in Iowa, Past and Present*, Edgar B. Hurd, Iowa Experiment Station, No. 268.

One of the important obstacles to the use of mathematical analysis in problems of this kind is the form in which the variables must be expressed, and in many cases the limited number of observations. The dependent variable *system of farming* is not in itself a number; neither can soil types be expressed in numerical terms. Systems of farming, however, may be reduced to a numerical expression by putting them in the form of percentages of the farm land in the various counties or townships which is in a given system of farming. Occasionally the same method may be used for expressing soil types, or soil types may be indicated indirectly in the form of average yield of certain major crops, or of ratios between the yields of the two major crops. Topography may be expressed according to the index of topography described on page 56 of Bulletin No. 2 of this series dealing with research in Land Utilization.

If the unit in the study is the county, the area included must be rather large if it is to give a sufficient number of observations for satisfactory correlation analysis, particularly of the multiple type. Ordinarily the results will not be very significant if less than 50 counties are included. If township data can be obtained, as is expected for the 1930 census, then the number of observations can be increased very greatly and the correlation analysis can be made much more significant. If the study is made on an intensive basis, and individual farms are the units, then such analysis can be refined still further. Such analysis would prove a valuable addition to many farm business surveys.

Of the little analysis of this type thus far undertaken, most of it has followed the lines of working out the relations between various factors, mostly natural, and the acreage and distribution of particular crops of livestock taken one at a time. There is room of course for an almost unlimited amount of analysis along these lines. The difficulty is that the correlations between the various independent variables above mentioned and the distribution of any one crop taken by itself is only a fragment of the whole situation. Moreover, the relations found to exist for any one crop are greatly affected by the other crops and type of livestock combined in the same farming systems with it. One can work out a separate analysis for each of the major crops and forms of livestock produced in the area and then attempt to synthesize the results in various ways; but the procedure is likely to become complicated and the results may be inconclusive; as above explained, this type of project is developed with the idea of making a complete system of farming the unit in the dependent variable and thus doing the synthesizing at the start.

The historical phase of this project will have the same relation to the cross-section phase of it as was indicated for visual correlation above. Separate analyses can be made along the foregoing lines at each census period, the results compared, and the differences explained or interpreted in various ways. The advantage of this over

the method of visual correlation will be that many of the results will be expressed in definite quantitative terms so that closer comparisons can be made between census periods. One can reduce to formal coefficients the relationships between the secular trends and deviations therefrom for the variables of the sort here in question; but such coefficients frequently add little to what is visible to the eye. The principal reason for computing them is to protect oneself and the reader against the danger of overrating the relationships.

In spite of the mathematical form of statement of the results of such analysis, there is still the same need as with visual correlation for careful consideration of the inferences which can safely be made, and for thorough exploration of the economic bases of the relationships. The net correlation between yields of oats and corn and percentages of oats and corn in the system of farming may be either positive or negative because of the way in which comparative advantage in production works out in the area.

Those who expect that correlation of the type here outlined will add greatly to the results obtained by simple visual correlation are probably doomed to disappointment. Very few new relationships will be discovered in this way. The principal gain will be that fewer hypotheses will be advanced, and more of those advanced will be recognized for what they are.⁵

C. *The farm set-up method.*

Methods A and B above outlined for the most part provide only for an empirical form of analysis—analysis that contents itself with observing existing associations or co-occurrences in place and time. The reverse of this is the analytical method, that attempts to discover what lies behind these associations. To use Karl Pearson's language, in analytical procedures one attempts to go back to earlier "stages in the routine of experience" or links in the "chain of antecedent probabilities". (See discussion of "What is Science" in *Research Method and Procedure in Agricultural Economics*.) Method C of accounting for types of farming is more analytical than Methods A and B to the extent that it carries the analysis back to conditions on farms and endeavors to discover what may have led the operators to practice their systems of farming. It does not undertake this in any thoroughgoing way—the task would be too great; but it tests out the one motive which is generally accepted as most powerful, namely the *profits motive*.

(5) I agree that extreme care should be exercised in attempting to get quantitative measures of so-called causal factors accounting for farming types. There is so much inertia and lag in agricultural adjustments and the data are so poor that high degrees of association between certain factors and particular farm organizations and farm enterprises at a particular time, may not be as significant as some investigators have sometimes considered them. These should be accepted, therefore, with a great deal of caution and should be based on a thoroughgoing qualitative analysis. (F. F. ELLIOTT.)

Perhaps it would be better called the *motive of economic advantage*, since we do not want it thought of in purely monetary terms. The essential idea of the method is to relate the changes that have occurred in the systems of farming of an area to the economic advantage of the farm operators and their families, to see whether or not a reason of this nature can be found for the changes. It is assumed that there will be an appreciable lag in adjustment of systems of farming to meet changes in the environment; hence an important feature of the method is discovering the extent and nature of the lag. Obviously the whole theory of the dynamics of production is involved in this. (For brief discussion, see J. D. Black, *Introduction to Production Economics*, Chapters XXII, XXIII, XXVIII, XXIX.) In carrying out this procedure, one will naturally begin with the present types of farming in the area and see to what extent they seem to be based on present economic advantage and to what extent affected by lag, and any other possible factors that lend themselves to treatment. One will begin with the present because the data for it are most complete, and because the various influences that are most significant now will more likely be revealed in a study of the current situation. These influences can then be followed back to earlier periods and thus have their whole history traced.

Such a study thus really begins as a current cross-section analysis; but it cannot be thought of as having two distinct phases, cross-section and historical. There is really one continuous analysis starting with the present and continuing backward as far as data or resources permit.

The particular analytical device most used in this approach is that of constructing various complete farm set-ups for the principal types of farming and major variations therein (such as available family labor, special markets for supplementary products, etc.) for the different type-of-farming areas or sub-areas being studied, and attempting to discover, by trying out the effect on net incomes of various modifications of these several systems of farming, whether the systems of farming being practised at that time represented economic advantage at the time, economic advantage being defined as the best combination of profits and desirable mode of living for the family. This device is outlined in considerable detail in Project 8 under the name of the "synthetic" method. As a device to be used in determining the relative advantage from different *major uses* of land, it is outlined in Project 11 of Bulletin No. 2 in this series, dealing with research in Land Utilization.

Such analysis sometimes indicates that the systems of farming prevailing at the time in various parts of an area, with no modifications whatever, represented economic advantage with most farmers; at other times that some system less usual in the area, or some system just beginning to appear, represented economic advantage. Thus is revealed at one stroke the motive for change, and

the phenomena of lag in response to the motive. Trying out, by the same method of testing the effect on net incomes, these same types of farm set-ups, and various forms of them, under conditions such as prevailed earlier—conditions of different relative prices for the several products involved, of different relative expense rates for hired labor, feed, fertilizer and other producer's goods, of different types of farm equipment and farm practices—will reveal these phenomena still further. This process will need to be carried far enough to reveal the period when the systems of farming now existing in the area, but no longer most advantageous, were the most advantageous. Such analysis might reveal, for example, that in a section of southern Minnesota a system of farming giving major emphasis to corn growing and hogs was clearly most profitable in the period from 1910 to 1920, but no longer is, because of a new set of market conditions and prices for strictly corn-fed hogs. It might further reveal that even more emphasis on corn and hogs than prevailed would have been profitable in the period from 1910 to 1920, especially in the early part of it; that farmers lagged perhaps 5 to 10 years in adjusting their farming to take advantage of the high corn and hog prices of the period.

Explaining variations in systems of farming between farms in the present or at any historical cut-off also lends itself in part to this method of attack, if the data needed can be obtained. The basis for it is a full classification of all the systems of farming in the area (as in Project 2), and of all the variants in supplies of labor available, capital available, combinations of types of land, distances from market, markets for locally grown products, and other important factors likely to produce differences in farm set-ups. Given the foregoing, one can test out the economic advantage of the systems of farming found under these special sets of conditions. Motives of the sort crudely designated as "non-economic", such as special skills of the farm operator, and individual backgrounds of experience, will be found playing a large role in such variations in systems of farming.

The superiority of this method over the other two should be clearly apparent. It gives the whole structure of the present situation, and the account of its genesis and evolution. It also indicates definitely the direction which further changes are likely to take if they follow the usual economic law of working toward a new equilibrium in terms of the set of conditions now prevailing.

The principal limitation of the method is in the availability of the necessary data. So far as the present cross-section is concerned, one can get all the data needed in order to use the synthetic method thoroughly. It will, of course, consume considerable time and money to do it on as thoroughgoing a basis as many farm management workers think desirable. The writer is of the opinion that the early work along these lines in any area should be directed at reveal-

ing only the more important of the relationships and maladjustments, the refinements being left for more detailed study later. It is with the historical part of the project that the limitations of data are most apparent. For a thorough job, one really needs a series of prices at the farm for the different products concerned over the whole series of years being explored; also a series of expense-rates for hired labor of different types, hired machine labor (threshing, silo-filling, tractor work if hired, etc.), purchased feed, purchased fertilizer, and other machinery and equipment, etc.; also data as to farm practices followed as well as farming systems, and as to physical inputs of the important factors and yields and production—in fact, all the data needed in order to set up the major items in an operating farm budget at each point in the past taken for exploration. As to farming systems, the data of an occasional cut-off—such as a 5- or 10-year census—may serve fairly well, but should be supplemented by local evidence where possible. The price series collected by the Bureau of Crop and Livestock Estimates will commonly not be sufficiently in detail locally, or sufficiently accurate, to serve except in a general way. Sometimes better series can be built up by obtaining data from railroads as to freight charges to the nearest wholesale market and figuring backwards from the wholesale price series. In many cases, one will need to collect local historical price data from local sources, as Mr. Arthur Peterson and Mr. Roger Hale have done for Virginia and Maryland respectively. (See Virginia Technical Bulletin No. 37, *Historical Study of Prices Received by Producers of Farm Products in Virginia, 1801-1927*; and Maryland Bulletin No. 321, *Prices Paid for Maryland Farm Products, 1851-1927*, for details of this procedure; also the projects dealing with this problem in the number in this series dealing with Prices of Farm Products.) Most of the data as to historical changes in expense rates will need to be collected from local sources the same as for local prices; likewise the data as to changes in farming practices and type of machinery and equipment used. The available yield and production series also are not available in sufficient degree of local detail.⁶

In most cases, especially for earlier periods, one will not be able to build up a complete farm budget with all the items as accurate as one could wish. But there may be items enough that are reasonably accurate, and the others may be estimated with enough approxi-

(6) The writer has taken the position that projects of the sort of Peterson's and Hale's should be expanded to include these other local data; that if they are restricted to prices of farm products alone, the usefulness of the results will be greatly limited; that while one is incurring the expense of locating dairies, local business records and the like, and transcribing data from them, one might as well put in the additional time needed to obtain the other data needed for farm management analysis of the sort here outlined. The reader may be interested in the discussion between the writer and Dr. O. C. Stine on this point before the American Farm Economic Association in 1927. (See *Journal of Farm Economics*, January 1928.)

mation to reasonableness, so that the budget obtained will be well worth testing out.

It is well at this point to state specifically one other major difference between this method and A and B. In this case, the budget statement brings together in their proper relationship all the factors entering into and determining systems of farming—the natural factors through their effect on yields and production, prices and expense rates in proportion to their effect on net incomes, etc. The budget does the synthesizing of these, just as the system of farming does the synthesizing of the various lines of production involved. In contrast, Methods A and B relate the systems of farming to each of the natural factors and to each of the economic factors separately. By multiple correlation procedure, one may seek to bring them all into one analysis; but the mathematical results will defy interpretation, so complex are the interrelations between the variables involved. It is a common rule of correlation procedure, well founded in correlation theory, that all possible mathematical operations, such as of addition, subtraction, multiplication, etc., which express true relationships between the data, should be made before setting up the variables; likewise that all relationships should be reduced to their simplest terms. The combining of the items above listed into one budget statement is thoroughly in accord with this rule.

Economic historians who have become interested in applying statistical technique to the explanation of changes have commonly thought of their problem as one of correlating the changes observed with some one or more of the major environmental changes—such as prices or yields—taken one at a time.⁷ It should be clear from the above that although some significant correlation coefficients may be obtained, the results are only fragments of the full explanation desired; and that commonly such students will greatly improve their analysis by synthesizing the data into historical farm budgets; and also into systems of farming. The same friendly suggestion is here offered to the geographers working in the field of agriculture.

It will be argued that in many cases the data are not available for making up budgets at historical cut-offs. This no doubt is true. But there is danger of insisting on too much detail in historical budgets. With no historical data available except prices of the major products, Method B should no doubt be used. With yield data available in addition, and also price series for the two or three major input factors, and a rough idea of the prevailing farm set-ups and cultural practice followed and equipment used, one will probably get better results if he puts these into historical budgets as an independent variable in multiple correlation analysis. The results of formal correlation analysis can be no more complete than the data available. With correlation analysis the effects of the omitted variables are in part included in the variables used with which they are commonly

inter-correlated, and in part appear as lower coefficients of correlation. With the farm set-up method, they may take the form of omitted items in the expense and receipt sides of the budget, which may or may not have increased or decreased with the items included or of making included budget items too approximate. They militate against the validity of the results in either case. With the budget method, one can see exactly what the discrepancies in the data are and obtain from historical sources general or approximate ideas as to the facts concerning them.

In interpreting such analysis, one must remember that the longer the period included in an analysis, provided the trends are continuous throughout the period, the less accuracy is needed in the data indicating the trend.

Relatively little use has so far been made of Method C. The writer has tested it out sufficiently in several studies to have faith in it. The first of these was in connection with a master's thesis written by Mr. George A. Sulrud dealing with shifts in farming in Clay County Minnesota. Mr. Sulrud had been reared in Clay County and was familiar with the changes in farm practices that had occurred. He made use of data of certain farms for which records were available for earlier years, and supplemented this by information concerning a number of other farms in the county supplied by the operator from memory mostly. The data were inadequate, and the analysis crude—as in the early stages of all such developments; but it sufficed to show clearly why the farmers in that territory had shifted a considerable acreage of their land from wheat and other small grains to potatoes and corn, and had expanded their livestock enterprises. It likewise furnished an explanation for the recent development of sugar-beet growing in the county. It also showed that if net money incomes alone were the only consideration, the shifts would surely have come more rapidly. The fact that the potato crop meant adding a lot of hard work, although at periods of the year not occupied by work on spring wheat, had been a powerful retarding factor.

Subsequently Mr. B. F. Alvord has undertaken to make a more thorough study of the situation in this area, in terms of four counties, and carrying the analysis back to 1880. Unfortunately there are some gaps in the officially collected annual yield and acreage figures for Minnesota which are proving difficult to fill from local sources.

Comments.

For fear of being misunderstood, the writer again wishes to emphasize that net money incomes will not alone serve as a measure of real advantage to farm families—the other elements in it will not be measureable in most cases, but they must be clearly recognized. Also that so far as individual farms are concerned, a score of factors

--some relating to the personality of the individual farmer and his background of experience and his aptitudes, some to the supply and labor and capital available, some to the special combinations of land types on the particular farm--will have more weight in determining the system of farming than those revealed by such studies as here outlined. Nevertheless if the factors here suggested and commonly recognized as determining farming type do have the significance ordinarily assigned, their effects will stand out from the maze of individual farm influences, and will be revealed by the procedure here suggested.

It should be pointed out that this project accepts the price structure found in the area as given, and hence does not enter into the problem of competition between areas, which is reserved for Project 6.

This project, as above stated, stops with the effort to account for the existing systems of farming in the area. It does not include forecasting future developments—for that an understanding of the competitive situation is of vital importance; nor even mapping out a program of farming for the area. But by revealing the factors that make, and have made, the agriculture of the area what it is, it should serve as a powerful corrective against rash proposals for untimely revolutions in systems of farming, and indicate the probable lines of future changes, particularly if Method C is used.*

The objective of developing principles of economics out of such studies will also be served by any study which has for its primary objective the development of an understanding of conditions in the area. Each study will serve as a case analysis. But studies especially designed to develop principles should be undertaken whenever possible. These are especially desirable as subjects for doctors' theses. Very commonly such projects will take the historical form and cover a much larger period, sometimes being confined entirely to the past. Some of the important principles concerned particularly need a long sweep of years for observation. But the data will be less complete, and the synthetic or budget method may sometimes have to be ruled out for this reason. The longer the span of years, however, the less accurate do the data need to be—time alone eliminates the minor variables producing temporary vacillations in the currents of change.

Much might be written as to the details of collection of the data of this project. But it would largely repeat suggestions made in other projects, particularly in No. 8. The problems of selection of areas, and of selection of type farms, and of sampling, where these are involved, are largely discussed in Project 2; also the discussion of the value and method of using the census data on acreage, production, etc.

*To the extent that definite lags are discovered, it will indicate directly the probable immediate direction of change in the area. (M. Ezekiel.)

Relation to Project 1.

We are now in position to understand the brief reference in Project 1 to the need for locating the limits of type-of-farming areas on the basis not of the distribution of crops and livestock at the most recent census period only, but on the basis of their distribution at earlier census periods as well. Suppose we have an area of ten counties within which a particular system of farming was dominant in 1930; but in four of these counties at one side of the area, different systems were dominant in 1910 and 1920; and before that there is a long history of occasional significant differences between these two parts of the area. The chances are that some fundamental differences in conditions of soil, rainfall, temperature, or distance from market are responsible for these significant divergencies in farming systems. Under these circumstances it would seem wise to split the area in two parts *because they have had different system-of-farming histories or sequences*. According to this concept of type-of-farming area, such an area represents a section all of which has had about the same crop and livestock sequence of changes, presumably because of basic similarities in the natural and economic environment. In applying this concept one should place the emphasis no doubt on the more recent changes in the sequence, because type-of-farming analysis is mostly intended to serve present and future needs. The recent changes are likely to reflect recent economic changes strongly.^{8 9}

(8) The farm set-up or budget method, I believe, is the better approach; yet it too has its limitations. Those using the method to date have been prone to accept minor differences in returns from different farm organizations as proving the superiority of the one over the other. Differences of \$100 or more between different budgets may not be significant in that the errors in estimates arising from the standard conversion factors used may more than account for such minor differences. Of course, to the extent that the error is constant, that is, applies equally to the two budgets then this criticism loses weight; but I doubt if such is the case.

The management factor, furthermore, is assumed to be constant and capable of handling either organization. So long as the difference between organizations is minor, this is a safe assumption; but if the difference is pronounced it will break down. The method has the advantage of simplicity and provides the basis for the correct approach to the problem, namely, from the standpoint of alternative opportunity, and furthermore, enables one to study the effect of changes upon the entire farm organization.

There has been a tendency to generalize from budget analysis without adequate qualification of the effect such general production shifts if carried out by the group would have upon the prices of the adjusted products. That is to say, the conclusions indicated by the budget might be warranted if only a few individuals made the adjustments, but would be disastrous if carried through by the group. I think that some or all of these points should be emphasized either in a footnote or in the context of the discussion relating to the use of the budget method. (F. F. Elliott.)

(9) Dr. C. L. Holmes comments on this project as follows:

"It seems to me that one of the greatest weaknesses in this project as it now stands is the failure to take into account the internal relationships between farm enterprises, complementary, supplementary, and competitive, in the process of determining, so far as possible, the causes of the types of farming that are found. One can not, except in occasional cases, determine the effect of peculiarities in land except as they work out through these internal farm relationships. The

PROJECT 4. A Type-of-farming Study in a State. (Utah, Nebraska and Connecticut as examples.)

This project will combine all parts of the research outlined in Projects 1, 2 and 3. Rather inclusive projects of this character have been undertaken in a number of states in the past few years. Similar projects will likely be undertaken in a number of other states in the near future, most of them in cooperation with the Division of Farm Management of the Bureau of Agricultural Economics.

The exact form taken by a state-wide type-of-farming project will depend upon the characteristics of the agriculture of the state, the personnel and funds available for the project, the amount and character of secondary data available, and many other circumstances which vary from state to state. In none of the state studies which have already been completed or which are now in progress has all of the phases of Projects 1, 2 and 3, as set forth in the preceding pages, been covered.

nature of the soil and surface may be the controlling factor in determining the cropping system but the nature and proportions of the various crop products will probably determine to a large extent the nature of their utilization through livestock or sale.

"Under 'Methods of Analysis' you list visual correlation as the first. It seems to me too much is made of this; for it has never gotten us very far in accounting for difference in types of farming, except in a very general way, mainly because it does not take into account the internal relationships cited above.

"Do you not dismiss mathematical association and correlation with too little consideration? No one, of course, places implicit dependence upon this method and its findings in determining causal relations in types of farming, but neither do they in other fields of research in which this general method is ordinarily used. I am inclined to think that the difficulties in the way of its use as a check on other methods are no greater than are to be found, for example, in price analysis.

"You refer to the farm set-up or budget method as analytic. Granted for the sake of argument that the type or types of organization representing the highest comparative advantage for a given farm type area can be worked out by this method, it seems to me that it does not show any causal relationships. Unless we go behind the mere arithmetic of the thing to the factors that make the figures what they are, we have not done anything helpful in the way of accounting for the type which proves more profitable, and it seems to me that it is in the causal relationships to be found that the major value of type-of-farming studies is to be found so far as they are to contribute to reorganization and to readjustment to changing economic conditions.

"It appears to me that the effective causal analysis which we need in connection with type-of-farming studies is of qualitative rather than quantitative nature. The key to it is to be found in the influence of natural and economic conditions upon the internal economy of the farm. I believe it is very difficult to reduce these relationships to quantitative formulas but they are of first importance nevertheless."

Dr. Holmes properly calls attention to the failure of Methods A and B to introduce internal relationships specifically as causal factors. The principal advantage of Method C is that it provides for this deficiency.

As to Dr. Holmes's point that Method C is not "analytic", I wish to say that all the "causative" factors he mentions are in plain sight in the budget statements. One merely has to test out the effect of differences in yields, prices, and other causative factors on the net incomes of different farm set-ups in different parts of an area or region or at different periods to see where or when these factors are responsible for differences or changes. Probably the discussion should have been more complete on this point.

In some states a type-of-farming study is looked upon as a project designed primarily to provide the research man with information that will be of value to him in planning and conducting studies with objectives such as those of Projects 8 and following in this report. In such cases the type-of-farming project is not likely to be carried out in as great detail as it will be in a state where an analytical description of the agriculture of the state, determining the reasons for the changes which have occurred in the types of farming of the state, and similar objectives, are considered to be of major importance.

As illustrative of the variations which may arise in the scope and method of a general type-of-farming study in a state, there are given below outlines of:

- A. A study now in progress in Utah.
- B. A study which has been completed in Nebraska.
- C. A study now in progress in Connecticut.

In Utah are found irrigated-farming areas, dry-farming areas and areas devoted exclusively to livestock production under range conditions. There are great variations within the state in elevation, topography and climate. The boundaries of the type-of-farming areas within the state will be quite distinct.

In Nebraska, variations in physical factors influencing type of farming are not nearly as great as in Utah, although precipitation is much less in the western part of the state than in the eastern part. The type-of-farming study in the state as described has been completed.

In Connecticut, heterogeneity of soil and topographic conditions have prevented the development of distinct type-of-farming areas in the state, and the complexity of the farming systems in many parts of the state makes the problem of developing a measure of farm types a difficult one. The study in this state is confined largely to the phases covered in Projects 2 and 3.

PROJECT 4-A. Type-of-farming Study in Utah.¹

(By Marion Clawson and W. P. Thomas.)

Some factors which are unimportant or absent in determining types of farming in humid regions may be of major importance in an arid section, as for instance, relationship of grazing areas—both public and privately owned—to the farm land, water available for irrigation, and drinking water for livestock on grazing land. Also

(1) The plan of this study conforms to an experiment station project in which the entire staff is compiling for analytical purposes available data pertaining to physical, biological, economic and social factors affecting Utah agriculture. The result of that analysis will serve as the basis of the type-of-farming study herein described and will also be used as the basis for a more effective research program in all departments of the experiment station.

there may be extreme variations in soils, climate and precipitation. The supply of irrigation water and its use may be a primary factor in determining the kind of crops that can be grown, while the proximity to public domain and National Forest range may govern the numbers and kinds of range livestock which may be kept. The availability of range land and water thus influence the size of the farm and the type of farming.

Data on grazing land and irrigation are not correctly reflected in census material, due to the fact that the census data are based principally on individual farm reports. The census reports land which is owned or rented by the operator, but in many cases range land is used and partly controlled by farm operators who have no legal claim to it, and no report of this land is included in the census. A comparison of the census report of one county in which most of the range land is owned, with another county in which much of the range land is public domain or National Forest and other reserves, may show very different conditions, when as a matter of fact the types of farming in the two areas may be very similar. In studying types of farming in the western states, census data should therefore be supplemented by information from other sources.

Utah has an area of 52,597,760 acres, of which 5,613,101 acres are in farms, with cropped land comprising 1,495,497 acres or 2.8 percent of the total acreage. It is estimated that less than 5 percent of the total area is capable of being tilled. The remainder must be utilized by some means other than crop production. Approximately 80 percent of the total area of the state is included in public domain, National Forest, mineral and oil reserves and national monuments.

The average precipitation is 16.3 inches, varying with location from less than 4 inches in the desert sections to 46 inches in some mountainous sections. The average growing season for the state ranges from 100 to 150 days, varying with altitude and latitude.

The most productive soils are found in the valleys parallel to the main mountain range extending through the central part of the state. These soils are of limestone formation and as a rule very productive. The soils of the eastern part of the state are derived from sandstone and shale. They are usually high in alkaline content and low in the elements required for plant growth. The western part of the state receives little rainfall and the soils are so highly impregnated with alkaline salts that they are unsuited to crop production and are principally used for winter grazing of livestock.

The average size of counties in Utah is 2 million acres ranging from $\frac{1}{2}$ million to 5 million acres. The number of farms per county in 1929 varied from 52 to over 3500. Counties with large areas frequently have a small number of farms. Any comparison between counties which is based on percentage of farms, crop acreage, or numbers of livestock is therefore likely to be misleading.

Elevations at which farming is practiced in Utah vary from 2500 to 7000 feet. Changing elevations affect climatic conditions, higher lands being shorter in season than valley and bench lands. In a small area in the southern part of the state, early truck crops, and even such crops as figs and cotton can be grown. In some mountain valleys, because of the short growing season, the only crop is wild hay. This wide variation of the climate results in a wide variation in the kinds of products produced. There is a wide variation in the type of farming even within many of the valleys, and it is obvious that there is a still wider range in type of farming within the state as a whole.

Factors influencing type of farming.

In the project, the factors listed below are being considered, and their relation to the types of farming in different parts of the state are being studied. Many of these factors affect the type of farming in any region. Only those which have special significance in the western states are discussed in detail.

I. Physical factors affecting type of farming.

A. Topography.

1. Drainage and watersheds.
2. Character or slope of land—mountains, valleys, bench lands.

In irrigated areas the valley with its surrounding watershed usually forms the bases of division of the state into areas. These are generally distinct physical units, readily perceptible to the casual observer travelling through the area. In a great many cases the political and economic divisions follow these lines, so that existing data will often conform to these major areas. It may be assumed for preliminary division into areas that areas of range land will be divided at least roughly on the same boundaries as the watersheds. Land might be classified according to its slope, the important item being to place the line dividing mountains from benches, and the line dividing bench lands and valleys. These divisions should not be difficult where there is a marked difference between areas, and where the difference is slight the exact location of the lines separating the various areas will be of less significance.

B. Water supply in its relation to type of farming.

1. Amount available, source and land area served.
 - a. Surface supply—natural and storage, and seasonal distribution.
 - b. Underground water.
2. Use.
 - a. Agricultural consumption—in crop production or as supply for livestock or ranges.
 - b. Domestic consumption.
 - c. Unused run-offs.

3. Irrigation practices—administration practices of water diversion, and efficiency of application.

The amount of water entering the major regions either by stream flow from some other area or by rainfall should be distributed to its various outlets, such as run-off used for irrigation, unused run-off, ground water available for plant use, and underground waters. The ultimate development of an area under irrigation is limited by the available water, its use, and the irrigation practices. All available data on the amount of water, land served, use of water and practices, should be carefully worked out for as long a period as possible. Considerable information on these factors is available from the U. S. Weather Bureau, the Office of the State Engineer, the U. S. Geological Survey, the experiment station records and local irrigation companies.

A more or less typical course of development of irrigation practice in an irrigated region seems to be from an initial stage of wasteful use of water to a much more efficient use of water by individuals as more complete utilization is reached.

In this phase of the study each of the major valleys of the state would be treated as a unit. It would be impossible to work it out by sizes and classes of farms, important though that might be, since this information is not on census schedules and would require a special canvass.

C. Soils—fertility, water relations, alkaline content.

In irrigated areas, water relations and alkaline content of the soil must be considered. Informal reconnaissance surveys should be made wherever information on these points cannot be obtained from soil surveys.

D. Climate—temperature, precipitation (rain and snow), and length of growing season.

Elevation largely determines the temperature and length of growing season. This, in turn, affects the kind of crops grown. The frost dates and length of growing season will be secured wherever this information is available. There is a close relationship between the type of farming, the seasonal precipitation, whether in the form of rain or snow, and the percentage of snow annually deposited on the watersheds. Data on seasonal precipitation in form of snow or rain should be ascertained as accurately as possible from U. S. Weather Bureau, experiment station records and other available sources.

II. Biological factors.

A. Plants—native and cultivated, distribution, production and utilization.

B. Livestock—numbers, distribution, migration, and feed requirements, both of range and of farm crops.

A study of native vegetation will give an indication of the relative carrying capacity of range areas and seasons of year in which they

could be used for ranging of livestock. Distribution and production of cultivated crops will be ascertained for each area from reports of the Bureau of the Census and the Division of Crop and Livestock Estimates.

For use in classifying the types of farming in each area, the number and distribution of livestock should be definitely determined, particularly with respect to migration between summer and winter ranges and with respect to feed requirements.²

III. Ownership and utilization of land as it affects type of farming.

A. Land ownership—federal and state, and as public domain, forests, reservations, parks, monuments, and privately owned.

B. Land use.

1. Range—summer, winter, spring.
2. Farm—irrigated, dry farm.
3. Waste land.
4. Other (townsites, rights of way, etc.)

In the western states, where large areas of land are in public domain or otherwise under control of the federal or state government, but where use is made of such lands by private individuals, the ownership of land and use of these public lands is a part of the basic economic structure, and influences greatly the systems of farming associated with it. In Utah approximately 50 percent of the state is unreserved public domain, and together with the remainder of the 80 percent not in farms, included in public domain, National Forests, mineral reserves and national monuments, is largely used for grazing purposes.

It cannot be emphasized too strongly that accurate maps of ownership of land and of topography of land will form maps of the important bases of determining the boundaries of areas as they are finally decided. The time of settlement and the law under which ownership was acquired may have an influence on the system of farming. The Federal Land Offices located in central cities of the West, and the State Land Offices, have plat maps on which are noted the class of ownership or reservation for each titlehold for any land in that section.

IV. Economic and social conditions affecting type of farming.

A. Historical.

B. Location with respect to markets.

C. Relative prices and other economic factors.

(2) The classification of physical and biological factors and the methods of measuring and portraying them are somewhat similar to the classification used and the methods suggested in Projects 2 to 9 inclusive of Bulletin No. 2 of this series dealing with research in Land Utilization. They are to be used in this project, however, as an aid in determining the boundaries of type-of-farming areas and in analyses designed to account for the location of the boundaries and the systems of farming found in each area, while in the land utilization projects they are related one at a time to land use in an area. In Project 3 of this report Dr. Black points out that on account of this difference in objective and point of view, the method of analysis in a type-of-farming study must be quite different from that in the land utilization projects. (H. R. Tolley.)

In Utah the relative importance of the historical aspect of a study of this kind is perhaps greater than in some other areas. The plan of colonization used by the Mormon pioneers was different from that usually found in the West. These people generally settled an area by a concerted group movement instead of by slow infiltration of individuals. Their leaders had detailed plans of organization of the farm community which were followed in nearly all parts of the state. The result has been the village system of economy with its small plots of land in the villages, scattered farm holdings for each individual, and residence at some distance from most of the farm land owned by the individual. The degree to which present systems of farming are the result of these early colonization programs will be at least estimated in the type of farming. A rather high birth rate and the desire of a large proportion of the young people to stay in the community in which they were reared has brought about in various communities a pressure of local labor supply on the various other factors of production, resulting in intensified systems in many areas, where, under other social conditions, such a development probably would not have occurred.

Location with respect to markets and marketing facilities has greatly influenced the local price situations within some areas. The recent development of roads and trucking services has changed the marketing facilities for many isolated sections, and this is bringing about a readjustment in the types of farming. These factors should be carefully studied to provide a basis for determining the ultimate influence which these improvements will have upon the farming systems in the areas affected.

Determining boundaries of type-of-farming areas and classifying the systems of farming in each area.

The county statistics of the 1930 Census of Agriculture will be analyzed following the method outlined in Project 1 of this report, and the results of this analysis related to the information on the physical, biological, and economic factors discussed above. When this is done, the boundaries of areas within which there is a considerable degree of uniformity in the type of farming should be evident. It is probable that on account of the great variations in physical factors, the boundaries of the areas will in most cases coincide with the boundaries of well defined physical areas.

To classify the systems of farming in each area, a sample of the individual census schedules for that area will be sorted in a manner similar to that described in Project 2, grouping the farms first into size groups, and then into types within these larger groups. Factors of organization, such as kinds and acreage of crops grown, and numbers and kinds of livestock will be used as measures of type.

The use that is being made in the various types of organization of pasture or range lands not owned by the farmer, either National

Forests and Reserves or public domain, will be ascertained for the farms to be classified. Since census material will provide no basis for these estimates, it will be necessary to obtain this information by direct field survey. The type of information needed would be: (1) seasons of year outside pasture was used; (2) number of head of each kind of stock placed on such range; (3) relative gains of weight made by stock (i. e., whether the range was maintenance only, the gains being made by farm feeding or pasture, or whether range gains were also made); (4) cash outlay involved in use of such range, for labor and supervision particularly; (5) degree of control by farmer over range, and likelihood of keeping such control.

This project will be followed by others organized along the lines of the projects discussed in the latter pages of this report. In particular, the next step will be to proceed from the description of present conditions to regional or area planning and organization for the future. The limits and possibilities for each area considered as a unit, and for producers as individuals within the area, will be determined. The goal of such planning will be maximum income for the area as a whole over a period of years.

Some of the problems peculiar to Utah that must be met are: (1) use of irrigation water to yield maximum economic production in conjunction with other resources; (2) interrelationship of range land and crop land so that maximum net return will result; (3) use of range so that deterioration and floods will not result; (4) necessary reserves to be carried, for area and individual, either in cash, harvested feed crops or incompletely grazed range, against crop shortages. This latter is particularly important in view of the general reliance placed on feed for livestock in the farming system, and the need of shipping animals out of the area when shortage of feed occurs.

PROJECT 4-B. Types of Farming in Nebraska.

(By F. F. Elliott and Harold Hedges.)

The particular objectives chosen to be stressed in the study of types of farming in Nebraska were as follows:

- (a) Mapping of type-of-farming areas with counties and townships as units.
- (b) A qualitative analysis and appraisal of the factors instrumental in determining the types of farming in each such area.
- (c) The selection of typical farming systems for each important size group, and determining the amount of dispersion existing in farm organization within each such area.

In segregating the various counties into type-of-farming areas, a study was first made of the geography of Nebraska's agriculture.

The distribution and concentration of the various crops and animal enterprises grown in the state were shown by means of dot charts and hachure maps using state and federal agricultural statistics as a basis. The relative importance of each group for each county or township was shown by relating its acreage or production to the total farm acreage in that county or township. The numbers of each class of livestock were shown on a per-square-mile basis. The counties or townships having about the same amounts and proportions of these various enterprises as shown by these ratios were grouped and were tentatively designated as type-of-farming areas.

The soil and physical conditions in these areas were next studied to determine the degree of uniformity existing. A study likewise was made to see if the historical changes in the acreage of crops and numbers of livestock in the areas had been the same or similar. Modifications in the first grouping of the counties occasioned by these additional checks were made and the final boundaries established as shown in the published bulletin (Nebraska Bulletin No. 244).

After the boundaries of the different areas had been established, an analysis was made of the specific conditions determining the type of farming in each area. This was done on a qualitative basis taking into consideration the various physical and economic conditions existing within the area and the possible alternatives available.

In determining the typical farming systems prevailing in each area, townships were first selected typifying the conditions found within the area. The acreage and production of each crop and number of each class of livestock were then obtained from the original files of the federal census for every farm in each of these representative townships. Approximately 90 townships, having a total of 7500 farms, were selected in the state. The farms in each of these townships were sorted by size and then arrayed and sub-arrayed on the basis of the most important enterprises. This grouping resulted in getting the farms together which had the same or essentially the same organization. The mode of these groups was then taken as the farming system typical of that group.

This method of approach works fairly satisfactorily in a state such as Nebraska where the physical conditions within local areas are fairly uniform. It is probable, however, that the limits of the type-of-farming areas could be more definitely established were the approach made from the individual farm standpoint rather than from the total township or county standpoint. The use of county or township totals will tend to show a greater degree of uniformity within an area than actually exists. It may be misleading, therefore, to assume that counties have the same type of farming simply because they show a high degree of similarity in their enterprise combinations based upon county or township group totals.

Were individual farms first classified by type, this delimitation of areas probably could be made considerably more definite. For

example, it would be possible to show areas in which a specified number of farms were of a given type, and at the same time show the relative importance of other types in the same area. As suggested in Project 1, the number of areas so designated would be determined by the degree of precision desired by the classifier.

This latter method of determining type-of-farming areas, is, we believe, superior to the method used by us in the Nebraska study. Furthermore, it would be considerably easier to show variations in farming systems within an area if individual farms were first classified by type. To show such variations it simply would be necessary to select a representative township within the area and go to the original files of the census and take off the organizations of all the farms, which had been classified by particular types, and then group them so as to show differences in the magnitude of operations and variations within each type. It is difficult to relate the type of farming in an area to the physical and economic conditions prevailing within such areas when the dispersion in type is not shown. Classifying the individual farms first by type and then grouping into areas would greatly reduce this difficulty and give more tangible and precise results. The typical farming systems as set up in the Nebraska Bulletin, No. 244, in the main are satisfactory, yet they lack somewhat in precision. A more detailed study of practices should have been made, particularly in the intensive feeding area.

PROJECT 4-C. Type-of-Farming Study in Connecticut.

(By I. G. Davis.)

While rainfall and general climatic conditions are nearly uniform throughout eastern areas of Connecticut, there is marked heterogeneity in soil topography and length of the growing season within townships. Differences in critical frost dates and in soil and topography give rise to important differences in farming within distances of three or four miles. The area is studied with cities and industrial villages, and the position of farms relative to these centers of population has an important relationship to type. While the state is covered with a network of hard roads, large numbers of farms are located on dirt roads and are less accessible to markets and cities. The urban and industrial character of the entire area has given rise to much use of farms for residential purposes and recreational purposes, and to manifold types of part-time farms, all of which must come within the scope of any type-of-farming study.

The purposes of the Connecticut type-of-farming study are:

1. To classify the farms found in certain areas into classes sufficiently homogeneous so that some fairly specific generalizations can be made concerning the nature of the adjustments to given price or technical changes. It is not essential that all the farms should fall into the classifica-

tions set up. Indeed, it may be and probably will be true that numerous farms will defy classification.

2. To determine the degree of association of farms of each main type with factors of the natural or economic environment, such as soil, size of fields and farms, distance to cities or towns, etc.
3. To determine the trend of changes in type of each important class of farms in each of the more important environments in which it is found. Studies in farm organization and management and in land utilization are related to these studies.

The steps taken in the study thus far have been as follows:

1. *Attempts to define areas by the use of township data.* Township census data were compiled and averaged on a per-farm basis. Land utilization, values of land, buildings, etc., acreages of crops and numbers of livestock were mapped. The trends of agricultural development were studied. An attempt was made by the use of productive man-work units to picture the average type of farm for each township in the state. Topographic and soil features and population centers were mapped and an attempt made by inspection and comparison of maps to arrive at conclusions. Storrs Station Bulletins Nos. 127 and 146 are devoted to results of these studies. While they yielded results of some value and importance in the orientation of general agricultural policy, they proved of little use in helping farmers in their adjustment problems or to either public or private agencies in projecting specific enterprises demanding definite localization. It was realized that even the township "average farm" was a composite of a number of farm types, and that it described none of them.

2. *Classification of farm types.* The next step was an attempt to find a method of farm classification which would meet the requirements set forth in Project 2 of this report. The use of census data relating to individual farms was discarded for the reasons there stated. For the preliminary studies, farm account data from about one hundred farms were employed. Various data describing the farm business were entered into classification charts and the relationships of these data inspected and studied. Various suggestions as to methods of classification were studied and discarded, and a method somewhat like that described in Project 2 finally evolved. The next was a trial survey in one township. A schedule (shown in Project 2, was set up intended to yield the requisite data in most convenient form, and nearly three hundred records were secured. As a result of this trial study, the tentative method of classification described in Project 2 was adopted.

Data have now been secured from twenty three hundred farms in twelve townships. The tentative system of classification will be checked by these records before finally adopted. Frequency distribu-

tions will be made of different enterprises and their characteristics, and as far as possible the classifications will be made to conform to the distributions thus found. It is probable that with this number of farms, new classifications or subclassifications other than those noted in Project 2 will appear.

3. *Explaining the existence and location of types of farming.* The existence and location of the various types of farming can undoubtedly be explained as an adjustment or economic organization to the relatively fixed factors of their natural surroundings and to the less stable factors of their economic and social environment. The trends of types in different situations can be explained as their adjustment to shifting prices, techniques, and methods of organization. The first step in the explanation of types of farming will be to examine the association between type of farm, and soil, topography, distance to market, and other measurable factors of the environment. Correlation studies may also be employed to help explain the size of business and enterprises under varying conditions.

Association analyses of this kind may be made not only between the type of farming and the environmental factors, but between specific characteristics of farms and of the environment.

These cross-section studies are likely to be much more illuminating if they can be supplemented by similar data taken from earlier periods, and analyzed in a similar way. The researcher should not be deterred if these earlier data are incomplete or fragmentary. They are likely to throw much light on the relationships being studied. Attention should be given to all the factors entering into an explanation of present types and their locations, those not capable of statistical measurement as much as those which are.

These association analyses and historical studies will not only afford a basis for explaining the present character of farming in the townships selected for the study, but they are a basis for the description of the agriculture of the entire region, and for projecting the trends in farm type somewhat into the future for each soil and set of local conditions. As a result of such studies, it should be possible to describe for any part of the area for which soil type, topography, size of farm and the general economic and historical background is known, the types of farms that probably will be found and their probable relative frequency of occurrence.

Comments on Type-of-Farming Studies. (I. G. Davis.)

The purpose of research in farm management and organization is to make possible certain generalizations capable of being applied to known groups or classes of farms. The finer the classification of farms and the more homogeneous the farms within a group, the more specific and definite these generalizations can be.

Project No. 1 is justified from the standpoint of agricultural economists who wish to understand the organization of the agricul-

ture of a region in the large. Project No. 2 yields a description of the farming types within regions and affords an accurate description of the farming within an area. It is, however, only when such studies are so integrated with other studies that results of specific value in the formulation either of public policy or farm management policy ensue, that they are justified. They should therefore be viewed as an essential basis for the development of a research program directed at the problems of farm management and public policy within a region.

In urban areas like the state of Connecticut, such studies also constitute the point of departure for studies in land utilization. Usually two and often more major uses of land are found in one landholding. Little or no land is submarginal for all uses. The problem of defining the margin does not appear in the form that it does in more remote areas, and the definition of areas adapted to a major use are complicated by the multiplicity of uses. Under such conditions the point of departure is the pattern of economic organization of landholdings. This is similar to the type-of-farming concept except that it allows for non-agricultural sources of income and types of use. The problems of land utilization and farm organization tend under these conditions to become merged. Broadly defined, type-of-farming studies, which include within their scope agricultural, semi-agricultural and even non-agricultural types or patterns of economic organization, are the initial phase of both studies.

The present sample used in crop reporting is to a considerable extent self selected. With adequate types-of-farming studies, the farmer reporters might be segregated in accordance with the type of their farms and the reports from different types so weighted as to give a properly weighted final estimate and one more likely to be correct.

The extension organization faces the problem of conducting the agricultural outlook and working out the best adjustment for the particular outlook situation. The same adjustment policy cannot wisely be applied to all forms in a region of diverse farm types. On the contrary, it is essential that advice as to adjustment procedure be adapted to each important type of farm in an area and that each farmer possess the means of identifying the type of his own farm. While farm classification probably cannot be carried to a degree of refinement which permits adjustment policies to be adapted in detail and specifically to the exact needs in individual farms, nevertheless type-of-farming studies properly conducted with farm organization research should make possible adjustment policies much more specific and useful to particular farmers than heretofore.

Comments on Type-of-Farming Studies. (H. R. Tolley.)

The space devoted to discussion of type-of-farming studies is out of proportion to their present importance in the research program.

Only 11 of the 48 states had such studies in progress in 1931. In some states those responsible for the formulation of the farm management program prefer to proceed directly to studies such as those presented later in this report without waiting to make the more general type-of-farming studies. In some of the states where a comprehensive program of farm management research has been under way for a number of years, the research workers have gained through their intimate contact with and studies of the systems of farming in the state, much of the knowledge that would have been obtained from some of the phases of type-of-farming studies.

A considerable part of the analysis that has been made in many of the studies of the farm business analysis type is closely related to the analysis called for in Projects 2, 3, and 4. In fact, Dr. R. McG. Carlsaw, an English student of farm management, who spent several months in the United States in 1929 studying the organization and methodology of farm management research, apparently failed to see any distinction between type-of-farming studies and farm business analysis studies in which the data were collected by the survey method. In his book *Farm Management Research Technique*, he uses the terms "type-of-farming studies" and farm business survey studies interchangeably.

The data obtained from individual farmers in the farm business analysis studies are, of course, considerably more comprehensive than the data obtained in the Census of Agriculture, and if it were possible to obtain suitable farm business survey schedules from every farmer in a state or region every five years, they would form a more satisfactory basis for type-of-farming studies than do the census schedules and tabulations. But on account of the great cost involved this is out of the question, and serious difficulties are involved in obtaining by the survey method a sample of farms that will be representative in every particular of all the farms in an area. (See discussion of sampling in farm management surveys in *Research Method and Procedure in Agricultural Economics*.)

Increasing emphasis is being placed by many research workers on (1) obtaining a more scientific basis for determining the extent of the applicability of results obtained and conclusions drawn from intensive studies of small samples of farms, and (2) understanding the forces and conditions which have been responsible for the development of the systems of farming in different areas and regions. Type-of-farming studies unquestionably can be of great value in both connections.

A classification of farms by types has been made in connection with the 1930 Census of Agriculture, and tabulations of the major items on the census schedule have been made by farm types for each county. While the classification and tabulation is not in as great detail as might be desired by many research workers, it will be very helpful in the future type-of-farming studies.

The methodology of type-of-farming studies is still in the developmental stage and the discussions should be helpful in stimulating further development, as well as in giving to those who may inaugurate such studies in the future the benefits of the viewpoints and experience of the workers who were responsible for some of the studies which had been completed or were in progress at the time of writing.

PROJECT 5. Current Changes in Farming.

OBJECTIVE: To measure and analyze changes in systems of farming practices in an area or state.

(By L. H. Hauter.)

The objective of this project will be to determine changes that are taking place in systems of farming and farm practices *as they occur*, and to analyze them from the standpoints of probable cause, soundness and probable economic effect.

Its value will be to keep research and extension workers, farmers and others informed regarding changes that are taking place, and the causes and desirability of the changes. It may also be used to provide information that will help to show the effect of outlook and other information that is being disseminated. It can also provide information that can be used to hasten or retard the changes, as may be desirable, and to suggest the need of meeting the effect that the changes are likely to have on the economic structure of the area.

It may cover an area of any size for the purpose of gathering the information, but when a large area is covered, including different types of farming, it will be desirable to make homogeneous subdivisions when making the analysis. A state will no doubt commonly constitute the unit.

Sources of data and methods of collecting it.

Suitably planned farm management surveys conducted in successive years in a representative subdivision of a type-of-farming area or in a representative sample of the farms of the area would yield the information needed in this project if the results could be summarized promptly. If changes in farm practices are to be covered, however, some information will be needed which is not included in the standard conventionalized farm business survey; and much of the information of such surveys will not be needed. Similarly, farm account books for successive years would supply much of the information on crop acreages, numbers of livestock, yields, etc., if the accounts were from representative farms and if they could be summarized promptly at the end of the year, and if they were similarly supplemented by certain data on farm practices. However, since it has not been the primary objective in the farm business surveys and the farm accounting projects to measure and analyze changes *as they occur*, the methods of selecting farms have not been

such as to insure representative samples, and often the data have not been summarized and analyzed promptly enough to meet the needs envisaged here. Moreover, such procedures for collecting data are so expensive as to rule them out for any project that is to be continued year after year over a large area.¹

The tabulations of the Census of Agriculture if analyzed by the methods which have been developed in connection with type-of-farming studies would yield much information for census years; but the federal census is taken only every five years, and the tabulations are not available until at least a year after the time of taking the census. It might be possible for some states to work out a co-operative arrangement with the agencies making the annual state censuses so as to have collected most of the data needed. No doubt the experiment station would have to tabulate them so as to get the results promptly and in the form desired. Sampling could be resorted to to reduce the labor involved. The annual estimates of crop acreages, yields per acre, and numbers of different kinds of livestock in each state which are made and published promptly at the end of each year by the state and federal crop reporting services are useful in this connection, but the estimates are made for each state as a whole. With present crop and livestock reporting methods, reliable estimates cannot be made for subdivisions of a state.

An annual agricultural census of sample townships throughout the country, as has been advocated for several years by many agricultural economists in the United States Department of Agriculture and the agricultural colleges, would give an excellent measure of year-to-year changes in systems of farming and farm practices in every area of the country. One or more representative townships in each type-of-farming area in the country would be selected, a complete agricultural census of each of these townships would be made every year—the schedules and method of enumeration resembling those used in the regular agricultural census—and the results summarized and made available immediately upon the completion of the enumeration.

For the present, apparently, most institutions wanting to keep abreast of current changes in their agriculture, will need to develop machinery of their own, less elaborate and less expensive to operate

(1) This type of project is particularly important if the farm management research program of an experiment station follows the lines indicated in Projects 1, 2, 8, 9, 14 and 17, that is, of classifying the systems of farming, working out the more permanent physical relationships involved in such farm set-ups, and combining these with the constantly changing price and other economic data, into farm organizations that best fit conditions at the time, making use of the synthetic or budget method outlined in Project 8. Given carefully worked out physical data, and carefully reported economic data, the resulting farm organizations cannot fail to fit, except in so far as they may be forecasts. The contrasting program, advocated by Professor Myers—See Project 8—is to repeat a standard farm business survey every five years or so. This fails to recognize the differences in the nature of physical and economic data, and employs procedures particularly suited to neither. (EDITORS.)

than the above. Two procedures are possible for obtaining the data, one to begin by sending mailed questionnaires to a large list of farmers and gradually develop from this their own list of farmers who will make usable reports year after year; the other, to begin by making farm-to-farm surveys in selected areas, intended to be representative, and follow this with mailed questionnaires to the same farmers in subsequent years. This survey at the start will establish the contacts needed, stimulate interest in the project, and instruct the farmers as to how to make accurate reports. This second procedure is the better if it can be afforded.

It will be apparent that type-of-farming study of the state or region will furnish an excellent basis for planning and laying out such a project. Any farm organization and management studies that have been made in any of the type-of-farming areas will also be useful in furnishing a background for interpreting the data of annual change.

A limited amount of supplementary information can also be secured from dealers, cooperative associations, etc., regarding products bought by and sold by farmers, sales of supplies and farm machinery, etc.

The organization for carrying on a project following the lines last suggested and covering an area such as a state can be a simple one, so far as the collecting and summarizing of the data are concerned. Ordinarily one man in charge of the project with suitable clerical help will be all that is necessary, and since most of the data will be gathered only once a year, it will require only a portion of his time. The man in charge should be intimately acquainted with the systems of farming and farming practices. Since this is a type of study that might well be extended into several states, a cooperative agreement between several states, or between a state and the United States Department of Agriculture, to carry on similar projects, would greatly increase the reliability and usefulness of the study.

Selection of farms.

The method of selecting the farms and the number to be selected will depend on the area to be covered. Since most of the information is to be gathered with mailed questionnaires, a random sample would not be possible even if it were sought. Only certain types of people would fill out the questionnaire regularly. A high degree of selectivity usually develops using such methods. (See discussion of this in *Research Method and Procedure in Agricultural Economics*.) Under these circumstances, one might as well set out deliberately to secure farmers who are willing and able to cooperate, but who when selected will represent the agriculture of each type-of-farming area. This will require that the representatives of the farmers reporting will need to be tested out empirically or by checking them against census data and the like. (See discussion of such methods in

Research Method and Procedure in Agricultural Economics.) Such a selection might be made with the assistance of the county agents or others who are acquainted with a great many of the farmers, in case it is not possible to start out with a survey. If a survey is made, it should include as a vital part the selecting of farmers who indicate their willingness to continue the cooperation by filling out mailed questionnaires, as well as securing the needed representativeness. If the questionnaires are merely sent out to a random list of farmers, the final list being built up of those who continue to cooperate, it will be even more necessary to test for representativeness, and revise the lists as needed. Regardless of what method is used to obtain the original list, a certain amount of elimination will be necessary, as there will be some on the list who will later prove unwilling or unable to fill out the questionnaires properly and regularly.

Regardless of the method used in selecting the reporters, their distribution should be based on the importance and homogeneity of the area. For a type-of-farming area that is reasonably homogeneous, which ordinarily means rather limited in territory, 100 to 200 reports should give fairly reliable results. To the extent that the area is not homogeneous, or that it needs to be subdivided, a larger number of reports should be secured.

Period to be covered.

The period to be covered will usually be indefinite. In some cases it might be desirable to secure the information for a limited time only, during the development of an area or during an important transition period. Again it might be desirable to secure information of this kind for a limited period, one to five years, for the purpose of studying the effect of outlook work or other efforts of the extension service to secure a change in practices. In most cases, however, the project will want to be continued as long as it is giving valuable information. The value of the information and the analysis will usually be materially increased as the length of the period is increased.

Measuring changes in systems of farming.

Changes in systems of farming involve principally changes in the acreages of crops, and changes in the number and kind of livestock kept. For both crops and livestock, the farmer should be asked to report each year the actual situation on his own farm. For the purpose of measuring and analyzing the changes from year to year, the acreage used for different crops should be converted to percentages of total land or total crop land. For livestock, one may use the number of head of different kinds and classes of livestock per farm, or per hundred acres of land, or per hundred acres of crop land, according to which best fits the area. Possibly all three of them may be needed to tell the whole story. The percentages or ratios can be based on the average of the farms reporting, if there

arc but few changes in reporters from year to year. For a state average, the reports by districts need to be weighted according to the importance of the district which they represent. Census figures for crop acreage might be used for weighting. With this method, both frequency and average figures can be used.

If there is a considerable change in the reporters from year to year, it would be more satisfactory to use the reporting farms to indicate the percentage of change from the preceding year, using only those reports each year where reports were also available for the previous year. These percentage changes could then be converted into actual figures for the whole area by applying them to the census or some other reliable data, in the same way as is done by the Division of Crop and Livestock Estimates. If this procedure is followed, the area must be subdivided to correspond with the divisions used by the Bureau of the Census for its reporting, unless other data are available that can be used as a basis for breaking up the census totals.

The livestock classification to be used would depend on the area studied. In most cases it would be desirable to report milk cows, brood sows, ewes, etc., separate from the young stock, as the number of head of breeding or producing stock is usually the more significant in reflecting the system. Where livestock is purchased for feeding, this should be reported separately.

Receipts from different products might be used to measure changes in the system of farming, but since receipts are influenced both by yields and by prices, they would not be a reliable basis for measuring changes from year to year. Physical units, such as acreage and number of livestock, reflecting the farmers' intentions, are more satisfactory for measuring annual changes, and they are much more easily secured with a mailed questionnaire.

Changes in farming practices.

Changes in farming practices may pertain to many things, and the practices to be included will depend on the area covered. The use of tractors, the size of implements, the depth of plowing, the number of cultivations, the time of planting, the method of harvesting, the use of fertilizers, the use of silage, the method of feeding, the time of breeding, and the method of housing are a few of a great many practices that might be included. Questions should be made very specific and in such a way that the answers will be suitable for group analysis.

Farmers should be asked to report the practice used on their own farms, with such quantitative and qualitative description as may be desirable. That is, we may be interested not only in knowing how many farmers are using tractors, but we may also want to know the kind and size of tractor used. Most of the information could be tabulated on a percentage-of-total basis for comparative purposes

from year to year. For instance, the percentage of all farmers that are using tractors could be determined, and then the percentage of those who have tractors of different sizes could be determined. Such a tabulation would require some grouping, but it would be more satisfactory than average figures for making the comparisons and the analysis, although average figures might also be determined.

In case of equipment, information should be secured on new equipment purchased as well as on equipment used. Farmers frequently use old equipment for many years after they realize it is obsolete because they do not feel that they can afford to discard it for the new. The type of new equipment purchased is much more significant in indicating the change that is taking place than the type of equipment used. This is of special importance when looking into the future.

Analysis.

A project of this sort should not content itself with merely collecting the data of change. It should attempt to account for this change, and see to what extent it reflects needed readjustments of farm organization and farm practice to changing economic and other conditions. If this analysis is going to be as effective as desirable, one should have information as to the history of the same types of changes in the period leading up to the present. This means that at the beginning of this study, one really needs to make some sort of a historical study of the changes in each type-of-farming area. Such a project as No. 3 will provide exactly the kind of information and analysis that is needed. The new data each year can then be added on to the series already established, to see whether they continue these trends, modify or reverse them. One can then relate these results to the causal analysis developed in Project 3, and if the trends are changed in any way, set about discovering the new influences present, or changes in relative weight of the old ones.

As in the case of price forecasting, this year-to-year checking of the results of the historical analysis is of great value in testing the validity of the historical analysis, and its applicability to the future.

In practice, of course, an experiment station may want to start a project such as No. 5 before one like No. 3 has been undertaken; and it should not be discouraged from doing so. But as much historical work as possible should be done, in the early years of it especially.

Cross-section comparisons of the changes in different type-of-farming areas, and relating of these to old and new influences, will be as helpful as the historical analysis.

The method of determining what part a given environmental change has had in producing given changes in farm organization and

farm practice, that is likely to be most conclusive, is that of relating it to the effect on net farm incomes, in the manner outlined in Project 3. The results of all studies in farm management and related fields should be useful in explaining changes which are occurring. An earlier study of the effect on net income of growing different proportions of corn and wheat would furnish data and analysis to use in explaining why farmers are changing from one crop to another. A study of the relative advantage of horses and tractors might furnish the information needed to explain why there was a change from horses to tractors. There may be a definite correlation between the price of cotton and the use of fertilizers which accompanying analysis shows, which may explain a change in the practice of using fertilizers.

If changes are taking place that are likely to continue, the analysis might point out some of the effects that such changes are likely to have on the economic structure of the area. Such an analysis will help research and extension workers, farmers and others to be prepared to meet the change.

Obviously such a project as this would keep a staff constantly informed as to new developments needing to be studied. It might therefore largely furnish the basis for laying out the whole research program in farm management. This might prove to be its most important value.

PROJECT 6. Interregional Competition in Agricultural Production.

OBJECTIVE: To determine the nature and extent of the competition between two regions producing the same product, the changes that have taken place in this competition and reasons therefor, and present trends in the same.

(By J. D. Black.)

Many situations arise calling for an analysis of the form and nature of the competition between areas in the production of some product, and of the probable outcome of such competition. The commonest situation is where an area finds itself losing some of its market to another, as New England is now losing some of its market for cream to the Midwest, and develops an interest in the reasons for this, and in whether or not to attempt to meet the competition, and if so, how. The obverse of this develops when an area becomes interested in invading further a market now largely held by some other region. Questions of regional competition arise wherever one starts planning a long-time production program for an area; or the nation begins planning for the production of a given crop. The Federal Farm Board should have had such studies at hand before setting forth on a campaign to reduce the acreage of wheat to the point where no wheat is exported. Without such analysis, the Board

was in no position even to guess whether or not the wheat growers of the United States would continue in the export market.

The objectives of this project as here outlined are, first, to furnish the understanding of the competition in question that is needed as a guide to production activity in any of the foregoing situations; and second, to elaborate the body of principles of economics relating to such competition.

The actual planning of the agriculture for a region is reserved for Project 12.

Scope of project.

The five preceding projects deal with type-of-farming analysis. This project and Project 7 are primarily upon a commodity basis, albeit the commodity always as tied with others in systems of farming. In the various competing areas involved, the commodity in question will probably be tied in with almost as many different systems of farming as there are areas. For example, compare the systems of farming in which wheat is combined in eastern and western Kansas, in Indiana, in Maryland, in Minnesota, in western North Dakota, and in the Palouse area of Washington—to say nothing of the areas in other countries. It is this variety in systems of farming in which the product is included that makes this project extremely complex.

A further reason for its complexity is the manner in which natural and economic and other social factors became combined in it. This same combination has been noted in Projects 1 to 4; but in none of these was the interaction of natural and social factors so intense and so vital to the solution of the problem.

Physical factors change in some measure over a period of years no longer than may come under the purview of this project—for example, the soil in an area may be depleted by erosion. Biological factors may change much more in such a period—at least, in extreme cases such as the boll weevil infestation. But the major shifts in areas of production for most of our farm products have not come because of changes in physical or biological factors. They have resulted from changes in economic conditions that have revealed themselves in changes in relative prices of different products in the area, or in relative prices of production factors, or in both. A relative decline in local price of wool in the New England states and a relative rise in price of milk has accompanied the shift from sheep to dairy cows in that section. Wool could be produced in abundance in the broad prairie regions of the earth and shipped to Boston; and its price decline in consequence. As the population of New England grew in numbers, more and more fluid milk was needed, and it is expensive and difficult to transport; in consequence, local prices of milk rose relatively in New England. Price changes of this nature will generally be found accompanying all shifts between major lines of production in a region. In some cases, however,

changes in supplies and prices of labor or other cost-factors have contributed as much to these shifts as changes in prices of the products, or perhaps changes in the technique of production have made it possible to get along with less labor, or secure larger outputs per unit of labor. The relationships that are most vital will therefore usually be found essentially economic in character in most cases; and hence the analytic methods will need to be those suited to economics.

Since the main objective of the project relates to explaining present competition, the project must be essentially a cross-section analysis. The cross-section approach, however, should be reinforced by a certain amount of genetic or historical approach. The competition between regions will thus be accounted for in two ways, one by showing the factors and circumstances that are associated with it now; and the other, by tracing the stages by which it grew to be the way it is now, and the other changes that have been associated with these stages.

The cross-section analysis will be in terms of variables associated with difference in space, but this does not make it just geography. Likewise the analysis in terms of variables associated with differences in time will not be just history. Not all analysis in terms of space is geography; and not all analysis in terms of time is history. If they were, then nearly all of science would have to be classified as either geography or history. (See classification of scientific methods in *Research Method and Procedure in Agricultural Economics*.)

A project of this kind can be undertaken on four levels of intensity and thoroughness, as follows:

- A. A largely qualitative analysis that contents itself with showing the trends in production in the competing areas considered, and such related factors as the competitive price structure, and the market and transportation set-ups for these areas, with changes in them.
- B. An approach from the standpoint of some one producing area and its market outlets, this area being given a thorough analysis, with trends carefully delineated and explored.
- C. A thorough analysis of competition between two or several areas that are in close competition with each other, probably all in the same country.
- D. A thorough analysis that covers all important areas in actual or potential competition with each other.

All four of these will be discussed, the most thorough and complete one first, so that in discussing the remaining three, we shall always understand what is omitted.

The procedure in this project depends absolutely and entirely upon the theory upon which it is based. This theory is presented in

textbooks and treatises generally available; but not all in one of them. Accordingly, it needs to be briefly outlined here, with references to fuller discussion elsewhere.

Basic qualitative analysis.

The economic analyses involved in this project relate basically to the principles of Specialization and of Comparative Advantage, the first of which affirms, when applied to land, that any given area within which conditions are homogeneous tends to be used in producing one product and one only; and the second of which affirms that the product which tends to predominate in such an area is the one which has the highest ratio of advantage in production there, account being taken, however, of the relative demand for the products competing for the area. Thus the land in a certain tract may pasture nearly as many cattle per acre as any within reach of competition with it, and be outdone by several in its returns when planted to grain; and yet it may be used for grain if grain is relatively the scarcer of the two in the market place. The price of grain will be high enough so that enough will be produced to satisfy the consumer's wants for grain as well as they are supplied for cattle products. (For an explanation of this principle, see Black, *Introduction to Production Economics*, Chapters V and IX; and Garver and Hansen, *Principles of Economics*, Chapter XXXVI.)

The competition between farm products in any one area and between the same products in different areas, is an exemplification of the foregoing principles. In practice, of course, the land in many areas varies greatly in soil, topography, etc., and in consequence different products have advantage in different parts of the area. The problem therefore may not be as simple as if one could assume each area to be homogeneous. In practice, also, conditions from one part of one area to another shade into each gradually; and hence advantageous uses shade into each other gradually. Also as prices change, due to changing relative demands for the different products, or because new regions begin producing any of these products for the same market, or drop out of production, the margin between the parts of an area where any product has advantage will shift.

If land always at once found the uses at which it has comparative advantage, there would be no need for any studies in regional competition. But it fails to find such uses promptly. It fails because the utilizers of it do not know enough about its natural qualities, about the regions with which it must compete for a market, and about the nature of the demand for the various products to which it might be devoted; because they fail to foresee the changes that will take place in competition and demand; and because of the time it takes to shift to a new use even after it is recognized as needed. Shifts commonly make useless some previous investment, and it may even be good economy to make them in such a way as to realize

part of the remaining values in the old investment. (See Black, *Introduction to Production Economics*, Chapters XXII and XXVIII, for a fuller discussion of maladjustment in production.)

The operation of the principles of Specialization and Comparative Advantage is profoundly affected in agriculture by the circumstance that different species of crops and livestock supplement each other, that is, they use land, labor and management, and buildings and equipment at different times of the day, in different seasons of the year, and in different years in a crop rotation; they also use some land and labor that would otherwise not be used at all. Thus livestock grazing on waste lowlands and uplands may provide the only possible use of the grass growing there. The *complementary* relationship involves the use by one line of production of the products of another, as the dairy herd uses the crops as feed, and the crops use the manure from the herd. The *joint-product* relationship involves obtaining two or more products from one source, as milk and meat from cows, or breaking up of a product into several physical components, as the cotton ball into cotton and cotton seed. The term *conflicting* is also used in such analysis, in large part as an opposite of supplementary. Thus two products which use labor or land at the same time are said to be conflicting in that use. The use of land for woodlot and pasture at the same time is conflicting to the extent that one use reduces the income from the other. (See Black, *Introduction to Production Economics*, Chapter VIII, for a fuller discussion of these relationships.)

The effect of these relationships on analysis in terms of comparative advantage is that the advantage compared may not be between individual products, but between the different combinations of products in which these products are included. Thus in a given area, systems of farming in which a fourth of the land is in corn will be compared with systems in which a third or a half is in corn; and similarly for the other areas that are being considered as in competition with this one. At any given set of prices for the competing products, and for the input factors that must be purchased, some one of these combinations will yield the largest net income to the farm family and its investments. This combination has comparative advantage under these circumstances. It derives this advantage from the fact that its soil and other factors combine with the relative prices of the different products, and the lines of production supplement and complement each other, in a certain way that gives maximum economic product. The supplementary and complementary relationships, and for that matter the joint-product relationships, have no small part in determining what combination has advantage. There is likely to be time in the year's operations, or space in a crop rotation, for a line of production only of a certain size; if it is larger, it will conflict in the use of labor or land with a more important line of production and reduce the income. Too large

a grazing unit supports more cows in summer than can be kept over winter on the forage grown on the crop land; and too small a grazing unit leaves a surplus of forage to find an outside market.

Within an area having about the same type of land throughout, one normally will find a considerable range in proportions between products. These may be justified because of differences in the relative abilities of the different farmers as crop husbandmen and animal husbandmen; in the available supplies of family labor, or the farmers' abilities to handle hired labor; in the available supplies of capital or credit, etc. But many of the differences in the proportion of products will represent maladjustments—farmers using combinations which do not represent relative advantage for them. These maladjustments greatly complicate the analysis of regional competition.

Textbook discussions of comparative advantage usually illustrate the principle, for simplicity's sake, in terms of labor only. All economists recognize that relative returns to all the factors of production must be taken into account. In practice, this is sometimes attempted by combining all the production factors into a composite unit-cost figure—that is, the amounts of the input factors used in producing units of each of the competing products are combined on a value basis. This procedure is feasible where a plant is turning out one product only, or several if there are no supplementary, complementary or joint-product relationships within the producing units, and further if all the input factors are purchased for these specific uses in the open market. This situation would maintain if one were comparing the advantage of all-wheat and all-beef-cattle farms on which all the labor was hired. The composite unit-cost procedure is not feasible where two or more uses are combined in one producing unit and the same land or labor is used for the different products. The farming units which are compared in studies of regional competition nearly always have several products, as diverse perhaps as milk, eggs, beef, potatoes, and hay. The unit-cost procedure therefore has very little use in comparative advantage analysis of regional competition in agriculture, and where used has commonly pointed to irrational conclusions. (See the fuller discussion of this in the projects on tariff duty analysis in the report on research in Agricultural Policy.)

The alternative procedure suggested by the foregoing discussion is to compare the net incomes obtained from the different *systems of farming* in which the product in question is included in different proportions. Obviously this procedure is but the mathematical reciprocal of the above. Advantage is compared in terms of output over input in place of input over output. The gain is that the output over input does not have to be reduced to a unit-of-product basis—the unit can be the whole farm business. The result is expressed in relative incomes per farm from the different systems of farming.

On this basis, however, the incomes should be net incomes, to take account of the fact that the different products or combinations of products involve different expenditures for hired labor and supplies, buildings, equipment, etc. The net income figures can be obtained merely by deducting current expenditures for hired labor and supplies. Net incomes on this basis would represent returns to the entrepreneurs and their family labor and their investment in buildings, equipment and land. The products to be compared may be such that these net income figures will be most satisfactory. In more cases, a deduction will want to be made also for at least the annual cost of the investments in buildings, equipment and livestock, since the ratios of investments in these to land and to labor will vary considerably between different products and systems of farming.¹ What will be left will be returns to the entrepreneurs for their management, and labor if any, to the labor not hired, and to the land and its improvements. No doubt this will be the most satisfactory basis of comparison in many cases.

If, however, more family labor is commonly used in some systems of farming or areas being compared than in others, some method of allowing for this may be needed. No method as now practiced would be satisfactory. Valuing family labor at what it would cost to hire a substitute nearly always results in over-valuation. Family labor is ordinarily used in less valuable ways than hired labor. (See *Scope and Method of Research Relating to Agricultural Income* for the further discussion of this subject.) A safer procedure would be to make comparisons only of farm businesses using about the same amount of family labor; or isolate by statistical methods the effect on income of varying amounts of family labor and adjust the income on the basis of this. The simplest statistical procedure would be to group the farms into classes according to the amount of hired labor employed, and for each group construct a dot chart with net income and amount of family labor as the two abscissas, from which one would be able to determine at what rate on the average farm incomes were increased by additions of family labor.

The results of such an analysis will no doubt show different levels of income in the different regions. The various combinations of pork, beef and dairy products in the Midwest region may continue to show for generations a range of net income per enterprise a half larger than those of some competing region. The larger incomes in one region may be due to prevalingly larger farm businesses in it than in those competing with it; or to a higher order of ability as farmers; or to the use of better methods of production. If these differences were to disappear through shifting of the population and in other ways, the differences in income would disappear. But such differences seem to abate only slowly in a country as new as ours.

(1) In the short run, investments in buildings can be ignored as a factor in regional competition.

But we are not concerned in this study with the absolute levels of incomes in any region—only with the ratio between incomes from different systems of farming in the same region. If expanding the dairying will increase the net farm incomes of one region by a larger percentage than it will those of another, then this region apparently has a higher ratio of advantage in dairying, regardless of the absolute size of the incomes, and will out-compete the others in dairying.

The incomes from the different systems of farming competing with each other in each competing region can also be reduced to a man-unit basis, and these can be reduced to ratios for each region, which ratios can be compared to see which is the larger, in the manner of the conventional illustrations in textbooks. (See Black, *Introduction to Production Economics*, pp. 132-44.) But these comparisons will not take account of all the factors of production unless incomes to labor are reduced to a net basis; and if this were done, the assumption would be that maximizing the return to labor was the impelling motive in farming readjustments.

Methods of analysis.

Method D: Ideally, before starting on a project of this type, one should have available the results of Projects 1 to 3 for each of the regions competing with each other in the markets for the product in question. One would then know the boundaries of the various competing regions, the type-of-farming areas within each, the types of farming within each type-of-farming area and their relative numbers, the probable reasons for the existence of these systems of farming where they are, the historical changes in the foregoing and the probable reason for them, the current trends in production and the probable reasons; and from the foregoing the outlook for each region and the various parts of it, *in-so far as these can be determined on the basis of evidence within each area.*

The orthodox procedure for doing this is to work with one product at a time, not a whole type of farming, and determine the nature of the competition between the different areas or regions producing this product, and the probable outcome of such competition—that is, how much of the product will be produced by the competing areas, and how this volume will be divided between them. The only way that types of farming enter into such analysis is that the product being analyzed is a component of different systems of farming in different regions. If the product is pork, it is produced along with beef in the heart of the corn belt, along with milk on the northern edge of the corn belt, along with wheat on the southern and western borders of it, and along with cotton farther south. The analysis will have to take account of the fact that pork competes with a different set of products in the various competing areas.

Following this procedure, the steps in the analysis are as follows: First, construct supply schedules for pork in each of the different

competing areas or regions, and then combine these schedules into what is essentially a composite supply schedule for all the areas or regions combined; then analyze similarly all the markets or consuming areas for which these regions compete, and derive therefrom a composite demand schedule for pork for all these markets combined; then combine these composite supply and composite demand schedules for pork into an *equilibrium* analysis, deriving therefrom an *equilibrium price*; and then figure back from these curves and the equilibrium price to see how much each of the competing areas should contribute to the markets. The competition between pork and other products within each of the competing regions enters into the analysis in that it affects the slope and shape and position of the supply curves.²

What we are interested in, of course, is the outlook for competition in the future. The foregoing analysis fits future conditions only to the extent that the supply and demand curves fit the future. In practice they are commonly based on supply, demand and price relationships in the past, and may describe even the present only very approximately. Recently, however, methods have come into use for showing shifts in supply and demand curves. If such analysis furnishes evidence that the pork supply schedules for the different areas are changing according to an ascertainable trend line, and likewise that the demand schedules are so changing, then one may project a series of composite supply and composite demand schedules, with the resulting equilibrium points. Obviously these projections will all be forecasts, with all the usual possibilities that they may be in error. But one is in a position where one must choose between two alternatives, one that the present set of conditions, as near as it can be described by obtainable curves of supply and demand, will be repeated next year and the year following; and the other that the new conditions will differ from the present ones according to a trend line that has been carefully surveyed and analyzed. Obviously both are forecasting—the latter on much the more reasonable basis.

In using supply and demand curves in this way, one must make allowance for the usually occurring lag in the response of production and consumption to changing prices. The amount of pork which producers bring forth at any given time is likely to be less if the price of the product is rising, and more if the reverse is true, than they will be producing at the same prices a few years later when

(2) Theoretically all right, but I fear impractical. The objections to statistical demand and supply curves are well known and have not been successfully answered. It would be practically impossible to derive these curves for "areas". They are questionable enough when derived for a market or for a nation in which total supply and demand are considered and where the supply is made up of contributions of product from innumerable areas. This proposal seems to me to be an endless job and one whose conclusions would be almost useless when completed owing to the practical impossibility of securing sufficient reliable data with which to work. (A. G. Black.)

they have caught up in these responses. These changes in responses appear as shifts or trends, if the movement continues long enough, in the position of the pork-supply curves. The forecasting procedure above outlined is therefore necessary also on account of this element of lag in responses.

Unless this forecasting is done, in the final step in the analysis, that of calculating the contributions of each region to the markets, one will find that when the supply schedules of the different regions are combined, in most cases more of the product, or less of it, will be available at present prices than the markets have been absorbing at these prices. Present prices are as high as they are because lag in adjustment to prices has kept supplies down. If the situation calls for less of a given product, the lag has kept supplies high, and prices low. As lag disappears, the supplies will increase and prices decline; or the reverse of this. At the lower prices, less will be produced in each of the competing areas. At the same time, however, consumption will be likely to expand. For other products competing in the areas, the opposite of the foregoing will happen. These processes make toward an equilibrium point at which a somewhat larger amount of one product will be produced and consumed than at present at somewhat lower prices; and a somewhat smaller amount of the others at somewhat higher prices. The readjustments toward such new equilibrium points appear in the analysis as changing supply schedules and demand schedules, whose direction of change must be forecasted.

This whole analysis of supply and demand in relation to price which is basic to analysis of interregional competition is usually considered as coming in the field of Prices of Farm Products, and will be discussed in the report in this series bearing that title.³ The projects dealing with supply responses, however, draw heavily upon production analysis, and are indicated as joint with Farm Manage-

(3) Following are a few useful references on the subject:

- Bean, L. H., "The Farmers' Response to Price," *Journal of Farm Economics*, 1929, pp. 368-385.
- Black, J. D., "Elasticity of Supply of Farm Products," *Journal of Farm Economics*, 1924, pp. 145-155.
- Elliott, F. F., *Adjusting Hog Production to Market Demand*. Illinois Bulletin 298.
- Ezekiel, M., "Statistical Analysis of the Laws of Price," *Quarterly Journal of Economics*, 1928, pp. 203-212.
- Leontief, W., "Ein Versuch zur statistischen Analyse von Angebot und Nachfrage," *Weltwirtschaftliches Archiv*, 1929.
- Schultz, H., "The Shifting Demand for Selected Agricultural Commodities, 1875-1929," *Journal of Farm Economics*, 1932.
- Schultz, H., *Statistical Laws of Supply and Demand*.
- Waite, W. C., "The Effect of a Business Depression on the Demand for Live-stock Products and the Outlook for these Products," *Journal of Farm Economics*, 1932.
- Working, E. J., "What do Statistical Demand Curves Show?" *Quarterly Journal of Economics*, 1927, pp. 212-227.
- Working, H., "The Statistical Determination of Demand Curves," *Quarterly Journal of Economics*, 1925, pp. 503-539.

ment. Some of the projects dealing with demand responses draw heavily upon marketing analysis and are listed as joint with Marketing of Farm Products. Lag in response of consumption to price changes may be almost as important as lag in response of production, and hence forecasting analysis is vital to this part of the project also. If no studies of market areas similar to those outlined in Projects 1, 2 and 3 above for producing areas have been made, then one will have to begin the demand part of the study with an analysis of markets and consumption somewhat parallel to the studies outlined for supply areas. The data will be obtained from records of carlot shipments, boat shipments in some markets, and truck shipments, and from records of wholesale receivers, dealers and other handlers of the products in question. These records will furnish evidence as to the amounts of the product being consumed or otherwise absorbed in the market supplied by these regions, or likely to be supplied by them, at various prices. Data will also be needed as to transportation charges from the competing areas to the different markets and handling charges within the markets.

With supply and demand schedules for the product that are in terms of all the competing regions combined and all the market outlets, and data as to transportation and handling charges, it should be possible to establish equilibrium prices for each region and each market, and volumes of production for each region; and following this to allocate the volume of pork to be contributed by the various competing regions—not forgetting, however, that if the supply and demand curves are shifting in ascertainable directions, then volumes of production will need to be forecasted for the coming years in accordance therewith.

If such an analysis is complete, it will take account of all the different types of farming in a region, and also of all the different competing regions. In practice, however, one would ordinarily not include minor producing areas. Care should be taken, however, to omit none which is important potentially, though furnishing little competition at present.

The sampling of the areas studied is highly important. The different types of farming in a region need to be represented in the data in sufficient numbers to provide for all the important variations in conditions associated with them, in approximate proportion to their frequency of occurrence. What is really desired is a sampling of the price-sensitiveness of the producers. This manifests itself in two ways—producers swing in and out of production of the various products as prices change, or they merely change the proportions of their products as prices change. In some competing areas, it will take the first form mostly; in others the second. For main crops in the heart of a type-of-farming area, it will take the first form; for less important crops in such areas, and for most crops in “twilight zone” areas, it will take the second form. The sampling

must include all the important conditions affecting price-sensitiveness of either of these two forms, and ordinary combinations of the two, in rough proportion to their frequency.

To determine competition for a *whole type of farming* according to the above procedure, one will need to make a separate analysis as above outlined for each of the products making up the type of farming. Having done this, one will have to forecast how much of each of the products will be produced on farms practicing this type of farming, and hence the relative importance of each product in the type of farming. In practice, however, the data needed for supply curves will commonly be for areas or regions as wholes, in which several types and perhaps many systems of farming are found, and the analysis will in effect merge all these into one *average* system of farming for the region; and the results will be expressed as an *average* proportion between products for the whole area or region. It may well be that some systems of farming will need to look forward to producing more pork, and others less, all in the same type-of-farming area. This is because the competition of pork may be with different other products in the different types of farming. Accordingly, *the forecasts are not of great value until they can be reduced to a type-of-farming basis.* The procedure apparently must be that of testing out various likely modifications of the different types of farming, by the method described as the "farm set-up" method in Project 3, under the set of forecasted equilibrium prices determined as above outlined. This procedure will probably indicate the direction and approximate magnitude of the changes in products and proportions of products that are needed for each of the types of farming in the area, under the conditions of competition forecasted to develop.

Synthetic supply and demand curves.

It is apparent that the foregoing is an elaborate and difficult procedure for analyzing competition between areas or regions in production. Not only this, but it has definite shortcomings, the principal one being that last outlined, that its end results are not on a type-of-farming basis, as they need to be if they are going to be put to effective use; and no altogether satisfactory method for converting them to a type-of-farming basis is available. Also in many cases it will not be possible to obtain the data needed to illustrate the supply and demand curves needed; and the whole technique for doing this even after the data are available is seriously questioned by many students. As will be pointed out in the report on Prices of Farm Products, we probably are not sure in some cases whether our curves really have separated supply-price relationships from demand-price relationships.

An alternative procedure for part of the above analysis is therefore suggested here, namely, that of using the farm set-up method to construct "synthetic" supply curves; that is, to build up for any

system of farming a set of quantities of each of its products that will be produced at greatest profit to the farms producing this system of farming, at different sets of relative prices for the different products. One would no doubt begin with the existing set of prices, then raise the price of the major product, leaving the price of the others as now; and for each set of prices determine by observing the probable effect on the net income the proportion of products that would be most advantageous. Out of this would come a series of pairs of prices and quantities from which could be constructed a synthetic supply curve. The writer believes that this alternative procedure will obtain results that will serve as a check on the usual method, and that in particular it will throw a strong light on the probable trends in the supply curves because it will reveal elements of lag in readjustments. But considered as a complete method by itself, it has the defect that it assumes that producers have shifted their production in accordance with what is to their economic advantage. (The supply schedule actually needed must be in terms of how producers actually do respond, not in terms of how they should respond.) Moreover, as pointed out in Project 3, economic advantage is itself a complex thing and difficult to determine fully, involving much more than apparent money income; and other things than economic advantage determine production responses. But if this procedure reveals that present farm set-ups are not in accord with economic advantage in so far as it can be determined by the synthetic method, either because of lag in adjustments or because of other factors than economic advantage, this information will be of great value in forecasting future developments.

An outstanding advantage of the synthetic approach to the problem is that it gets its results directly in the form needed for forecasting changes in specific types of farming; and no doubt in more dependable form, in so far as the type-of-farming analysis is concerned.⁴

The synthetic method probably can be used for determining demand curves as well as supply curves; but the detailed procedure for it has not been developed; and the objections to it are more serious. It would take the form of estimating the relative advantage or economy of including different amounts of the product in question in the family budget at different prices for it. The difficulty is that economic advantage is even more difficult to determine in consumption than in production. It must take account of many forms of utility besides ability to satisfy the need for food and drink, warmth, etc. One might determine with fair certainty that including more cereal and vegetables and less meat in the budget would result in a lower expenditure of effort for food at no loss in apparent real quality

(4) Project 12 in the report in this series on research in Land Utilization outlines in more detail the use of the synthetic method in analyzing competition between major uses of the land—crops, grazing, timber. For full discussion, also see Project 8 following.

of living; but could one be sure that consumption would change in that direction? Nevertheless, evidence is abundant that the consumption of food budgets and of other budgets does change with relative price changes. It would seem, therefore, that this procedure is worth trying as a supplement to the historical price-consumption type of studies of demand. If properly made, they should reveal much about the relative stability of use of different articles of consumption that will help in estimating the extent to which consumption will respond to economic advantage.

The synthetic approach to this problem of competition may be looked upon as an additional feature designed to check and refine results; and hence as a luxury to be dispensed with in most cases. But no doubt projects will be undertaken in which it will be more important to add this part of the analysis than some others. There also will be projects in which the synthetic method for the supply curves will obtain more useful results than the method first described.

Method C.

In practice, this is the form which Method D will frequently take. The order of work in this type of project will commonly be to take two areas that are in close competition with each other, like New England and Wisconsin-Minnesota in dairy production, and work out the analysis for them first. This may reveal the presence of important additional values from bringing in a third area and a fourth. Of course the supply curves set up will represent only a part of the production; but supplemental study may furnish a basis for judging as to how well this part describes the rest. Ordinarily the region taken first will be competing directly in the same market. Hence one demand curve may largely suffice.

Method B.

The real question with this method is as to how valuable the conclusions are which one can reach without having supply curves for the competing regions. For the other areas one can construct historigrams showing the relative course of local prices of the product, acreage and production, and possibly of some of the important input factors. In some cases, ratios can be devised between prices of the product and of major expense factors such as feed; between the price of the product in question and its principal competitors in the area. Careful study of the historigrams of these ratios, and comparing them for similar charts for competing areas, may show price situations more favorable to the product in some areas than in others, or expense ratios, and resulting trends in production already under way. Such analysis may indicate very clearly the future history of competition in the product; and enable one to forecast in general terms the relative changes in volume from the competing areas. The careful study of the one area will provide supply curves for this one area which will enable one to forecast

with considerable more definiteness its outlook for a share in the market. Development of demand curves for the market which this area supplies will be a valuable additional feature.

Method A.

Like Method B except that supply and demand curves for the one area and market are omitted, the whole analysis being in terms of historigrams of prices and ratios for all the competing areas.

PROJECT 7. The Economics of Production of a Commodity.

(By M. R. Cooper and R. D. Jennings.)

EDITOR'S NOTE: A project fitting exactly under the above title would cover all the aspects of the economics of production of a particular commodity that are presented in the various projects in this report; and it would confine itself to production, excluding marketing, prices, etc., except as affecting production. Such a project would be very comprehensive in its scope, and probably unmanageable if the analysis was at all detailed or thorough. In practice, such projects are likely to select particular aspects for more careful study, these having become important in the area or at the time. The other aspects are likely to be treated in a very general fashion.

Also in practice, such projects are likely to include many aspects other than production—price factors and price trends, consumer preference, marketing methods, etc., these being important at the time or in the area. In effect, the studies of these other aspects are almost separate projects, since they are usually undertaken by other groups of workers with appropriate training for them. They are related to the production studies in that they are carried on at the same time, and with the products of the same area, and in that an effort is made to coordinate the results into conclusions and recommendations in which price, marketing and production factors are brought to bear upon each other. Our concern here is of course only with the production aspects of such joint projects—the methodology of the associated marketing and price research will be discussed in separate reports.

It stands to reason, also, that projects as comprehensive as indicated in the foregoing are likely to be undertaken only with minor crops, usually specialty crops, and crops produced on highly specialized farms. Thus the crops in which the Bureau of Agricultural Economics has co-operated with the states along the foregoing lines are apples, peaches, strawberries, grapes and pecans.

A very important aspect of the production of many crops is inter-regional competition. This is well illustrated by the case of apples and peaches. Hence such projects can with advantage be undertaken on a national basis. This accounts for the interest of the Bureau of Agricultural Economics in such projects. If thoroughly done, such analysis would follow the lines of analysis outlined in Project 6 above. In practice, the analysis of the competitive aspects of such projects seldom gets beyond discovering trends in production, consumption and prices in competing areas and markets.

The discussion following is a description and appraisal of the commodity projects in which the Bureau of Agricultural Economics has engaged.

Most of the commodity studies in which the Bureau of Agricultural Economics has cooperated have been limited to intensive crops grown in widely separated areas. These studies have usually been undertaken in response to a demand for help from the producers and marketers who are having difficulties on account of over-expansion of production, changes in demand or other causes. In general, the objective is to provide the producers of the commodity and those interested in its production in the different areas, with information as to prospective supply, demand and price, interregional competition, etc., that will be helpful in making plans for the future.

The data ordinarily compiled and analyzed in these studies include: A, Statistics of production, imports, exports, carry-over, price trends, freight rates, etc. B, The amounts of labor, power, equipment and materials used in production and the prices of these elements; different practices and their effects on costs; the place of the commodity in the farm organization; acreage, yield and farm prices of commodities; dates of harvest and their variation. C, Local marketing agencies; methods of grading and packing, seasonal supply for different markets; channels of trade used in distribution; class of trade served; competition with other products; marketing margins; consumers' preference as to varieties, packages, etc. Analysis of the above information should develop the present status, recent trends and probable future developments in each area; the demand and prices for different varieties, types and grades; the competition between different areas; types, varieties and grades for each of the important markets.

The list of agencies that would normally be cooperators in such a study are the departments of agricultural economics and the horticultural (or other) departments of the experiment stations in the states in which the study is to be carried on; the Division of Farm Management and Costs and the appropriate commodity marketing division of the Bureaus of Agricultural Economics and of Plant Industry (or Animal Industry) of the U. S. Department of Agriculture. Both the state and federal extension specialists should be kept in active touch with the progress of the work so that when the time comes for utilizing the results, they will have a greater interest in the extension of this material.

The bulk of the information obtained in such a study falls as a rule on the farm management and marketing departments. The usual practice is to list the information desired and assign it to the various cooperating agencies. General statistical information such as from the census, crop estimates and market news reports will usually be allotted to the federal agencies. Most of the information used in developing the farm management aspects of the problem is usually obtained by farm management surveys on a representative

group of farms in each of the producing areas, with some special study of the individual enterprises of these farms. The supplementary data needed on local marketing practices may be collected by the farm management workers unless it is so specialized as to require the services of a marketing specialist.

In working up the data, the principal thing to be kept in mind is that the usefulness of the work depends to a large extent on the speed with which the results are published and utilized. Therefore the aim should be to obtain a broad view of the situation facing the industry and the effect this will have on each of the producing areas. Publication of the results is ordinarily divided between the states and the federal agencies. The state publication may present the findings with particular reference to the status of the commodity as produced in the state and its relation to competing areas. It should point toward a definite program for producers of the commodity within the state. The federal publication may take up the subject from the national viewpoint, giving special emphasis to the trend of supply and demand for the different varieties and classes.

Apples.

If an analysis of apple production is to be helpful, it must be made separately for each important apple section, and each major variety. Since changes are constantly going on in the relative importance, the organization and the operation of commercial and farm orchards, changes in the two classes frequently being in opposite directions, the data for the two must be kept separate. It is not enough to have data on acreage and number of trees as indicators of production trends. The data on the number of trees must be by ages, and show the relation of age to production.

Data are available on annual production of apples for each state since 1889, and on commercial production since 1917. For the census years, 1890-1930, information is available by counties on total production and number of trees of bearing age. For the census years beginning with 1910, additional information is available showing number of trees not of bearing age. Mailed questionnaires were used to obtain information as to ages of varieties, the lists being made up from memberships in horticultural associations and individual census returns. Two follow-up letters were sent out. The orchards reported in the returns were considered as commercial if having more than 100 trees.

In the end this survey resulted in the classification of apple trees in 25,264 orchards, containing 14,583,249 trees, according to age and variety, in such detail that almost any combination with respect to geographic unit, variety, size of orchard, age of trees, etc., could be obtained. These sample data were made the basis for estimating totals for the United States and for the different regions in the

United States, after being supplemented by special tabulations from the census returns of 1925 for important apple counties, showing the number of orchards of various sizes. The tree survey was made in 1926 and 1927, and the schedules included questions with respect to plantings and removals during 1926 and 1927, so that the final estimates were made as of January 1, 1928. The final figures were estimates of the total number of trees of each variety and each age in commercial and farm orchards in each geographic unit. The results indicated where the young trees and the old trees of each variety were, how numerous they were in the various sections, and gave a fairly good idea of periods of heavy and light planting of the different varieties in different sections of the country, and hence showed whether the future bearing capacity of orchards already planted was likely to increase or decrease, and where. This information readily ties in with information already available and furnished periodically on domestic disappearance, exports and prices, and with the information obtained by the Foreign Service of the Bureau on conditions in the apple industry abroad, showing prospects for future production in competing countries.

Although the part of the joint project here discussed does not include marketing and prices, it will be well to indicate what marketing and price information was collected in the other parts of the study. The Division of Fruits and Vegetables assisted by various persons in other divisions of the Bureau of Agricultural Economics assembled information relating to the following subjects: sources of market supplies, shipments of apples by carload and by motor trucks; cold-storage holdings and time of movement to market; important commercial varieties in 41 markets and sources and distance from which these markets drew their carlot supplies; and the relative quantities of the different varieties taken in each market. Other information collected in the markets of specified cities had reference to: containers used for apples; channels of city distribution; distribution in trade territory surrounding carlot markets, and retailing practices. Under market prices, the following factors were treated: price level as influenced by supply; prices as influenced by varieties; effect of grade on price; size of apples as a price factor; variation in price during the season; relation of container to price; origin of supply as a price factor; and prices in different central markets, particularly Chicago and New York. The annual apple price series collected by the Division of Crop and Livestock Estimates relates to prices at the farm. Although this series of prices is useful, it does not indicate anything with respect to variety, size and grade, method of sale, or kind of package. It was recognized early in the study that what was needed was an understanding of the effect on price of varying supplies of apples of different varieties, grades, etc. But the project as yet has not progressed

to the point where such a regional or national analysis of apple prices has been made. But in a number of states¹ price series were compiled over a period of years for different grades and sizes of each important variety, in some cases also for different parts of the state.

The work done varied by states. In Arkansas, a cooperative study analyzed trends in production by varieties as related to Arkansas and competing states. In the orchard-operation and management phase of the study, the costs connected with developing an orchard to bearing age and of operating the orchard thereafter were assembled. The data on developing an orchard—crews, rates of work, materials, etc.—were set forth in detail for each of nine years. The data on operating an orchard of bearing age were presented by varieties and included the details of operation, such as crews, rates of work, materials, yields, etc. The depreciation of the orchard was based on the costs of developing an orchard and its productive life, for each of a number of important varieties.

The Utah apple study followed the lines of the Arkansas study, but included a farm business analysis of the organization and operation of apple farms. This was important since Utah apple farms are somewhat diversified and rather intensified, being on irrigated land.

In Virginia, West Virginia and Pennsylvania, a regional project was set up extending over a 5-year period ending in 1932. For some time it had been felt that the reason that many of the orchards in this region were not profitable was that the trees produced little fruit. The first object of the study, therefore, was to determine something about this phase of producers' problems. The work was carried on cooperatively by the three state agricultural experiment stations, and the following federal agencies: Office of Horticulture, Bureau of Plant Industry; Division of Agricultural Meteorology, Weather Bureau; Division of Farm Management and Costs, Bureau of Agricultural Economics. Approximately five hundred blocks of apple trees were included in the study. These orchards were visited by representatives of the various cooperating agencies and information obtained for each important variety. Particular attention was given to the ages of the trees, the care which had been given them in the past, the yields which they had produced, and the causes of low yields, which included data and discussions on such topics as frost, hail and drought, slope, soil, cultural practices, insects and diseases, off year, failure of fruit to set, planting distances, and missing trees.

An analysis was made of price differentials for different varieties grown in the region in both domestic and foreign markets, as well as of variations in prices received for the same varieties grown in

(1) Arkansas, Idaho, Utah, Washington, Oregon, California, New York, Virginia, Pennsylvania and West Virginia.

different parts of the region; also of time of sale, and grade and size in relation to price; of methods of sale, containers used, and charges for marketing services both domestic and foreign.

In the management phase of the study, the production data were collected by the route method, a temporary office being established at Winchester, and three men and one clerk were assigned to the project for full time. Approximately eighty apple growers scattered throughout the apple-growing region of the three states cooperated in the study. Detailed information on each of the operations incident to the running of the farm and the details of expenditures and receipts together with complete inventories were obtained. In addition to the actual figures obtained from these farmers, the route men spent a great deal of time studying the individual orchards. They plotted the various orchard blocks for the purpose of determining numbers of trees per acre and how these trees were set with respect to distances and combinations of varieties. Considerable attention was given to the slope of the orchard, pollination methods, and to the condition of the soil and of the trees at the time the survey was started. The route men visited the farmers while they were spraying, pruning, harvesting, grading and packing, for the purpose of determining how well they did each particular job and the relative efficiency of the different cooperators in performing these tasks. Throughout the study special attention was given to each major problem with respect to varieties and type of orchard. The types of orchards studied were those planted in the valley, on the slopes, and on the elevations.

Other phases of the project included market outlets, prices received at final destination, cold storage facilities and trends in production.

The main factors developed in the New York study were the effect on price at country shipping point of variety, grade, kind of package, time of shipment, market, method of sale, and selling in straight or mixed cars. The information collected in the apple tree survey was used in connection with a study carried on by Cornell University relating to varieties, prices, yields and acreages of apples in the Newfane-Olcott area of western New York.

The Indiana study related particularly to the Indianapolis apple market, and included quantities of apples taken by rail and by truck, varieties received in Indianapolis from local and distant areas, varieties handled by chain stores and independent retailers, varieties used by fruit stands, peddlers and restaurants, varieties preferred by various classes of consumers, advantages and disadvantages of various containers for local and distant supplies, sizing practices and grades by wholesalers, consumers' purchases with respect to size of purchase and varieties bought, the time of the year when different varieties were on the market, and prices at which the different varieties sold. This is essentially marketing analysis, but the results are useful in planning production.

These studies bring out the fact that the major problems concerning a commodity may not be the same in all areas at the same time. Certain phases of this type of study are, however, of most use if made in a number of areas at the same time and in comparable form. It is felt that the part of the apple study relating to local problems would have been of much more use had the types of local studies been more uniform and had such studies been conducted in more of the major apple-producing sections and at approximately the same time. It is realized, however, that for many obvious reasons such a project would be difficult to arrange.

Peaches.

In the study relating to peaches the problems and the methods of study were much the same as indicated for apples, except that the project was regional in character rather than national. The study may be considered as having three phases. One included a tree survey, in which peach trees were classified in all important peach states by age and variety. No attempt was made, however, to estimate and classify all trees in a state, district or region. The final figures were only for the orchards reporting; but in many cases these represented a very large part of all trees in commercial orchards. The analysis of the tree survey and other data was made by districts and regions, in order of date of ripening of peaches. The analysis also included a discussion of varieties. The study of peaches was made in 1925-1926 by the Divisions of Farm Management and Costs, Crop Estimates, and Fruit and Vegetables, and state agencies. In 1929 the tree survey was repeated in the southern peach states, where changes had been most pronounced.

Another part of the study had to do with the assembling of available information relating to production areas, competition, distribution, marketing and prices. Study was also made of "Factors Affecting the Price of Peaches in the New York City Market", two important market factors being particularly considered, namely, peach supplies, and variations in individual lots of peaches.

The third phase of the study related to costs and practices in developing an orchard in 21 peach districts and the costs connected with producing peaches after the orchard had come into bearing in 22 districts. Production costs were considered for the bearing life of orchards in each district and were related to returns from peaches.

These various data were used to set forth the peach situation in the southern states at the time of the survey with respect to production, carlot shipments, competition among the various areas and varieties. The tree survey information was used in an analysis of the outlook for future production.

Pecans.

The tree survey part of the pecan study included estimating total trees by state and by age for improved varieties and for

seedlings and wild varieties. Improved varieties were also classified according to the numbers of trees of each major variety. The marketing part of the study included the attitude of the trade toward pecans, channels of market distribution, preferences and opinions of the wholesale trade, retail outlet and practices, and pecan marketing conditions in 22 cities.

A survey study of practices and costs in the development of pecan orchards and in the production of pecans was conducted by the Division of Farm Management and Costs and state agencies in nine pecan districts of five southern states. Considerable attention was given to yields of pecan trees and to the production that was necessary to meet expenses, since one of the major problems of the pecan orchardist is that of obtaining a paying production.

Strawberries.

This commodity study was regional in character and had application to the southern and eastern competing strawberry districts. One phase had to do with the origin and distribution of the commercial strawberry crop. Another included farm management, farm practices and costs, in twenty districts in eleven states, particular attention being given to the acreage of strawberries grown, frequency distribution of yield per acre, yield by age of field and production of leading varieties. A third related to factors affecting prices of strawberries in the New York City market, particular attention being given to prices in New York City for berries from different districts coming on to the market at the same time.

Grapes.

This project was conducted by the Division of Farm Management and Costs in cooperation with the state agricultural experiment stations of New York, Pennsylvania, Michigan and Arkansas, and a principal object of it was to determine the effect of western grape production on the eastern situation. The farm management part of the study covered 550 vineyards in much detail, each farm practice being treated at length and related to various cost factors. Particular attention was given to varieties, ages of vineyards, yields by age, variety and on different soils, and prices received for different varieties of grapes classified by various methods of sale.

The marketing and distribution parts of this study related to quantities and qualities desired by grape juice manufacturers and others, general market preferences, consumers' preferences as between eastern and western groups, and methods of assembling, packing, grading and distributing the crop by country marketing agencies.

PROJECT 8. Most Advantageous Organization and Practices in an Area.

OBJECTIVE: To determine the combination of enterprises and the practices for each major enterprise which will yield the most advantageous results, within a specified area.

(By Mordecai Ezekiel.)

Any one farm at any time is ordinarily being operated with a certain combination of the several enterprises; while each farm enterprise is being conducted with methods, practices, physical resources in the way of quality of seed, and of character of livestock, which combined result in a certain level of enterprise efficiency. In changing the combination of enterprises to try to increase income, the farmer has the additional alternative of changing the enterprise efficiency. There are, therefore, three different types of new situations which may be considered:

1. Improved combination of enterprises with present enterprise efficiency left unchanged.
2. Present combination of enterprises left unchanged, with improved enterprise efficiency.
3. Improved combination of enterprises, with improved enterprise efficiency.

There are almost an infinite number of modifications which can be considered under (1), (2) and (3) in any individual case. The resources of the particular farm, and the resources, capacity and preferences of the individual operator must be considered in selecting new combinations.

Any method of research which aimed at providing conclusions as to the desirability of various modifications in the combination of enterprises on the farms for an area must clearly recognize the differences between changes of Type 1 and of Type 2 above. Increased returns that are really due to changes in enterprise efficiency should not be ascribed to changes in the combination of enterprises; yet such a false conclusion is likely to be reached if the study makes a direct comparison of the present income from a farming business with the income which would result from simultaneous improvements in the combination of enterprises and in the efficiency with which the enterprises are conducted, without first considering the changes in income resulting from (1) and (2) separately.

The theoretically ideal way to determine the combination of enterprises on the farm and the organization that would be most advantageous on a particular farm under a given set of external economic conditions would be to experiment with a number of different combinations, trying each one out in turn for enough years to determine its usual output, while simultaneously keeping prices and costs at a fixed unchanging level. After trying out a number of

such combinations, and keeping careful records of the receipts and expenses under each one, it would be then possible to conclude with scientific accuracy which one of the combinations tried would have yielded that farm and that farmer the highest average income as long as economic conditions continued unchanged. The farmer could then use these results as a guide in selecting his system of farming—if external economic conditions had not changed too much, or if he had not meanwhile grown so old that the results no longer applied.

In practice, the operations of one farm cannot be observed under such a succession of different organizations, for economic conditions are constantly shifting. That is one reason why adjustments in farm organization constantly tend to lag behind the changed economic conditions which make them necessary. It would therefore be impossible to take many years to work out the best organization for a given farm, for by the time the answer was obtained, it would no longer be correct.

Since the form of organization which *does* yield the best returns for a given farm cannot be directly determined, some sort of a judgment as to the organization which *is likely* to yield the best returns must be arrived at instead. Instead of observing the results on the particular farm under a variety of different organizations, we may study a variety of farms with their variety of different organizations, and from the results of the study make inferences as to the organization that is likely to be most advantageous.

Methods of Studying Farm Organization.

The methods which have been developed for studying farm organization may be classified into two groups: The *comparative* method, and the *synthetic* method.¹ By the *comparative* method, differences in income on the different farms are compared with differences in their organization, the relations between various changes in organization and associated changes in incomes are determined, and from this study generalizations are made concerning the organization best suited to the farms of the area. The *synthetic* method attempts

(1) At one stage in the development of farm management research the cost-accounting method was rather widely used in studies to determine the most advantageous combination of enterprises. The procedure was to compute the costs of production in money terms of each commodity produced on the farm and subtract the cost from the selling price to obtain a measure of the "relative profitableness" of the different enterprises. The assumption was that the enterprises showing the greatest margins of "profit" should be expanded and that those showing low "profits" or "losses" should be curtailed or dropped from the organization entirely. It is now recognized that such an assumption is not valid. The reasons that costs of a given enterprise are high may be (1) that it is not expanded enough to realize economies from a larger scale of operation, (2) that it is over-expanded so that it encroaches upon and conflicts with other enterprises, or (3) that it is being conducted upon a low plane of efficiency. The profits may be low either because costs are high or because prices have recently declined. The action needed to correct this situation is different in each case. Moreover, no procedure for determining the costs of each of several

to provide all the detailed information necessary for constructing a farm budget, i. e., a forecast of receipts and expenses, for the combinations of enterprises characteristic of the farms of the area, and by constructing budgets for typical farm organizations in the area and for promising modifications of those organizations to determine the incomes to be expected on farms with different organizations. A comparison of these returns will indicate the combinations of enterprises (the farm organizations) which are likely to be the most advantageous on the farms of the area.

The *comparative* method shows the organizations and practices used by the farmers who make more money than their neighbors, as contrasted to the organizations used by those who make less money. By inference it thus suggests why some men make more money than others, and so may provide explanations of differences in income. The *synthetic* method shows directly the probable effect upon income under a given price situation of specific changes in any particular farm organization or on similar farms of which it is representative.

No matter which method is to be used in a study, preliminary work is needed as a basis for selecting the area and becoming acquainted with the local conditions. If the results of type-of-farming studies as outlined under Projects 1, 2, 3 and 4 are available, most if not all of the information needed for planning a study will be at hand. In any case, the forms to be used and the specific problems upon which attention is to be centered should be checked by a reconnaissance of the area, on a smaller or larger scale as conditions demand.

A. *The Comparative Method.*²

The fundamental elements of the comparative method are: (a) collection of information showing earnings on each of a number of different farms in the same area, together with relevant information as to size, resources, crops and livestock organization, enterprise efficiency and labor efficiency; (b) statistical analysis of these data to determine how far differences in income were associated with differences in the factors named; and (c) generalization concerning products produced on the same farm has ever been devised that indicates relative profitableness correctly for many of the products. For example, the oat enterprise nearly always appears at a disadvantage in the results, and yet all admit that it cannot be dropped without loss to the farm income over a period of years. As shown in the discussion of recent trends in farm management research in the earlier pages of this report, cost accounts are still being kept and money costs computed at a considerable number of the state colleges; but few workers in the United States are now attempting to use the cost-accounting method to determine the most advantageous combination of enterprises. But see pp. 857-8, *Proceedings of Second International Conference of Agricultural Economists.* (H. R. Tolley.)

(2) Studies in which this method is used are usually called "farm business analysis studies." Dr. George F. Warren and his associates at Cornell University first made extensive use of the comparative method in connection with their early work in farm management in New York State, and the method was later

(Continued on Page 112.)

the effect of various differences in organization and efficiency on the incomes received.

(a) *Collection of information:* The collecting of information by farm management surveys is discussed at much length in *Research Method and Procedure in Agricultural Economics*, under the heads of "The Survey Method" and "Farm Management Surveys", and all of this discussion must be considered as applying especially to this type of project and the "comparative method." This discussion was prepared by Professor E. G. Misner of Cornell University. The data may cover one year or a series of years. Such data may also be collected by supervised records or from account books kept by farmers. Since, however, for adequate analysis, 100 or more records are usually required, and in areas of complicated or heterogeneous types of farming, several hundred may be needed to give stable results, the more extensive survey methods are ordinarily employed. The survey schedule is so designed as to build up, from the farmers' memory and available records, a complete and accurate record of the financial operations of each farm for the year; together with such information as to physical operations as is necessary in understanding and analyzing the farm and enterprise organization and level of efficiency.

The sampling aspects of this type of project are of great importance. The discussion under the head of "Sampling" in *Research Method and Procedure in Agricultural Economics* lists thirteen different procedures that are followed in obtaining the farms to be included in cross-section studies in agriculture. Some of these procedures result in a random sample, or something which is near enough to its equivalent to satisfy scientific standards. But these procedures are the ones that are least used. In practice, the farms are

(Continued)

widely used in all parts of the country. The data essential to the particular form of analysis followed at Cornell, and with a few minor changes formerly followed by the U. S. Department of Agriculture, were described in U. S. D. A. Farmers' Bulletin 661, by E. H. Thomson and H. M. Dixon (1915), and Farmers' Bulletin 1139, by H. M. Dixon and H. W. Hawthorne (1920). Dr. W. I. Myers of Cornell gave his views as to the value and uses of these studies in an article, "Farm Business Analysis" in the *Journal of Farm Economics*, January, 1926, as follows:

"The object (of farm business analysis studies) should be to show actual economic conditions on farms and to point out ways in which these conditions may be improved.

"As long as agriculture continues to be dynamic, farm business analysis studies will continue to be an important part of any well considered program of farm management research. In every state, comprehensive studies should be made periodically in each of the important types of farming (areas) in the commonwealth. These studies should reveal the application of the principles of farm management under varying environmental and economic conditions. . . . The most important factor is to keep continually in mind the object of farm management research—to show farm operators how to organize their farms so as to obtain the greatest continuous profits."

Professor Myers' most recent statement on the subject is in his paper read at the Second International Conference of Agricultural Economics. (H. R. Tolley.)

mostly "selected" rather than obtained by valid sampling procedures, and in most cases, as is demonstrated by evidence given in the discussion of "Farm Management Surveys" cited above, in such a way as to secure a group of farms differing considerably from the farms in the area. For example, the 1115 farms included in the North Carolina survey cited in the foregoing reference averaged 128 acres as compared with 66 acres for the census of the same area. Completely random samples, however, are needed only if the objective is that of *describing* the agriculture of the area. The objective of this project is not description, however, but the specific determination of the most advantageous combination of enterprises in the area, in other words, the determining of economic relationships in the area. In an area of varied conditions, a random sample will usually have too few of the unusual types and sizes of farms to reveal adequately the nature of all the relationships present. A group of farms taken in such a way as to include relatively more of specified or unusual cases may therefore give a more satisfactory basis for analytical work. But the principles of random sampling cannot be altogether ignored even in such cases. The group of farms to be included must be planned in advance in such a way as to include all the variants needed. The best procedure perhaps is to take a random sample, perhaps ruling out certain classes of farms as not having significance for the quest in hand, and then supplement it by adding more farms at the extremes or of types likely to reveal desired relationships.

It will be noted that the objective of this project is to determine the most advantageous combination of enterprises for the farms of an area rather than to describe the conditions in an area. For this, the investigator must have the knowledge of the systems of farming prevailing in an area, and of methods used in conducting the different enterprises that this type of project provides. But he must also know the yields of different crops with different cultural practices and of the different soils of the area, the production of different classes of livestock with various feeding practices, and many other things which can be learned only partly, if at all from a series of farm business records such as those suggested for use in this project.

If mere description of the systems of farming and farm practices in an area is all that is wanted, this can be obtained more readily and at much less expense from secondary sources than as a part of the particular study outlined here, or from these sources supplemented by an inexpensive type of reconnaissance survey. In this report, projects designed to describe and classify systems of farming in an area (See Project 2), to account for their existence (See Project 3), and to measure the changes in systems of farming and in farming practices as they occur (See Project 5) have been outlined separately from projects such as this one (Project 8), and several of those outlined in the later pages of this report, which may be

thought of as being designed primarily to determine desirable changes or adjustments in the combinations of enterprises and the methods of production on the farms of an area.

In some of the studies by this method which have been carried on for a number of successive years on the same farms, or which have been repeated at two or more intervals in the same area, a considerable part of the analysis has been given over to the changes that occurred during the period covered by the study in the level of incomes from farming in the area. (See, for example, *Farm Profits. Figures from the Same Farms for a Series of Years*, by H. M. Dixon and H. W. Hawthorne, U.S.D.A. Bulletin 920, 1920; *Farm Organization and Management in Clinton Co., Indiana, A business analysis of 100 farms for eight years*, by H. W. Hawthorne and H. M. Dixon, U.S.D.A. Bulletin 1258, 1924; and *Incomes from Farming and Cost of Apple Production in the Shenandoah Valley*, by C. R. Swinson, U.S.D.A. Bulletin 1455, 1927. Measuring the incomes from farming in an area and accounting for the historical changes that have occurred in it is a problem distinctly different from that of determining the systems of farming best suited to the area, and it seems that this difference should be recognized in planning the research program, and organizing the research project. (Studies designed to determine the general level of incomes from farming and to account for changes are discussed in the bulletin in this series dealing with research in Agricultural Income.)

The foregoing statements are not to be interpreted to mean that one should never attempt to conserve time and funds by collecting the data for two or more projects at the same time. On the contrary it is frequently wise to do this, especially if the data for the different projects pertain to the same period of time and if they are to be obtained from the same sources. But one must keep the different objectives distinct in one's mind; and above all not confuse the analysis.³

If the survey method of collecting the data is used, the inaccuracies of the farmer's memory may be partly guarded against by such devices as checking the acreage in different uses against the entire farm acreage; the production of each crop or livestock product against its disposition as sales, feed, family use, seed, or carryover; the opening and closing livestock inventories against sales, births, and deaths; the farm-raised and purchased feed used by important classes of livestock against the production; the yields of the different crops on each farm against each other and against yields on adjacent farms; and prices paid or received against prices reported (for the same dates) on neighboring farms. At the same time, such supplementary records as check-book or other records of expenditures; and records of milk purchased from or feed sold to individual farmers, or grain or other products purchased from individual

(3) The last four paragraphs were supplied by H. R. Tolley.

farmers, which may be secured from local shipping stations, elevators, or feed dealers, can be used to fill in details of the survey records or to put the record of principal items of income or expenditure on a more reliable basis. Where the records are collected by the survey method, especially by a large crew of men, this checking and comparison of items should be completed in the field, so that missing items may be secured and inconsistent or erroneous items corrected while still on the spot.

The essential groups of items usually included in a study of farm organization by the comparative method are as follows:

Location and description of the farm.

Crop acreage, production, home use, and distribution.

Livestock inventories, births, deaths and sales.

Production, home use, and sales of livestock products.

Family and hired labor supplies, distribution and types.

Character and use of purchased materials (seed, feed, fertilizer, etc.).

Other cash expenditures.

Other sources of income.

Tenure arrangements.

Inventory and value of farm property, including real estate, buildings, and machinery, and estimated rates of depreciation.

Besides these items, other supplementary information concerning production practices in handling the principal enterprise or enterprises may be secured; such data are often essential if the effects of differences on enterprise efficiency upon the farmer's success are to be allowed for. Additional information has sometimes been obtained, such as the education, history and experience of the operator, the price paid for the farm, the farmer's indebtedness, and the individual items of farm equipment. Frequently a great part of such information has not been used after burdening the farmer and record-taker with it.

The record should be such as to provide a complete statement of cash expenses and receipts; of quantities of farm products used by the family; of amounts of family labor used on the farm; and changes in inventory value of crops, livestock, or farm equipment due to physical changes in farm resources (but *not* those due to changes in the prices of those resources); and value of farm capital employed in production. It is then possible to compute the excess of cash receipts over cash expenses; or to add to this the increase in inventory, and subtract from it appropriate charges for the family labor if such can be determined and interest on capital, and so secure a final net figure which indicates the estimated economic success of the farm for the year, after making allowances for farm products consumed on the farm, unpaid labor and the use of capital. There are various accounting means of combining these several items

into specific net figures, such as labor income, operator's earnings, management wage, etc. All give roughly the same results as comparisons between farms so far as statistical averages and correlation coefficients are concerned; but the particular measure used may affect greatly the ranking of any farm which is at all abnormal in any of several ways, such as in fixed investment, in amount of family labor employed, and in system of farming.

The effect upon the estimated income of *two* of the different methods of accounting which have been proposed is shown in the table below.

The more important distinctions between the "labor income" figure and the "operator's earnings" are as follows:

1. In the method of charging for capital: labor income charges interest, taxes, and depreciation at the going rate on the estimated value of the whole farm; operator's earnings charges working capital at the rate currently paid for bank credit and real estate at the usual rate for cash rented farms.

2. In the charges or credits for special items: labor income makes no allowance for family use of farm-raised products, and includes income from non-farm sources; operator's earnings includes an allowance for family use of farm products, and excludes outside earnings.

As a consequence of these differences, the operator's earnings measure provides a more exact indicator of the economic success of each individual farm than does the labor income. At least a number of statistical studies have showed that labor income is but 65% to 75% as sensitive to differences in size and efficiency of operation as operator's earnings.⁴

If labor income is used as a basis for ranking individual farms, a farm with a large family might consume considerable produce at home which would be sold on a similar farm, no more efficiently operated, with a small family—the labor income would be larger on the latter than on the former. Or one man might be a poor farmer, but do much outside work; including this, as in labor income, would make him appear an unusually successful man. The operator's earnings measure gives a fairer weight to such items.

But not even the operator's earnings measure as ordinarily used discriminates between a farm where labor is used inefficiently or at less important work merely because much unpaid family labor is available, and those where labor is used sparingly because it is hired. This is unfailingly the case if family labor is valued at what it would cost to *hire labor of the same age and type for the same period of time*—as is still done in some business surveys; and even

(4) See "A Statistical Test of Measures of Farmers' Financial Success" by Mordecai Ezekiel, *Journal of Farm Economics*, October 1925; and "Farm Business Analysis" by W. I. Myers, *Journal of Farm Economics*, January 1926.

true if the family labor is valued at what it would cost to *hire the same work done*, since considerable of the work would not be done if labor had to be hired for it. In some business surveys, the basis of valuation sought is *what the farmer would have been willing to pay out for hired labor to do the same work*. If a reasonably correct answer could be obtained to the latter question, the results would be comparable for farms with different proportions of family labor. But it is doubtful if such a question is properly answered by most farmers. A safer procedure is to handle family labor in the analysis the same as indicated in the table for values of farm dwellings, that is, to correlate the physical amounts of unpaid family labor with the net earnings before any deduction for family labor is made, and determine statistically the regression line for contribution of family labor to net earnings, and from the regression line determine the deduction for each farm. The net earnings figure for each farm will then be comparable with that of all other farms with the same proportion of unpaid family labor.

COMPARISON OF HANDLING OF DIFFERENT ITEMS UNDER THE "LABOR INCOME" AND "OPERATOR'S EARNINGS" BASIS.
(270 dairy farms Chester County, Pa., 1922-23)

ITEMS	Labor Income basis		Operator's earnings basis	
	Items	Totals	Items	Totals
Total farm capital		\$16,269		
Working capital		3,619		\$3,619
Real estate		12,650		
Real estate used in agricultural production ¹				9,422
Products sold	\$3,437		\$3,437	
Farm products used by farm family			274	
Gains in inventory	150			
Gains in inventory less adjustment for horse depreciation			132	
Income from outside sources	30			
Total value product		3,617		\$3,843
Cash expenses other than on real estate or interest	1,947		1,947	
Cash value of family labor	262		262	
Value of farm products used by family labor			26	
Taxes, insurance, building repairs and depreciation	546			
Interest on capital at 5 percent	813			
Interest on working capital at 6 per cent. .			217	
Interest on productive real estate at 4 percent			377	
Total charges		3,568		2,829
Labor income		49		
Operators' earnings				1,014

(1) Obtained by eliminating contribution of dwellings to farm value on a multiple correlation basis.

(b) *Analysis of the data*: In the procedure usually followed in these studies, the data are summarized to show the variations in the net incomes and in the items thought to be associated with variations in incomes on the farms included in the study. They are then

analyzed to obtain measures of the amount of change in net income associated with each item and the degree to which net income is correlated with the various items. Various measures of net income have been used as mentioned above, and the association between certain factors ("factors affecting profits" or "factors affecting financial success," pretty well standardized in the conventional studies) and net incomes has been shown in the many studies by this method which have been conducted. Dr. W. I. Myers in "Results of Farm Management Research in the Northeastern United States," published in the *Proceedings of the Second International Conference of Agricultural Economists* held at Cornell University in 1930, stresses as important business factors affecting financial success in farming: (a) size of the farm business; (b) yields of crops and rates of production of animals; (c) labor efficiency; and (d) organization of enterprises. Dr. A. F. Vass, of the University of Wyoming, in "Research Investigations on the Livestock Ranches of the United States" in the same publication stresses (1) size of business, (2) percent of investment in cattle, (3) calf crop, (4) calf loss, (5) cattle per man, (6) cow loss, and (7) cows per bull; and shows for some Wyoming cattle ranches coefficients of gross and net correlation between each of these factors and net income measured as rate of return on investment.

It should be noted that data of this sort reflect all factors causing differences from farm to farm, and therefore reflect differences in enterprise efficiency as well as differences in the farm organization. Unless both types of factors are recognized and are properly allowed for in the analysis, differences in income which are really due to one set of factors may be ascribed to another. Thus in one area the data showed an apparent relation between acres in crops and operators as follows:

Acres in crops	Average income
Acres	Dollars
16 to 30	680
31 to 45	870
46 to 60	970
61 to 75	1050
76 to 90	1110
91 to 105	1280

Such evidence might be interpreted (and in many studies has been) to indicate that income varied directly with number of crop acres. When, however, the number of cows was considered as well, the data appeared as follows:

Number of cows	Acreage in crop					
	16-30	31-45	46-60	61-75	76-90	91-105
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
6 — 10	600	670	670	710	—	—
11 — 15	980	810	950	960	610	290
16 — 20		1870	950	1340	1120	1670
21 — 25			1480	660	1320	1550

When viewed in this way, it is evident that it is not number of acres in crops, but the size of the dairy herd which determined income that year. For farms with the same size of herd, the income was about the same, regardless of the number of acres in crops.

But carrying the matter still further it was found that it was not so much the size of the herd as the differences in the efficiency with which the dairy enterprise was conducted, which really were responsible for the differences in income. This shows clearly in the following table:

Dairy index in dollars ⁵	5 to 10 cows	10 to 15 cows	15 to 20 cows	20 to 25 cows	25 to 30 cows
	Dollars	Dollars	Dollars	Dollars	Dollars
-50 to 0			-1700		
0 to 50	590	110	320	1280	300
50 to 100	590	800	970	1340	770
100 to 150	960	1270	1690	1680	1730
150 to 200	1200	2150	2870	2800	3750
200 to 250		2000	2700		

(5) Value of milk and calves per cow less value of feed consumed, other than pasture.

On farms with each cow returning less than \$50 above feed costs, those with 25 to 30 cows showed no larger operator's earnings than those with 5 to 10 cows. But even on farms with small herds, income was much larger when the "dairy index" was at 100 or 150 than on those when it was below 50. In every size-group the same relation holds true—except that the additional return with additional efficiency became even greater as the number of cows was larger.

Even this analysis does not answer the final problem as to how farmers in the area may increase their incomes. What must the dairyman do to raise the efficiency of his dairy enterprise? In this investigation, this question was answered by a direct study of the details of the dairy enterprise, as shown by the survey records. Proper balancing of ration, freshening at the proper season of the year, proper adjustment of butter-fat content of the milk to the economic conditions, and the use of cows of good productive ability, were all found to be important items, and the relation between each item and the feed cost of milk production was shown from the farm records themselves. (The relations were determined by an input-output study using multiple correlation analysis.) This gave a concrete answer as to what practices were necessary for increased income.⁶

In most studies using the "comparative" method, where a similar complete analysis has been made, parallel results have been obtained. Where one enterprise is dominant, it is the size of that enterprise and the efficiency with which it is conducted which is most important in determining incomes. It may be acres in tobacco and yield per acre in Virginia, acres in cotton and yield per acre of cotton and

(6) See *Factors Affecting Farmers' Earnings in Southeastern Pennsylvania*, by Mordecai Ezekiel, U. S. D. A. Bulletin 1400, pp. 20 to 35.

supplementary crops in the South, or number of sows and pork produced per sow in the Corn Belt. Unless the records are full enough to go into efficiency as well as organization, and unless the statistical technique is adequate to reveal such underlying relationships, farm management studies using the comparative method are likely to fall far short of determining the true situation, or of being of real use to farmers. Where such a complete study is made, the question of the relative advantage of changes in combination of enterprises *versus* improvements in enterprise efficiency may be definitely appraised, at least to the extent that variations in both types of factors were present on the farms included in the study in sufficient numbers to permit of reliable conclusions.⁷

The actual analysis of the data collected involves the techniques and principles presented in detail in *Research Method and Procedure in Agricultural Economics*, and in the textbooks on statistical methods. The analysis is especially difficult because of the many variables which influence incomes on individual farms. Some of these have already been suggested. In addition, incomes reflect the economic and natural conditions of the particular year or years covered by the record. In a beef and hog area, hog farms may show to advantage in a year when hog prices are high, and beef farms in a year of favorable beef prices. Or some cattle feeders may make money because they happened to buy and sell cattle at such times as to secure a favorable margin, while other feeders in the same year, equally efficient as producers, happened to sell just at the wrong time for the prices of that year. In a year of crop failure, a corn belt area might show that the more acres of corn a man had, the more money he had made (or at least the less he had lost), while in a year of good crops, the reverse might be true.

These peculiarities of the period covered by the survey may be allowed for in three different ways: (1) by analyzing the data from a single year as they stand, but interpreting the results with reference to the representativeness of conditions that year, and the possibility of different conclusions with other conditions; (2) by spreading the study over a series of years, so as to try to average out conditions and secure representative or "normal" results; or (3) by adjusting the individual farm data so as to make them more representative of normal or expected conditions. Examples of this last procedure would be substitution of normal yields on each farm for actual yields, and normal or expected prices for actual prices, and then computing an "adjusted" income from these modified data. Where this difficulty has been faced at all in practice, it has usually been by the second method. The last method has been tried out to some extent, however, and seems fairly promising.

(7) For a fuller discussion of the possibilities of enterprise-efficiency studies see "Studies of the Effectiveness of Individual Farm Enterprises" by Mordecai Ezekiel, *Journal of Farm Economics*, Vol. 8, pp. 86-101, 1926.

In addition to the difficulties of analyzing the data so as to eliminate the influence of the peculiar conditions of the year or years in which the records were secured, care is necessary to handle the data so that results are not imputed to variables with which they happen to be associated but to which they are not due. For example, the best farmers in a particular area might happen to have Holstein cattle while the poorer farmers happened to have Jersey cattle. Classifying the incomes with respect to the breed of the cattle, the conclusion might be reached that Holstein cattle produced high incomes and Jersey cattle produced low ones. Multiple correlation and other elaborate statistical techniques may be called upon to eliminate the influence of factors which happen to be associated in this way. But where such methods are used in practice by persons familiar only with the mechanics of such techniques, and not understanding this significance, they have as often confused as clarified the results. Furthermore, even a statistically significant correlation coefficient is no proof that causation exists. The fact that the men in a given area who follow certain practices obtain higher incomes is not in and of itself proof that if other men followed those same practices they would increase their incomes. Only experiment would determine whether the poorer men were capable of using to good effect the more advanced methods.

Advantages and disadvantages.

The principal advantages of the comparative method are that its data represent the results actually secured by farmers in the area in so far as these results can be measured. Any conclusions based on these data, even for the area as a whole, are of course only statistical probabilities. The averages represent a number of different farms, and even with a detailed cross-classification it is difficult to arrive at satisfactory figures for any individual system of farm organization or set of natural conditions. For that reason, although the results may in general hold true for the average of the area, it is frequently difficult to tell how they should be interpreted for any one individual set of conditions.

Comments. (J. D. Black.)

While it will be impossible in the space that can be made available here to develop properly the statements made in the foregoing two paragraphs, it will be worth while to amplify them a little. The difficulty of establishing true relationships is well illustrated in the case of the commonly stated relationship between size of business and farm income. Larger incomes are as much due to size of farmers as to size of the farms. (This discussion assumes any reasonable measure of size of farms that one wishes to use.) In general, farmers with large capacity tend to get on large farms, and farmers with small capacity on small farms. The increase in incomes with size of farms is due in part to the increase in size of the farmers operating them. Of course it is difficult to provide proof for this

in quantitative terms—for the reason that size of farmers is difficult to express quantitatively. But almost any set of survey records furnishes a strong presumption of its truth by reason of the wide scatter about the line of regression with size of farms. In particular, there will usually be found a considerable number of rather large farms with low incomes, which strongly suggest cases of farmers on farms too large for them. The common method of analysing such relationships, or at least presenting them, in the form of tables of average income per farm for farms within a series of size groups, has the effect of concealing the amount of scatter about the regression line. This was well illustrated by Tolley and Mendum in their analysis of the income and size relationship for 320 farms in Chester County, Pennsylvania. The income by size groups increased with beautiful regularity from \$547 to \$1488. But the actual scatter was so great that a Pearsonian coefficient of correlation was only +0.32. Probably most of the farm management surveys would show a higher coefficient than this. In effect, such coefficients are as much an indication of the extent to which capacity of farmers is associated with size of farms as they are of the association of size of farms with incomes.

This whole relationship is also further complicated by the difference between *capacity* and *efficiency* of farmers. Some of the good incomes for small- to medium-sized farms are due to the superior efficiency of the farmers, and they might or might not have larger incomes on larger farms, for many such farmers have higher relative efficiency than capacity. Space does not permit fuller development of the line of thought. (But see textbooks of H. C. Taylor, C. L. Holmes, or J. D. Black for definitions of capacity and efficiency.)

It follows from the foregoing that one cannot reason from the usual statement of relationship between size of farm and income to a conclusion (a) that any particular farmer should increase the size of his business, even though it may be rather small now; or (b) that the whole group of farmers in the survey would be better off if they were on larger farms. There may be as many farmers in a particular area who need to decrease the volume of their business as increase it (although on *a priori* grounds the odds are in favor of larger sizes).

This foregoing conclusion receives much support from the evidence of agricultural history in the United States. In spite of the large volume of preaching in favor of larger farms based on the farm business surveys made since 1908, farms have failed to increase in size measured in acres or improved acres, except that since 1920 the tractor and tractor-combine have been a powerful enough influence over a considerable area to overcome contrary influences. Of course scattering counties or larger areas may be found in many sections where increases have occurred. Livingston County, New York, is apparently in this class.

Measured in terms of inputs of capital or labor, or of outputs, however, the size of farms has increased over a large part of the United States from 1900 to 1910. This was a phenomenon of increasing intensity of agriculture, associated with increasing relative prices of farm products, increasing land values and the like, and cannot be thought of merely in terms of size of the farm business.

This latter points to the fact that the prevailing size of farms, however measured, is a function of the ratio of the population to natural resources, in particular, of the ratio of farm population to land available for agriculture. In a period when the population is increasing faster than the land supply, and yet at the same time per-capita real incomes of the nation are increasing, as in the United States from 1910 to 1917, one will find acres of land per farm decreasing, and also acres of land per person engaged in agriculture, and other evidences of intensification; and at the same time an increase in income per farm family. Farmers generally did not get more land to work in this period because they could not take it away from other folks who needed it more. The market functions even in such matters. Persons with more ability than the average were of course able to outbid others for more land. But on the average there was no increase. The way to increase the average size of farms in any area, it follows, is to increase the ability of farmers in it to outbid other farmers for it. The way to increase the average size of all farms is to make farmers abler persons than they are now. Certain advantages which farms have as places of residence, and that family labor gives to all family farms, are much more important in farm organization than is recognized in conventional farm business surveys, and are relatively much more important on small farms than on large ones. This is one of the reasons that the farmers with larger capacity have not been able to outbid smaller farmers for more land. Changes in technology, such as toward the use of more power, may, however, work to the opposite effect. They appear to be doing so now.

The commonly stated relations between output per acre, per man, per horse, per cow, etc., and farm income, are also subject to serious qualification. The logical application to make of such a generalization is that each farmer in the area ought to use more labor or more fertilizer or otherwise increase his inputs so as to increase his output per acre; and that all farmers in the area ought to do so. But neither of these would be a safe recommendation. The scatter about the line of regression of inputs per acre and net income is too great. There are too many conditions that are special to each farm that affect yields. The correlation itself is partly due to a number of circumstances that have no element of cause and effect in them whatever. For example, high yields generally occur on the best land, and also the best farmers and highest net incomes. The deduction in the form of higher interest on the more valuable land allows

for this only for a fraction of its importance. Anything that may happen anywhere in the area that makes yields higher on some farms than on others without making the expense proportionately greater—differences in loss from crop damage, in planting at the right time, etc.—will produce a bias in favor of a correlation between yields and net income. Similar elements of spurious correlation are involved in the analysis of relation between product per cow and net farm income. (See note in the *Journal of Farm Economics*, October 1930, "On the Relation of Yields to Income," for a fuller discussion of this point.)

B. *The Synthetic Method.*³

The essential feature of the synthetic method is the estimation of probable income from specified variants in systems of farming by the use of budgets of prospective receipts and expenses, and in this way determining which variant promises the best results. Various systems of farming and combinations of enterprises found in an area may be studied in this way, and conclusions reached as to the extent to which a particular change in the system of farming or combination of enterprises is likely to influence the income from a farm of specified size and resources. Furthermore, modifications in the efficiency with which the different enterprises are conducted may be

(8) The method here outlined has been called the "Method of Substitution" by J. D. Black in the *Introduction to Production Economics* (p. 237), the "Estimate Method of Cost Analysis" by C. L. Holmes in *Economics of Farm Organization and Management* (p. 355) and the "Budgeting Method" by J. B. Hutson in his *Progress in Development of Budgeting Method of Planning in Agricultural Economics* (Ph. D. Thesis, Columbia University, published in 1930).

As a member of the Division of Farm Management and Costs of the Bureau of Agricultural Economics between 1925 and 1929, Dr. Hutson took an active part in the development of this method. In the publication mentioned above (page 4) he summarizes the point of view and procedure in studies in which this method is used, as follows: "There has developed the point of view that the research worker in farm organization must interpret his results in the light of present conditions and prospective developments if they are to be most useful. The budgeting method . . . is suggested as a definite and logical way of aiding in making this interpretation.

"In using the budgeting method the research worker in farm organization studies past relationships, some of which may be revealed by his own special studies, and some of which may be revealed by the studies of others particularly in the field of prices and farm practices; some of each group may be revealed by long-period and some by short-period data; in addition he considers conditions that prevailed during each of these periods, existing conditions, prospective developments, and makes estimates as to relationships that appear probable during the period of years just ahead. More specifically he uses such research results as are available, outlines systems of farming for the most common sets of resources in a local area, and prepares complete budget statements for each system outlined. In preparing these outlines he considers a local area a unit of study and makes long-time forecasts or estimates as to cost factors, production, and prices for the different farm commodities that are being produced in this area and in other areas under similar conditions. These outlines, including the budget statements, represent, in summary form, his conclusions as to the possibilities, during the period of years just ahead, of the various systems of farming that are being or that may be followed in the section. He also in most cases shows the actual relationships upon which his conclusions are based." (H. R. Tolley.)

considered, and the relative influence of a change in the efficiency of production determined.

The synthetic method depends for accurate results upon obtaining a sufficiently complete knowledge of the details of farm operation in the particular area so that the results of a year's operation may be fairly accurately forecasted on the basis of this knowledge. It involves setting up representative standards or input-output ratios for crop and livestock production with the various methods and practices followed in the area, the materials, labor, and expenses per unit used with each practice, and the yield or product obtained in the community with these practices. Thus in setting up standards for dairy cows, the prevailing inputs of feed, labor, etc., may be shown separately for cows producing 150 pounds, 200 pounds, 250 pounds of butterfat per year and so on. Where there are several different practices in the conduct of an individual enterprise, such as, for example, cultivating corn with a 1-row cultivator, a 2-row cultivator, or a 3-row cultivator, the standards should cover each commonly prevailing practice and show the changes in the inputs and in outputs on farms of various sizes for each such practice.

These data on labor and material inputs may be based partly upon the actual farm experience in the area and partly upon the results of feeding experiments, soil and fertilizer experiments and other experimental work which can be directly interpreted with regard to the possibilities of the area. Thus, for example, agronomic experiments in Texas have shown that rotating cotton with another crop materially increases the average yield on certain types of soils. Few farmers are as yet following this practice, but by incorporating the results of these experiments in the analysis, it is possible to work out the probable income under a revised system of farming and to estimate whether or not it is likely to pay the farmers in this area to shift from the present system, which is typically almost all cotton, to a system involving a much smaller proportion of cotton (but with higher yields per acre) and a higher proportion of other crops.

The material and labor inputs for the different enterprises may be obtained in part by means of special surveys and in part from records kept in cooperation with the farmers themselves, with varying degrees of supervision. (See discussion under Projects 8A and 21.) In areas where the farmers specialize in growing one dominant crop or a few important crops on each farm, and where supplementary and complementary relations between the several enterprises are of relatively slight importance, the labor and material standards can sometimes be established with a high degree of reliability by the use of enterprise survey records. On the other hand, where farmers are following a highly diversified system of farming with a good deal of conflict between the different enterprises, the farmer's memory may not be adequate to recall the amounts of labor used on the different crops. In such cases it may be necessary to use data from records

which have been kept under the supervision of the agency conducting the research. A full discussion of this point will be found in the statement by J. B. Hutson on "Supervised Records of Farming Operations" in *Research Method and Procedure in Agricultural Economics*.

In collecting data from farmers to use in determining input-output ratios, or production standards, the farms should be so selected as to provide adequate information on all of the enterprises which are to be considered in studying the possibilities of different systems of farming.⁹ Adequate information must also be secured to indicate the influence of different methods and practices upon the relation between input and output for each enterprise, so that the standards and ratios can be obtained that will be applicable not only to the methods and practices most common in the area, but also to other improved methods and practices which yield a higher level of efficiency. All of this means that the data cannot be collected by mere random sampling, for then there may be insufficient data to work out standards for the less frequent enterprises and the less common practices; at the same time more data than are needed for reliable conclusions may be obtained for the most common methods and practices for the important enterprises. Instead, a purposive sampling must be used. The groups of farms must be so constituted as to cover all the variety of conditions that are to be considered, with a sufficient body of data for each different enterprise and practice to provide a reliable basis for determining standards and ratios. The necessity for this purposive sampling makes a preliminary or reconnaissance study of the area very important. This preliminary study must provide enough information about the conditions in the area so that the systems of farming to be compared, the enterprises to be considered, and the variations in methods and practices for the different enterprises are known before the actual collection of data is begun.

The reconnaissance may be based largely on census information already available, or on a special tabulation of individual census schedules, as suggested in Projects 1, 2 and 4 of this report, supplemented where necessary by an appropriate survey covering the entire farm business. The survey could be simplified somewhat and use a smaller number of records than would be necessary were the survey itself to be made the basis of the final conclusions. Such a reconnaissance survey should be aimed at determining the principal

(9) To provide all the information needed for thoroughly dependable results in this part of the analysis a series of specific projects similar to those outlined in Projects 17 to 21 in this report would be required—one project for each enterprise and each farm practice to be considered. In areas where such studies have not been made, information obtained from farmers after the manner suggested here must be relied upon to furnish the basis for approximating input-output ratios for the various enterprises and practices considered in the analysis. This latter is the procedure which has been followed in most of the studies by the *synthetic* method which have been made to date. (H. R. Tolley.)

systems of farming now in use, the modifications which are being tried, the important enterprises, and the variations in methods and practices. It should thus determine what points are to be emphasized in the subsequent analysis, rather than itself providing the answers. If studies such as those outlined in Projects 1 to 5 inclusive in this report have been made in the area, the reconnaissance should not be necessary.

Once a decision has been reached as to the variety of systems of farming, enterprises, and methods and practices which are to be considered, sufficient information must be secured on each point to indicate accurately what farmers in the area are doing and the results that can actually be secured. Experimental data should be examined and compared with the farm experience, and both considered in setting up the standards, especially for improved methods which may not have been yet tried out in the area. The results of studies such as those outlined in Projects 17 to 21 inclusive in this report are needed at this point.

When the input-output ratios or enterprise standards have been established in sufficient detail to cover the range of differences in equipment, efficiency, soil, topography, size, etc., of the farms of the area, the next step is to decide on the prices of products and prices of cost goods to be used in working out the budgets. Here the results of research relating to prices are needed. Studies designed to measure and explain prices, and studies concerned with forecasting production, consumption and prices, as outlined in the report in this series on research relating to Prices of Farm Products will all be helpful. Still more helpful would be studies like those discussed in Project 16 of this report designed to develop a basis for forecasting prices *at the farm*. Also studies relating to the prices of farm supplies are needed as a basis for judging the probable prices of cost goods.

The average prices which seem likely to prevail in the immediate future (say, the next year or two), or the probable average for a longer term of years, may be used. The price to be used will depend upon the specific objective being pursued. Thus if in 1929 a farmer in southeastern South Dakota were considering whether to shift from beef cattle as the principal livestock enterprise to dairy cattle, he would need to consider the long-time prospective prices for beef and for butterfat to reach a decision as to which promised the greater long-time return. But he would also need to consider the prospective prices for the immediate future, for it might well be that even though dairying offered the most promising long-time returns, beef would pay better during the next two or three years.

In addition to the average prices expected to prevail, the probable highest and lowest prices to be expected might be determined. These would provide a basis for considering, for any given system of farming, whether or not it would pay to make a specified change in

the combination of enterprises under extreme price conditions, even if it did not pay under average price conditions. On the other hand, this procedure might demonstrate that a given combination of enterprises offers the most satisfactory returns for the farms of an area under extreme price conditions as well as under average conditions. For example, in certain areas of New York, farms organized so as to produce fluid milk to best advantage might readily have the best combination of enterprises no matter whether milk prices were high or low, or feed prices were low or high. On the other hand, farmers in some areas of Illinois might ordinarily make the best returns by raising hogs and feeding most of their corn, yet be at a considerable disadvantage in periods of low hog prices and high corn prices unless they reduced their hog enterprise to the minimum necessary to maintain the breeding herd and sold as much corn as possible.

Constructing budgets.

With the input-output ratios or enterprise standards and the prospective prices worked out, the next step is to construct the budgets for the various sizes of farms and systems of farming which are to be considered.

The technique of constructing farm budgets and the computations involved have been discussed fully by J. B. Hutson in U. S. D. A. Farmers' Bulletin 1564, *Farm Budgeting*, and in his *Progress in Development of the Budgeting Method of Planning in Agricultural Economics*, above cited.

Where the study outlined in Project 2 of this report has been made, the typical systems of farming for the most common sizes of farms in the area might be the first ones to be considered, since the results would then be of value to the largest proportion of farmers. The budgets should first be worked out with the level of enterprise efficiency characteristic of the present farmers. Then the system should be modified to change the combination of enterprises in various ways that may seem feasible, but still maintaining the same representative level of enterprise efficiency.¹⁰ This will indicate the probable influence on income of changes in farm organization as distinguished from changes in efficiency. Following that, various modifications in methods and practices (or changes in efficiency) may be considered. In introducing these improved practices, with the resulting higher level of enterprise efficiency, the specific production methods and practices which will result in higher efficiency must be shown. If the improved results can be secured only by a long process of development in building up the quality of cows, the fertility of the fields, or the ability of the farmer, that must be clearly indicated and allowed for in working out the results to be expected on the farms of the area during the years when the new level is being developed.

Once the probable returns from a given combination of enterprises

(10) This would of course be futile if this level of efficiency was so low as to have no practical value. (John J. Hopkins, Jr.)

has been determined for one set of prices, such as for the expected long-time average, the returns which could be expected in years when other price combinations prevail can be readily determined by merely recalculating the values of the products sold at the new prices, and changing the costs of feeds, etc., so far as they are affected." By comparing the probable returns under several different combinations of prices in this way, and comparing alternative organizations which represent only such changes as could be made over short periods in response to price outlook indications, one can reach conclusions as to how far it would pay typical farmers in the region to maintain a given combination of enterprises without regard to cyclical price changes, and how far it might pay to shift from time to time in response to changes in the outlook.

In areas such as the semi-arid regions, where crop yields are uncertain and vary greatly from year to year, the standards may be set up to show the highest and lowest yields to be expected as well as the average. The budgets can then be worked through to show the probable return in years of low yields and high yields as well as in average years. In this way it should be possible to indicate the risk involved in different alternative systems. It might well be that the system which offered the best returns on the average would be so much less profitable than others in unfavorable years that it could be followed only by men who had unusually strong financial reserves. The probable returns over a series of poor years might also be worked out, to indicate the relative desirability of different systems during cycles of poor yields such as have occurred in the past.

Testing results.

The final step in studying farm organization problems by the synthetic method is to test out the budgets in actual operation. This may be regarded as an essential portion of the research work. If cooperating farmers can be selected whose farms approach closely the typical or representative systems used as a basis of departure, and who are willing to test out one of the proposed reorganizations, records may be secured comparing actual results year by year on each individual farm with the prospective results shown by the budget computations. This procedure will determine how closely actual results can be expected to follow the estimated results, and whether the conclusions reached by the budget computations as to the relative advantage of different systems of organization are sustained in practice.¹² (See Project 15 in this report.)

(11) This would not be sufficient in periods of extreme price changes, for these might necessitate modifying the production standards as well. (See discussion under Project 11.)

(12) I suggest pointing out here or elsewhere that many "set-ups" have been unsuccessful because (although based on reliable data as far as these went) they were mere "paper" plans and not workable. Testing would readily show up such defects. Also, perfect tests may be difficult to arrange for; but imperfect or partial tests will help greatly. The experimental method will probably help out here—when it is further developed. (J. D. Pope.)

A less elaborate checking of the conclusions reached by comparisons of calculated budgets may be obtained by having the standards and computations subjected to the scrutiny of a group of leading farmers in the area. If any errors have crept into the systems, or if any standards have been set higher than farmers in the area can possibly attain, they will be discovered and remedied by the farmers. In this way the practical experience and knowledge of successful farmers can be drawn on to insure that the conclusions, based on the entire mass of data, are thoroughly sound and practicable.

Advantages and disadvantages.

The synthetic method has the disadvantage that the conclusions are ordinarily not applicable in total to many of the farms of an area; also that the conclusions are based on forecasts of what is most likely to happen, rather than on deductions from what has already happened. But deductions from what has already happened are of no value until applied to future situations. And when so applied, one is no more sure as to what is going to be the outcome than if an out-and-out forecast were made. Hence in effect there is no essential difference in this respect between the comparative and the synthetic method.

The advantages of the synthetic method are that for the particular enterprise combinations and organizations studied, conclusions can be reached as to the probable direct effect upon the income of particular changes in combination of enterprises or in methods and practices of operating an individual enterprise. It is thus possible to examine separately each particular change in combination or in operation which may be considered and so to determine directly its desirability or undesirability, as measured by probable influence upon income. Furthermore, changes in prices may also be introduced, and conclusions reached as to the most desirable combinations for any given set of price conditions, as discussed in Project 9 of this report.

Finally the synthetic method has the great advantage that it provides a mechanism for focusing price outlook information directly upon the problem of determining the most advantageous combination of enterprises for the farms of an area.

Comments. (H. R. Tolley and J. D. Black.)

There are many conflicts of opinion among farm management research workers as to the relative merits of the two methods of studying the combination and organization of enterprises outlined in this project. Both methods are being widely used. As shown in the statement in the introduction on "Recent Trends in Farm Management Research", 35 projects of the "farm analysis" type were in progress in 21 states in 1931, and 36 projects of the "re-organization" type were in progress in 23 states. In practically all of the "farm analysis" projects the *comparative* method of study was

being used, and in practically all those of the "reorganization" type the *synthetic* method was being used.

In a letter commenting on Dr. Ezekiel's statement, Dr. W. I. Myers says:

"As a method of research in farm management, I think the synthetic method is at present vastly overrated. Without a most careful and painstaking method of control, I believe that the synthetic method may easily become the best means yet devised for misleading farmers. One of the most serious weaknesses in this method is the fact that the casual reader cannot determine the adequacy or accuracy of the data upon which the results are based. It seems to me that the synthetic method does not provide as adequate checks and safeguards as the comparative method. While any method of research is dangerous in the hands of a careless worker, the results of carelessness are more easily concealed by the synthetic method.

"The financial success of a farm operator is affected by many economic factors. In order to show the effect of all of the important factors and also of various combinations of factors, an endless number of budgets would be required. This would make teaching more difficult and would tend to obscure rather than clarify the results of the study. It seems to me that the synthetic method is an excellent way of showing the effect of various changes in price level on income with any given farm organization, but that it is not a useful way of showing the important business factors affecting the incomes of farmers."

On the other hand, there are many, including the writers of this comment, who believe that the synthetic method is under most circumstances the best method yet devised for use in the combination-of-enterprises and farm-organization phase of farm management research. It is unavoidably forward-looking. In practice, the comparative method seldom yields more than a summary of the present, or rather, of the past. Rarely is any adequate analysis presented as to its application to the future. The synthetic method makes use of all available information which has a bearing on the problem being studied. The research worker who bases his conclusions on the showing of a series of carefully constructed budgets is viewing his problem from the standpoint of the farm proprietor endeavoring to make the best use of his resources.¹³

It is true that there are some obvious defects in the present use of the synthetic method; but research workers can if they will do much to overcome these defects by planning their research programs to obtain the information which is now lacking, and by more precise statements of their results and conclusions. The project above outlined is free of the more important of these defects.

(13) I suggest emphasizing this further by pointing out that the farmer must follow this kind of procedure if he is to apply "principles" successfully and intelligently no matter how they were arrived at. The synthetic method is essentially the intelligent farmers' method of planned progress. (J. D. Pope.)

The farm budget as a research device was introduced in this country only a few years ago, although it apparently has been in use in farm management research in Germany for a great many years.¹⁴

With respect to Dr. Myers' comments, it is only proper to remark that the comparative method cannot serve as a control in the accuracy of the conclusions of the synthetic method. Enough has been said above to indicate that the comparative method is also capable of producing seriously misleading conclusions as to the past and the present, to say nothing of what it might not do if used as a basis for conclusions as to future actions. If the two methods so applied were to lead to opposite action, there are no valid reasons for thinking those based on the comparative type of analysis are more dependable than those based on the synthetic type. If the data upon which the budgets are made, and the methods of combining them, are presented as required in all good scientific work, there is no more difficulty about checking the accuracy of the analysis than with any other type of procedure. A prevailing characteristic of the usual presentations of material in comparative studies of farm businesses is that one is provided with no basis for judging the validity of the conclusions. Rarely are the data presented in scatter diagrams so that one can judge the real nature of the relationships. Seldom are the several very important assumptions stated. Commonly no reference is made to important variables omitted in the data and the analysis; or to important intercorrelations. Frequently the reports do not present even the simple coefficients of correlation between the variables. It is rare to find any recognition given of the severe limitations upon the applicability of the generalizations to individual farms. Hence much of the apparent conclusiveness of such analysis is specious. The accuracy of the synthetic method is determined absolutely by the accuracy of the data which are put together in making the budgets; and these data are as accurate as the survey data or records from which they were obtained, and the subsequent analysis made of them. The accuracy of the conclusions derived from the comparative method are likewise as accurate as the data obtained, and the analysis of them. There is no difference between the two methods in this respect. On the whole, of course, the synthetic method as above outlined calls for more careful data than are ordinarily obtained by the survey method; and surely for more thorough analysis of the data.

It is true that a good many farm set-ups are needed in order to test all the possible combinations of the important variables. Why not test them all? It is just as worth while to be spending time and money this way as in collecting data in the field. The presentation of the results can take the form of tables, except for a few of the

(14) See the article by Walter J. Roth, "Farm Budgeting in Germany," in the *Journal of Farm Economics*, October 1929.

set-ups that are finally selected as best suited to the more important sets of conditions prevailing.

PROJECT 8A. An Example of a Synthetic Study.¹

OBJECTIVES: To determine the systems of farming likely to give good results in the area over a period of years, including enterprise combinations which appear advantageous; practices giving good results in the principal enterprises; and adjustments between and within the enterprises likely to be desirable with changing conditions.

(By L. P. Gabbard and C. A. Bonnen.)

This project uses the statistical method so far as the collecting of the data and working out relationships are concerned. This means that the principles of sampling must be observed, and that enough farms must be included to represent the area included. The final step in the analysis, however, consists in employing the data obtained from the statistical analysis in constructing budgets for various farm set-ups, according to the methods outlined in the second part of Project 8, in order to discover the more promising systems of farming, practices, etc.

Projects of this type should be confined to well-defined agricultural areas (the method of determining such areas is outlined in Project 1) in which a high degree of similarity in soils, topography, climate, and market facilities exists. However, if it seems desirable, the project may be limited to a subdivision of the area. It should also be limited to a particular type of farming, as this term is defined in Project 1, unless it seems wise to include additional types of farming in order to make comparisons, or to provide for differences in available labor, in combinations of land types, in size of farm, that are likely to be found in most areas in the region. The more types of farms that are included, the more farms that must be included. Enough farms need to be included so as to give a representative frequency distribution according to the major variables for each type of farming. Type of farming should not, of course, be defined too narrowly—variation within a type of farming is needed in order to observe the variable effects under study. When the study is planned, a decision should be made as to which characters are to be held

(1) This discussion follows in many details a project which has been completed at the Texas Agricultural College, the results of which have been published in Texas Station Bulletin 395, *Systems of Farming for the Black Waxy Prairie of Texas*, by L. P. Gabbard, J. B. Hutson, and T. L. Gaston, Jr. It corresponds more closely with a current project in the High Plains cotton area. The scope of this project and the method of procedure are typical of a number of studies now in progress or recently completed. It is presented here in order to show the present state of development of this method of study. Dr. Ezekiel feels that it does not measure up to the requirements of a good budget set-up study as outlined in the second part of Project 8, being especially deficient in recognition of long-time outlook considerations. (Editors.)

more or less constant and which are to be allowed to vary. The first set of characters constitutes the definition of the type or types of farming to be included in the study. Size will ordinarily be in the group of characteristics that are allowed to vary. In any case, extremes in size or other variables will need to be omitted; also farms that are abnormal in any significant respects. Farms following unusual systems of farming should not be included, at least not in the statistical analysis; there may be purpose in including a few of them for supplemental study by the case method.

Organization.

In addition to the specialist in charge and a field representative, a certain amount of clerical help is required in tabulating, summarizing, and preparing reports. The scope and technique of the project is ordinarily improved through cooperation between state and federal research agencies. Such an arrangement should be particularly helpful in states where such projects are being undertaken for the first time.

Procedure.

1. If no study of the types of Projects 1 and 2 have been made in the region, one will need to begin with a careful examination of all available descriptive information such as census reports, crop and livestock estimates, soil surveys, weather records, etc., supplementing this information with suggestions from extension agents and others familiar with the character of farming throughout the area, and in this way drawing the boundaries around the area that is to be included. Some of this may be needed in any case, since studies of the type of Project 1 may not be in sufficient detail to provide a small enough area for the purpose of this project.

2. As a first step in the selection of cooperators, a prospective list of farms conforming to the above requirements should be prepared with the aid of county agents and others. Each farmer on the list should be visited for the purpose of securing further information relative to his farm organization and to explain the nature of the project being planned in case the system of farming practiced makes it eligible for the project. In order to furnish a basis for a representative sample in the cooperators finally selected, from three to five times as many farmers will need to be visited as the number of cooperators desired. Since the sample is to be a "selected sample", one must have determined in advance, from census and other data, the shape and range of the frequency distribution desired, and check the distribution of farms selected against the desired range and frequency. Care will need to be observed in this process not to get a sample that is lop-sided as to other characters not covered in the check distributions. At the best, some of this cannot be prevented—for example, the less intelligent of the farmers will not be able to keep the needed records.

3. In most cases, it will be desirable to make a farm-to-farm survey of the area as a supplement to the more detailed study of the smaller number of farms. This will reduce the number of the farms that need to be studied in detail because it will make it possible to tell where the farms studied in detail fit into the frequency distribution for the whole area; and from this small number to construct frequency distributions for the whole area for attributes, such as labor distribution, covered only in the detailed studies. In most cases, this survey should be made in advance of the selection of the farms for detailed study. The choice of data to be collected in the survey and in the detailed study is an important matter, which we cannot take space to develop here. The discussion of collecting data by the survey method and by "supervised records" in *Research Method and Procedure in Agricultural Economics* will furnish a basis for such a decision. Bulletins cited later will also be of considerable assistance.

4. Records obtained in the detailed study should include a complete financial record, crop yields, livestock production, products from the farm used in the home, and man-labor, horse-work, materials, and miscellaneous expenses involved in growing different crops and livestock. Records showing the practices followed in growing each crop and class of livestock should also be secured. Information relating to local prices of products sold and amounts paid for material purchased by farmers in the area should be assembled for the period of the study and for as many years previous as local data permit. As accurate records of significant weather data as simple devices will permit should be secured on each farm. Records of this kind are useful in explaining variations in yields and quality of crops produced.

5. The period of time covered by the project will normally be from two to five years, depending on the year-to-year variations in climatic conditions. At Longview in Northeast Texas where the average annual rainfall is 43 inches, the deviations from year to year average only 17 percent, while at Big Spring at the southern end of the High Plains cotton area, the deviations average almost 40 percent from an average annual rainfall of 18 inches. It is obvious that a longer period of years will be required to obtain adequate data in the latter area than in the former.*

Analysis.

1. The first step in analyzing the data is to reduce them to convenient tabular form, first by systems of farming, then according

*Of course it is not possible in either type of area to include enough years so that the actual data obtained will represent average conditions. What one must do is to adjust the actual data obtained to the basis of an average season in the area as indicated by the climatic records for it. To make this adjustment, however, one must have examples of different sorts of weather-years to see how in practice farm operations are affected by them and how farmers adjust themselves to them. (Editors.)

to the more important variables of the study, such as investments in various forms of farm property, classified farm sales and purchases showing quantities and values, amounts and values of farm-grown products used in the home, crop data showing for each crop on each farm the acreage, yields, quantities and values of materials used per acre, crop practices revealing total labor used per acre and for each operation, number of times and the dates for each operation, and the duty of the different sizes of machines and power units used. Livestock tables should show for each type and class of livestock: the number, weights, etc., per farm, hours of labor and power, quantities and values of feed, pasture, and miscellaneous expenses per head and per unit of product. The data in these tables should be so arranged as readily to indicate significant variations and permit conclusions as to normal inputs and yields for different methods of production. ‡

2. As a basis for further analysis and conclusions, standard yields, livestock production, production inputs, and normal price relationships must be established. These norms should reflect, in so far as possible, the effect of differences in systems of farming and enterprise practices.⁴

3. The full significance of the relationships established in the above data may be better visualized if reduced to chart form. Such devices are particularly helpful in giving a picture of the distribution of the labor requirements for each crop and the competition among crops for the available labor at different seasons in the year. Similar charts may also be prepared for the livestock enterprises.

4. Local prices over a period of years for commodities sold and purchased by farmers of the area should be considered in relation to long-time price series of central market prices to indicate as nearly as possible normal price relationships between the commodities and between central and local markets.

5. We are now ready to analyze the systems of farming included and their variants so as to bring out the details of their organization and operations and to indicate possible weaknesses. The details of each system may be outlined in budget forms and amplified with charts showing in physical units the distribution of labor between enterprises. Similarly, the effect of changes designed to correct these weaknesses may be shown. Excellent illustrations of this type of analysis are contained in Minnesota Bulletin 205, above cited;

‡A rather large sample will be needed to make such data as these accurate enough for practical use. (Mordecai Ezekiel.)

(2) For illustrations see Texas Station Bulletin 395, Gabbard, L. P., Hutson, J. B., and Gaston, T. L., Jr., *Systems of Farming for the Black Waxy Prairie Belt of Texas*; Kentucky Bulletin 292, Hutson, J. B., Finn, W. G., and Galloway, Z. L., *Systems of Farming for the Purchase Region of Kentucky*; Minnesota Bulletin 205, Pond, George W., and Tapp, Jesse W., *A Study of Farm Organization in Southwestern Minnesota*; South Dakota Bulletin 235, Bonnen, C. A., and Rogers, R. H., *Profitable Farming Systems for the Intensive Spring Wheat Area in South Dakota*.

and variations from this treatment in the South Dakota and Kentucky Bulletins also mentioned.

PROJECT 9. Effect of Price Changes in Farm Organization.

OBJECTIVE: To determine the combination of enterprises that would be most advantageous on the farms in an area (or for particular combinations of farm resources) at different levels of prices for the products and for the input factors.

(By Oris V. Wells.)

This project is designed to show the effect of (a) changes in the prices received for farm commodities, and (b) changes in the prices paid for goods and services used in the farm production process, upon the returns to be secured from a wide range of typical or possible farm organizations within a given area.

The chief value of this type of project is derived from the circumstance that our agricultural price system has as its dominant feature the continual changing of price changes through time. The usual farm organization has been brought to a close in the past by deciding that systems of farming might be expected to be the most profitable in the future on the basis of what prices have been in the past—often in the past five years.

The defect of this system is apparent. The conclusions with reference to the single set of prices used may have been correct; but as soon as prices have materially changed, the value of the study has been much reduced, since (a) no consideration has been given to the changed price situation, since (b) changes in prices require marked changes in the combination of the various productive elements to maintain efficiency and profits, and since usually (c) the basic input and organization data have not been presented in such a manner as to enable one to make a re-analysis. As a result, the study may be out-of-date before the report is completed. Also the conclusions have often been given with reference to the average crop for a single year, and as a result they have had only limited application, since the yields to be expected may change somewhat from season to season and may change materially from farm to farm within the same general area.

In contrast to this method of limited interpretation, the type of project which we now have under consideration is designed to introduce an elastic element into the interpretation and use of our farm organization data by considering what system or systems may be expected to be the most profitable under a wide range of possible yield and price conditions, and by presenting the conclusions in such a manner that the farmer and the extension man may be placed in a position to determine easily and quickly the most profitable system

to be followed with respect to any given prospective yield or price situation on farms similar to typical farms in the region or area.

Scope and relation to other research.

In one sense the scope of this project may appear to be very narrow; but within the specific field under consideration, the scope of the project should be quite wide. Although the work, once the necessary farm organization and input data have been brought together and organized as described in Project 8, will seem to be largely routine, and although the final product may seem to be only a long series of comparative tables, it is in the results of this routine work and these comparative tables that we are interested. We want to make an exhaustive study of the possible yield and price combinations which the farmer may face in the future.

In relation to the other projects presented in this bulletin, this project will belong between such basic farm organization and management studies as those outlined in Projects 8, 17, 18, 19, 20, 21 and 22, upon which it will be based, and such studies as are concerned with forecasting the most profitable future systems of farming as outlined in Projects, 11, 12 and 13, and in part in Project 8, to which it will in turn be basic.

Basic qualitative analysis.

The basic concept upon which the price part of this project is based is as follows: Since sales and cost prices may vary independently of the physical input-output ratios, which tend to remain constant through time, the highest-profit combination of input factors within any enterprise, and of enterprises for any given set of resources within any generalized farming system may and likely will vary through time as the individual commodity prices fluctuate in relation to each other. In short, the rates of input or the combination of enterprises which may be most profitable under a given price situation may or may not be the most profitable practice or combination under a changed price situation.

Such characteristic relations as those between yields realized or gains secured and the amount of seed used or the amount of feed fed, are physical relations which remain unchanged while prices fluctuate from season to season. This means that, once we have determined the physical relationship between the rates of input and the rate of output for any given enterprise in a given area in a year of average weather and disease loss, we can, by applying varying cost and sales prices to the input-output data, estimate the returns which may be expected in such an average year with the rates of input and the prices at various levels, and that our estimates will be correct and valid—provided the price conditions are fulfilled and provided the measure of input-output relationship is correct. Extreme price changes such as of the past two years may of course require input-output combinations that fall outside the range of the

data actually studied, and one may not safely extrapolate for them.

To date, there have been almost no studies that have adequately measured and represented the complex system of relationships which exist between the variations in rates of input and resulting output for even a single enterprise. The usual so-called "unit requirements" or "standards" are only approximations. Before the investigator begins to calculate returns to be expected from various farming systems, he should know to what extent he may rely upon his basic data.

Since a marked variation in the yield or output may be secured from the same physical pre-harvest input combination, because (a) of differences in the quality of the soil from farm to farm, and (b) of differences in the management factor from farmer to farmer, the project should consider not only the income to be expected with cost and sales prices at different levels, but also with different levels of yields—thus making the conclusions applicable in cross-sections as well as through time.

Method of analysis.

To begin, it is assumed that the investigator has the necessary input-output data at his command (secured from such studies as those outlined in Projects 17 and following) and that he has organized them as outlined under the "synthetic" method in Project 8. The next step is to select the systems of farming to be used as a basis for the calculations, to consider the varying yields which may be secured, and to apply varying prices to the sales and cost items in order to secure a series of estimated farm returns for each system which can then be compared with a similar series of estimated returns for every other system.

For example, let us suppose the study is in an area where the dominant crop is cotton, but that there is an alternative corn-hog enterprise.¹ We may begin our analysis with the consideration of a 40-acre owner-operated farm unit which has 30 acres devoted to the main enterprise or enterprises, and calculate the returns to be expected from two systems of farming:

System I—in which the entire 30 acres are in cotton.

System II—in which 15 acres are in cotton and 15 in corn.

If we consider three grades of land yielding 125, 150 and 175 pounds of lint cotton per acre respectively when no fertilizer is used, and that no fertilizer is used, we may make a series of calculations that will enable us to construct Table I. For the purposes of illustration we omit income from any minor enterprises.

(1) In this discussion, we shall use the term "farm return" in a general sense. Any one of several measures of farm return might be used. Also, the illustrative data which we have assumed are purely fictional—for example, in the case of cotton there is a joint product, cottonseed, which we have not considered, but which would have to be considered in an actual problem.

TABLE I: FARM RETURNS TO BE EXPECTED FROM SYSTEM I WITH COTTON SELLING AT VARYING PRICES.

With cotton at: (cents per lb.)	Farm return to be expected with the yield per acre in pounds at:		
	125	150	175
5	\$187.50	\$225.00	\$262.50
10	\$375.00	450.00	525.00
15	562.50	675.00	787.50

From this table, we can easily secure the estimated farm return (provided our input-output data were correct and provided that all the important factors which affect the farm return have been taken into consideration) to be expected from several yield and price combinations.

But let us next suppose that the application of fertilizer may be used to increase the yield, and that the application of one-half ton of low-grade fertilizer per acre will increase the yield of cotton on average grade land from 150 to 210 pounds per acre, and that the application of one ton per acre will still further increase the yield to 240 pounds per acre. We can then construct Table II.

TABLE II: FARM RETURNS TO BE EXPECTED FROM SYSTEM I WITH (1) COTTON AT DIFFERENT PRICES, (2) WITH DIFFERENT APPLICATIONS OF FERTILIZER PER ACRE, AND (3) WITH FERTILIZER AT DIFFERENT PRICES.

With cotton at: (cents per lb.)	Farm return to be expected with fertilizer at:					
	\$10 per ton			\$20 per ton		
	Rate of application per acre			Rate of application per acre		
	0.0	0.5	1.0	0.0	0.5	1.0
5	\$225.00	\$165.00	\$ 60.00	\$225.00	\$ 15.00	\$240.00
10	450.00	480.00	420.00	450.00	330.00	120.00
15	675.00	795.00	780.00	675.00	645.00	480.00

A table such as this is evidently of more value than a table such as Table I in that allowance is made for three instead of two variables. Apparently it pays to fertilize heavily only when cotton prices exceed 10 cents, and fertilizer costs less than \$20 per ton. The exact point at which fertilization begins to pay at various yields and prices requires more calculations. In case we wanted to include another variable in the table, we might use a double-classification stub just as we used a double-classification head. For example, for farms where the cotton is picked by hired labor, our stub arrangement might be:

With the picking charge per cwt. at:	With cotton at: (cents per lb.)
\$1.50	5
	10
	15
\$2.25	5
	10
	15

By this arrangement a fairly compact four-variable table can be constructed into which the results of our calculations can be systematically entered and which can be used to present the result of our work in convenient tabular form.

Now let us suppose (a) that a yield of 20 bushels of corn per acre can be secured on average grade land and (b) that the corn can be marketed as pork at the rate of 100 pounds of pork for each 10 bushels of corn, and construct Table III with reference to System II.

TABLE III: FARM RETURNS TO BE EXPECTED WITH (1) COTTON AT DIFFERENT PRICES AND (2) PORK AT DIFFERENT PRICES.

With cotton at: (cents per lb.)	Farm return to be expected with pork at:		
	\$5 per cwt.	\$10 per cwt.	\$15 per cwt.
5	\$262.50	\$412.50	\$562.50
10	375.00	525.00	675.00
15	487.50	637.50	787.50

By comparing the returns listed in Table III for System II with those listed in Table I for System I, we can now draw some conclusions as to which system may be expected to be the more profitable under a given price situation. For example, we may conclude that with hogs at \$5 per hundredweight and cotton at 5 cents per pound, System II is the more profitable. Or, if we consider that 15 acres of corn has been substituted in System II for what was fifteen acres of cotton in System I, we may conclude that *when the ratio of the price of cotton per pound to the price of hogs per hundredweight is 1:1, the farmer will profit by increasing the size of his corn-hog enterprise at the expense of his cotton enterprise.* When the price of cotton is 10 cents per pound or the price ratio is 2:1, however, the situation is reversed.

For any specific project, this type of analysis can be extended to any desired limit (provided adequate data are available) by the multiplication of the number of systems considered and the number of variables considered with reference to each system. It can be used to estimate and compare the farm returns to be expected from a wide range of differential input-output combinations with regard to an equally wide range of price phenomena. The final result, however, will necessarily depend upon the amount of reliable basic data which is available and the individual ingenuity and common sense of the investigator.

Although the general method of analysis may appear to be quite mechanical, there are certain problems connected with calculating the comparative returns which must be carefully checked both before and after the routine calculations are made. The competitive, complementary and supplementary relationships which exist between the enterprises under consideration must never be forgotten. Only in case there are no such relationships can one compare the returns

to be secured from two enterprises on the basis of any of our present input-output data, which have taken no account of such relationships. Otherwise the conclusion from the above process may easily appear to be that when there is any considerable price differential in favor of either enterprise, the entire farm acreage should be devoted to the favored enterprise. Actually, this might be grossly incorrect. The data used must be adequate to show what happens to the care of the corn crop as it increases to the point where it conflicts with others in the use of labor, and what happens to corn yields in consequence, and similarly for the other crops competing with corn. The data upon which such determinations are based must be collected and analyzed in such a way as to show the effects on the distribution and amounts of labor and other input factors as proportions between enterprises change; and also the effects on physical outputs. The analysis outlined in the second part of Project 8 contemplates providing such data. Also account must be taken of the expense of shifting from one system of farming to another.

Some of the relationships involved are difficult if not impossible to measure. Perhaps the long-run effect on the soil is in this class. The extra demand on the time and energy of the farm operator is another. In general, the more enterprises combined, the more of such factors.

Presentation of results.

Since the ultimate aim of a project such as this is to help an individual farmer select a profitable farming system, either directly or indirectly through an extension agent, the research man should realize that his input-output data are rarely exact and that prices are usually thought of in even cents or nickels or dollars. In making the calculations, then, convenient measures should be used, and once the calculations are made, the investigator should realize that little weight is to be given to small differences in estimated returns.

Also inasmuch as the detailed presentation of the results of such a study as is outlined in this project would require a great amount of space and might easily obscure the main conclusions simply because the typical farmer or the busy extension man does not have the time (or will not take it) to study through a long series of complex tables, the research man in preparing his results for general presentation should select those systems and practices and yields which are clearly differentiated and present them in relation to the ranges in prices that are pertinent in any given situation. In explaining to a farmer or the extension man the importance of prices in determining choice of enterprises, one will present effects on returns to be secured from 5-cent cotton in comparison with 10-cent rather than in terms of comparison of 5.5 with 6-cent cotton. But in analyzing a given situation any year, one will need to work out his tables in terms of the prices then prevailing.

PROJECT 10. Adjustments to Obtain a Given Income.

OBJECTIVES: To determine the adjustments in the organization and operation of the farms of an area that will be necessary to provide a designated net income.

(By Oris V. Wells.)

In a project of this type, a fixed or desirable net farm income would be assumed, and the objective would be to determine the changes in the organization and the operation of the more typical, or specified, farms in an area, which would be necessary to raise the farm income to the desired level. The farm organization plans resulting from a project of this type might serve as a goal toward which progressive farmers and extension men might work, and indicate the type of changes needed to attain such a goal. It would seem that this would be particularly helpful in areas where maladjustment and low incomes are prevalent—unless the farmers are willing to continue to accept a low income.¹

The desired income would be thought of in terms of what is needed to attain certain living standards,² these ordinarily being determined for the project by specialists in research in farm family living. (See report in this series on this subject.) In an area where the typical farmer buys the greater part of the goods consumed by his family, these standards might be largely converted to a monetary expression; but in an area where small holdings are predominant and there is a concerted movement toward a "live at home" program, it would be indicated largely in physical terms. Both forms of expression would probably be needed in either case.

The source of the suggestion of such a project is obvious enough. Extension workers in several states have been attracted to it as a way of relating the farm family living to the farm business and providing a goal that will serve as an incentive to farming adjustments.

The method of analysis to be used in a project of this nature would be essentially the reverse of that used in Project 9. In Project 9, we were interested in determining the effect on income of holding the physical organization of the farming system or systems under consideration constant and varying the price factors; in this project, we would be interested in raising the income to a desired level while holding the price factors constant but varying the physical organization as need be.

Unfortunately such a project is by no means as simple to execute as appears at first glance. Those who have conceived it have been

(1) Some members of the committee doubt the research value or possibilities of this project. For example, Dr. Ezekiel says of it: "Its general sociological objectives are commendable. But it will be difficult to work out satisfactorily, and probably has more value as an extension lead than as research."

(2) Distinction is here made between "living standards", referring to the content of living which others think a population group should have, and the "standard of living", referring to what a group itself feels it should have and strives for.

thinking in terms of an analysis of farm organization that is altogether too much simplified for reality; as will be made apparent by the discussion in Project 8 above. If, however, one could accept the explanation of variations in farm income that is developed in many of the farm business analyses using the "comparative" method described in Project 8, the task would be relatively simple. One could look at the sets of tables showing how net incomes apparently increase with either yields per acre, or per tree, or per cow, or per hen; with size of business measured in terms of dollars of investment, number of cows, number of acres or of productive man-work units; and with perhaps one or two other items such as work-units per man and proportion of income from crop sales; and ordinarily from any one of these tables pick out the magnitude needed to produce the desired income. At least one could nearly always get the amount of income needed merely by taking a high enough yield, or a large enough business. In practice one would choose some combination of these, planning to obtain some of the larger income from better yields, some from larger volume of business, etc. Moreover, one would commonly choose several different combinations, some with more of the increase coming from volume, some with more of it coming from yields, etc., in order to provide for the variety of conditions prevailing on different farms.

One would, of course, need some other measure of income than "labor income" for this purpose. The measure would need to be in the same terms as are used for expressing the desired income, which, as indicated above, would be *net cash income*, plus certain quantities of consumption goods obtained directly from the farm, the proportion between these depending upon the practice in the area, or some departure therefrom that might be determined upon in advance as superior to present practice in this respect. Some allowance would need to be made for loss of inventory in equipment items, and changes in inventory in certain other items, if the data used are based on a single year's record.

If the synthetic method formed the basis for such a project, the beginning step in the analysis would be to take the typical system of farming or series of typical farming systems in the area and estimate the income to be secured using such farm organization, input and prospective price data as are available. The next step would be to compare the income to be secured from this typical system with the desired income and then roughly to estimate the changes in yields, in farm acreage, in the kind of crops grown and in the kind and number of livestock, that would be necessary to provide the income desired. The new system with these changes incorporated could then be budgeted and the estimated and desired income again compared. The process would be repeated until the desired answer was secured; or several sets of desired answers, as above indicated.

In some cases, the systems found on some larger or better planned

farms than those typical of the area might be taken as the starting point in such an analysis.

It would seem necessary to have as a basis for such a project a clearer idea than is ordinarily possessed as to what the factors are that stand in the way of increasing the incomes of the different farmers in an area. On what farms is the amount of land the limiting factor? and on which of these where this is the limiting factor can the amount of land be increased by buying additional land, suitably located, on reasonable terms? or by renting it instead? On what farms is quality of land the limiting factor, or a wrong combination of types of land (high land, low land, rough land and smooth land, etc.)? And on which of these can this deficiency be remedied by securing the other kinds of land needed on suitable terms?

One can of course recommend that farmers with too little land, or with the wrong kind of land, sell out and buy what they need elsewhere. But that does not solve the problem for the area; someone else has to buy these small or poor farms. The incomes of the area as a whole will be improved only if after the transfer there is a better combination of efficiencies and capacities of farmers and efficiency and capacity of land than was formerly the case. (See Chapter VIII, *Production Organization*, J. D. and A. G. Black, for discussion of this point.)

Or an alternative is that the smaller and poorer farms be bought out by the neighbors and the present operators become employees of the new larger farmers. But this raises some important questions. It assumes that these farmers would be better off as employees on larger farms than as operators of their own small or poor farms. In some cases, this would no doubt be true; but in other cases, probably more, it would not be true. All the data that have been collected that may seem to indicate advantage in changing to employees from small farmers are subject to serious qualifications. Some of the more important factors in the problem are not even capable of quantitative expression.

The same objections can be raised to any assumption that these families would be better off in other occupations. There is no conclusive evidence to indicate that relatively incompetent people do better in city occupations than as operators of small or poor farms. Misfits there are among these relatively incompetent—millions of them, no doubt—farm families that would do better in cities; but there are probably as many city families of this type that would do better on farms. Agriculture must always expect to have its due share of the incompetent.

Other limiting factors of the same type as the above are quality of livestock and equipment. To change this requires capital or credit in the first place; and this many farmers do not have. In the case of livestock, quality is not reproducible at will, although

much can be done to raise the general level of it in a few years if all the available resources are utilized in breeding operations. In practice, there is no quick way of getting additional quality into one farmer's herd without taking much of it from other herds.

The most important limitation is of course the ability of the farmer himself and his family. Incomes of the less capable can be increased in many cases—by no means all—by getting them supplied with more land; but the same land will probably add more to the incomes of the more capable farmers. There are cases, of course, of farmers with more land than they can use to as good advantage as some other farmers with less land, and these ought to be adjusted. But the only way to give small farmers more land generally without robbing farmers with more capacity is to reduce the number of farmers by shifting them to employees or city occupations in the manner above discussed. A similar analysis applies to the question of getting the less competent supplied with better land. In practice, of course, if the poorer farmers buy first-class land, they are likely to find themselves unable to meet the interest payments on it, and hence to lose it very shortly; or unable to meet the rent if they lease it.

If something can be done to raise the whole level of capacity and efficiency of farmers in an area, or to increase the capacities and efficiencies of the poorer farmers in the area, they can and will acquire more and better land by reaching out and taking it away from farmers in surrounding areas; but this process cannot be carried out in all areas at one time.

The capacity and efficiency of the farmers in an area can be increased considerably in a very few years. (There is not space here to discuss the ways and means for it.) Such increases commonly occur. They are, however, constantly held in check by the lower prices accompanying the increases in output resulting. This is particularly true of products that have a somewhat local market. Even in the case of staple products like wheat and cotton, improved technique in production has recently spread with surprising rapidity.

Any one who has worked out some simple arrangement, such as increasing the number of cows, by which the incomes of farmers in an area can be increased, should therefore ask himself at once *if these changes are taking place, and if so, why so slowly; and if not, why not?* He will in most cases find that factors such as above suggested have stood in the way; and before he has a real answer to his problem he will need to determine what are the limiting factors in each case, *and then work out ways and means of removing these limitations.*

Obviously any conclusion that is not based upon this latter type of analysis is certain to be fraught with great danger in its application to the individual case. Many farmers who set out to increase their incomes by taking over more land would be making a serious

mistake even from their own standpoint—the price or rent they would have to pay might reduce their net income. Such a decision must be based on the capacity of the individual farmer, his credit condition, and his labor supply, or his ability to use hired labor to advantage. There would be even more hazard in buying or renting better land. Increasing outputs per acre must also be carefully considered in each case—the type of the soil and its present condition of fertility are vital considerations. The capacity and efficiency of the cows in a given dairy herd must in considerable measure control the rate of feeding.

Even though the individual farmer might increase his net income by adopting such recommendations, the average net income of the whole area might be lowered; or of the farmers in other areas producing the same products. Any properly conceived farm or area extension program must look beyond the individual.

Further discussion which bears on this project will be found in Projects 12, 13 and 14.

PROJECT 11. Adjustments Based on the Outlook.

OBJECTIVE: To determine the adjustments needed in the farming of an area in the light of the outlook.

(By Mordecai Ezekiel and J. D. Black.)¹

The project assumes as vital a distinction between an *outlook* statement and the *adjustments* that may be needed in the light of the outlook statement. This distinction has not always been recognized. The whole process of outlook and adjustment analysis may be thought of as consisting of four steps or operations as follows:

1. Securing and presenting the facts as to past and current supply and demand and prices and conditions affecting these.
2. Interpreting these facts in the form of forecasts of demand, supply and prices for a period such as needed for planning adjustments.
3. Securing and presenting the needed facts as to production in the area in question.
4. Determining the adjustments which are needed in the production of the area in the light of the forecasts.

This project as here stated assumes that Nos. 1, 2 and 3 of the above are undertaken in other projects, the first two in projects in Prices of Farm Products, and the third in projects outlined above. This raises the important question as to how complete and thorough the information and analysis concerning an area must be before one can undertake to determine the adjustments that are required by a change in the outlook. All the analysis outlined in the foregoing

(1) See paper by H. R. Tolley in *Journal of Farm Economics*, October 1931.

ten projects would be helpful. Nos. 7 and 10 could most easily be spared; next in order, No. 3 and then No. 6, at least the intensive parts of the analysis in No. 6. This does not mean that a knowledge of why certain types of farming prevail in an area is not of great value in considering future adjustments; it merely means that the information and analysis of Nos. 1, 2, 5, 8 and 9 can even less be spared. Obviously any statement covering the adjustment needed in an area must take account of the meaning of the same outlook facts in other areas producing for the same market; but something less than the full analysis outlined in Methods D and C under Project 6 will make some useful consideration of these aspects of the problem possible. A project such as No. 5 as indicated below, is absolutely essential—the information about the area must be *current*.

In practice, adjustment analysis is being made following outlook statements with far less information and analysis than included even in Projects 1, 2, 5, 8 and 9. But each experiment station should seek to provide this information and analysis as a minimum at the earliest possible date.

In the meantime, various partial substitutes are resorted to with varying degrees of success. A common one is to call a meeting in a locality, perhaps representing all of a county or more, of the interested farmers, bankers, county agents, etc., at which are presented the general outlook facts and whatever additional local information is available, and this is combined with whatever knowledge and understanding of the area the farmers, bankers and the county agents can bring to it, under the guidance of economists who are supposed to have a larger comprehension than they of such factors in the problem as the effect of price changes on farm organization, and interregional competition. The value of this procedure depends greatly upon the amount of real understanding which the assisting economists possess, and how effective they are in guiding the discussion, but also depends upon the quality of the understanding of the thinking farmers participating in the meetings. One only has to compare the recommendations coming out of different conferences in the same general area to realize that there is a wide range in the usefulness of such conferences. Professor A. W. Manchester of the Connecticut Agricultural College, Storrs, Connecticut, is using such conferences very effectively. No doubt this is partly due to the extensiveness of the information and analysis already available in that state. (See Project 4C above.) But it is also due to a program of extension in that state pointed at developing thinking farmers.² Professor Rex E. Willard, now of Washington State Col-

(2) Professor Manchester wrote as follows concerning these local outlook conferences in March 1932:

"You might be interested to know that we are planning to follow this state conference with two sets of county conferences and then move down to individual communities. Here we hope to set up community councils to put into effect the

lege, Pullman, Washington, and Mr. P. V. Maris of Oregon have been leaders in developing this method of local conferences.³

However complete the information and analysis available, the holding of these local conferences should always continue to play an important part in outlook adjustment analysis. Those most closely in touch with conditions in an area will always have significant contributions to make to the adjustment conclusions reached.⁴

Some may have difficulty in recognizing these conferences as scientific research; they should not if they agree with the discussion of the "Nature of Farm Management" in the introduction to this report in which the final stage of refinement of generalizations to make them fit a particular area, even the testing out of these refined generalizations by applying them, is designated as science. A conference may be as good a place to collect some kinds of information and to make certain types of analysis as is a laboratory. But to contribute to research, these conferences must be conducted with the research end in view of developing generalizations out of them and testing these by relating them to the experience of the farmers who participate in the conference. It is highly important that all the facts and analysis bearing upon the situation in the area are made available at these conferences, and that these be organized in advance so that they can be readily coordinated with the information which the farmers bring to the conference.

Another substitute, in the writer's opinion a very poor one, and one which in itself contributes nothing to research, is merely to send out the outlook information, and then let the individual decide upon his own adjustments without further aid. Unfortunately only a small fraction of the farmers have had sufficient good instruction in farm organization analysis to be able to make such application without guidance. This is amply demonstrated by the rather blind way in which the mass of them respond to prices of their products in the preceding year, largely without regard to whether the price was high or low because of short or large supplies. (See report on Prices of Farm Products for analysis of this problem.)

It is recognized, of course, that in the last analysis each farmer must make his own decisions as to adjustments. No one can or desires to take that responsibility from him. Each farm has certain special circumstances as to soil, combination of land types, buildings, equipment, layout, indebtedness, credit, labor supply, and interests, abilities and skills of the farmer and farm family, that must have their influence upon the adjustments; and no outsider can know these recommendations of the various committees. Things are going very well, so far, and the outlook for securing much more adjustment to changed situations is better than at any previous time."

(3) See note by Professor Willard on "Economic Conferences in North Dakota", in *Journal of Farm Economics*, April 1930, p. 330.

(4) These conferences also have great value as devices for getting information as to outlook and adjustments out to the farmers; but this is aside from their value as a research device, in which we are here interested.

well enough to consider them properly in making decisions involving them. But admitting all this does not force us into the position of leaving the adjustments to the unaided analysis by the individual farmer.

The procedure outlined in this project assumes that individual farmers will be helped in deciding upon their own adjustments if:

1. *They are shown what adjustments are needed on farms that are much like their own—on farms following the same system of farming, of about the same size, and with about the same equipment.*

2. *They are shown how to figure out the needed adjustments, especially if it is done on farms much like their own. This is at its best if also it includes an explanation of the method of making allowance for the major characters commonly peculiar to individual farms—such as farm layout, labor supply, indebtedness, etc.*

Any outlook adjustment analysis which results in conclusions so positively stated as not to allow for special conditions on individual farms, is bad adjustment analysis. No doubt there is some danger of such analysis; and one must be a little on guard against it.

Even this does not mean, however, that a situation will not frequently arise in which it will be proper to conclude, to use an illustration, that in view of the present ratio of feed and milk price, producers of milk on a large majority of the farms in a whole state, or of the whole nation, should shift in some measure to their most favorable alternatives. In other words, some adjustment conclusions, properly phrased, can be stated for very large areas. The fundamental criticism of the Federal Farm Board's one-time wheat acreage reduction program is not so much with respect to the generalness of it as in that it was not based on an adequate analysis of the problem to see whether or not it was a sound recommendation—that is, whether the wheat farmers had any better alternative.

In general, however, conclusions as to needed adjustments are not very helpful until they are broken down into special statements for each type of producing area. If they can be narrowed down to particular types of farming, they will be even more helpful.

Since the preparation of outlook statements is already an accepted part of our program of public aid to agriculture, and is not likely to be dropped for a time while we are making the analysis of production that is needed as a basis for the adjustments to go with it, the rational procedure is to *make the best adjustment analysis we can with what analysis and information we have*, proceeding according to the two foregoing assumptions.

Federal agencies should lead off in such analysis by indicating the general direction that adjustments should take; and assist the state agencies as much as possible in adapting the general recommendations

to regions and type-of-farming areas.⁵ State agencies should work with the federal agencies in determining the form of the general adjustment statements as well as the regional and type-of-farming statements. Necessarily the state agencies will have to assume most of the responsibility for the latter. Finally, the state and local agencies should take to the locality all the federal, state and local outlook information and interpretation (meaning forecasts) that it can as to supply, demand, markets, prices, etc.; and all of the general and regional adjustment conclusions that have been developed; and all of the analysis of what the foregoing mean in terms of the principal types of farming in the locality, and variants thereof, in so far as the basic data are available; and then in session with the farmers themselves and other local agencies develop the final form of the adjustment conclusions for each locality.

The county agent should be able to give guidance to individual farmers on their problems of adjustment following the local conference.

Problems involved in determining adjustments.

When we come to the actual analytical process of determining what adjustments are needed, we must make careful distinction between different types of adjustments. Sometimes adjustments can be made advantageously to meet short-time fluctuations or cyclical changes in prices, if these changes can be foreseen. The long-time outlook will govern other changes—those which involve investments in machinery, buildings, or livestock or major changes in the systems of farming. Such changes can only pay for themselves over a series of years. The farm management research program to determine the necessary adjustments must therefore consider both the short-time and long-time outlook, and immediate and long-time adjustments to it, and provide and keep currently up-to-date the information necessary for calculating budgets to show the relative advantages of both short-time and long-time alternatives.

The desirability of some short-time changes may be studied without going into a full budgeting of the entire business—simply by considering the additional returns and additional expenses connected with the changes on typical farms in the area. These would be changes not involving new capital outlays, and which would not disturb seriously the system of farming as a whole, or the balance between the various enterprises. Substitution between wheat and flax, or between closely similar truck crops, or perhaps even between two litters of pigs per sow and one litter (where the necessary equipment was already available) might be illustrative cases.

(5) The 1932 Federal outlook report has no adjustment statements in it. The earlier outlook statements could properly be called "outlook and adjustment statements", although the adjustment part of them was necessarily limited because of lack of information concerning production by areas. Most of the state reports prepared in 1932 contain considerable adjustment analysis. (See reports for Kentucky, for Louisiana and for the New England states.)

In considering long-time changes, however, or situations in which investment in equipment, buildings, or livestock is involved, or where the complementary or supplementary relations between enterprises might be disturbed, the business as a whole would need to be considered. Budgets would be calculated, using the prices indicated by the outlook, for various adjustments in each of the typical systems of farming in the area to find what particular adjustment in each system promises the highest return. In shifts involving major changes in types of farming, such as going from cash-crop farming to dairying or hog production, the probable long-time swings and trends in all the products involved should be carefully appraised. There is always the danger of getting out of some enterprise just at the time it begins to pay, and of getting into some other just at the time it begins to be less advantageous.

The price outlook data needed bear on the prices the farmers within the area will probably receive. These must be farm or local market prices, as is discussed under Project 16 of this report. Definite research is needed in many areas to provide a basis of forecasting local prices.

The local price outlook must cover not only prospects for the year or season immediately ahead, but for the natural production period (probably 18 months to two years for hogs, perhaps two to three years for beef cattle, and many years for fruit trees). Such data are required in computing probable returns resulting from current changes in planting or breeding. Even a longer look ahead may be necessary to judge of the desirability of major changes in systems of farming. Outlook information covering 5, 10 or 20 years ahead is as yet almost wholly lacking; such information must be provided before valid conclusions can be reached as to the probable returns from farming readjustments involving long-time commitments. Locally, however, the situation frequently may be clearer. The growth of cities, in particular, is accompanied by shifts in agriculture in adjacent territory, as for example with respect to fluid milk production. Local geographic-historical studies may provide a definite basis for long-time outlook statements in such cases.

Farm management data for use in determining adjustments in the light of the outlook must be representative of the current situation. The problem might be stated as that of currently reviewing existing information in its entirety, determining to what extent it is still applicable, and securing new information where the old is antedated. Obviously, the rate and speed of obsolescence of data will vary between the factors. The input-output relations of feed, fertilizer, number of cultivations, etc., to product will tend to remain the same, or change slowly and in a relatively progressive fashion.

But drastic changes in price relations among the cost factors may necessitate equally drastic shifts in the proportions of different factors which it is most economical to use in production, and require corresponding significant changes in the quantities used in budgeting

production expenses. This has been especially evident during the rapid and unequal changes in wages, fertilizer costs, machinery costs, packing and material costs, and transportation costs during the period from 1929 to 1932. Not only the prices of the cost factors, but the prices of the product, determine what combination of the various elements in production will produce at greatest profit. Not unless the so-called "standards" used are valid for current and prospective conditions, instead of for some past period of radically different conditions, will the analysis be of value for current use. Similarly the materials used in the physical operations of harvesting and marketing (such as twine, bagging, containers) may change suddenly as production methods change. Labor inputs similarly may be radically changed by the adoption of new techniques, or by the discovery of new economies in using old techniques.

After all of the information is obtained and the budgeting calculations are completed, the investigator must consider questions such as the following before reaching definite conclusions: Will it pay on the principal types of farms in the area to modify the present plan of operation solely to meet the prospective conditions within the coming year? Will the modification be a permanent one, or will the previous plan be resumed later on? Will the modification be the first stage toward a subsequent complete change in the farming system through a series of successive modifications? Will the cost of the change repay itself within the immediate future? Are new outlays of operating capital required to make the readjustment proposed? Is that capital available? These are but a few of the questions which must be borne in mind in reaching a decision as to desirable readjustments.

Extreme care, in particular, is necessary when considering complete changes in system of farming as an adjustment to cyclical outlook conditions. Every analysis in which fundamental changes in organization are involved should take into account the additional cost of capital required to make the change, the successive steps involved in shifting from the old organization to the new, the period required before the new organization would be on a functioning basis, and the probable incomes during that period of transition.

The foregoing is not a complete discussion of the ways and means of determining needed adjustments in the light of the outlook. For the most part, this discussion is presented in earlier projects, particularly Projects 1, 2, 5, 8 and 9, and more particularly the latter part of Project 8 and Project 9. What is included here is supplementary detail as to actual procedures under conditions of continuing year-by-year changes in the economic environment.

PROJECT 12. Planning the Agriculture of an Area.

OBJECTIVE: To develop a plan for the agriculture of an area.

(By J. D. Black.)

Outlook adjustment analysis as discussed in Project 11 will never be altogether successful until it is reduced to a definite area basis, and enough information is obtained concerning each area so that one can determine specifically for it the changes that probably will prove most advantageous in the run of years just ahead and following thereafter. Outlook work cannot be of great value to farmers so long as it takes the form merely of trying to forecast what the market is going to do, and so long as the farmer looks upon it as such. What we need rather than this is the *formulation of production programs for the different areas*, in the light of what information the market affords as to the future.¹

The foregoing calls for a dual approach to the problem of outlook and readjustment: one approach from the standpoint of the market situation, both the general market situation and the local market situation; and the other from the standpoint of the area. It requires that while we are working away at one end on the problem of better and better outlook information and forecasts, at the other end we must be at work at building up for carefully mapped areas the basic information and relationships that are to be used in converting outlook statements into terms of specific production programs for these areas.

The term program connotes a course of action over a period of years. The emphasis in outlook and adjustment analysis should be upon programs thus understood. But programs need to be modified constantly as new developments appear. *Nothing is more essential to effective outlook and adjustment work than noting such developments the moment they appear in the offing and evaluating them and then modifying the program to fit them as nearly as it is safe to do so.* The moment that the program for a period of years is modified to fit anticipated changes, then the year-by-year farming plans, ordinarily beginning with the plan for the on-coming year, need to be adjusted in order to get the new program adopted as soon as is advantageous.

It is also true, of course, that some circumstances affecting most advantageous farm set-ups are highly temporary in their nature, such as high prices for pork because of a short pig crop of the year before, or high prices for butter because of drought in the dairy region during the summer, or an abundant supply of hay and forage, or temporarily large stocks of the product; and these frequently make advantageous certain departures year by year from the general program for the period.

(1) See H. R. Tolley's discussion of this problem in *The Journal of Farm Economics*, October, 1931, "History and Objectives of Outlook Work."

Other transient circumstances may not be so temporary as the foregoing, such as a surplus of the crop that has been accumulating for several years and which it will take two or three years to reduce. If these surpluses are due to essential changes in the production or consumption conditions, they of course require a modification of the whole production program. But often they are due to temporary factors, such as two or three years of favorable weather, or business recessions; and in this case the farming program needs to be modified only while the surplus is being consumed.

The project here outlined concerns itself with outlining a program for an area, in the light of the now prevailing or now anticipated conditions in the area and in the market, this program to be followed, except for the departures just indicated, until developments appear calling for its modification. The project does not concern itself except incidentally with the departures made desirable because of temporary circumstances such as above outlined.

The most essential phases of this project are as follows:

1. Mapping out the type-of-farming areas, discussed in Project 1.
2. Describing and classifying the types of farming in each area, discussed in Project 2.
3. Analysis of demand and price outlook for the products of these areas, discussed in the report in the series on Prices of Farm Products.
4. Analysis of competition in production and outlook for same, following lines laid out in Project 6 above. It is probable that in most cases this analysis will need to be confined to the simpler procedures there indicated in Methods A and B. This type of analysis is closely related to the price outlook analysis indicated under 3 above. The outlook for production will need to take account of impending developments in the technique of production.
5. Determining the most advantageous combination of products and farm practices for the important types of farming in each area, following the lines laid out particularly under the second method in Project 8 above.

As the research program of an experiment station becomes fuller and richer, it can include projects such as No. 3 above, designed to account for the existing types of farming in each area, and for historical changes that have occurred, and projects such as 14 and 15 below, designed to test out more thoroughly the types of farming and practices included in the suggested program for each area. Also better data can be collected on local prices, as indicated in Project 16; and the analysis of interregional competition can be carried into its more refined phases.

Such a project does not need to be carried out all at once. In practice, a project of the type of No. 1 will be followed by No. 2

for one area, perhaps combined with parts of the fourth phase, and then by the fifth phase, with varying degrees of intensity. It will commonly be best to carry additional areas through the earlier phases above outlined before doing the intensive work on the later phases for the first area studied. It must be remembered that each year the U. S. Department of Agriculture is coming out with a general outlook statement, which represents mostly the third phase above indicated. The research program for any state should be directed at getting this state as quickly as possible in position to supplement the federal outlook statements by analysis of the outlook conditions special to this state, and by such analysis of production in the various areas as will make possible the development of feasible production programs for each area, and modifications thereof from year to year as the outlook changes. Such an objection will not be realized if too much effort is concentrated on one area.

Once such a production program has been worked out, it should be given as effective publicity as possible. It should be taken up as the major extension enterprise in the area. But great care is needed in presenting it. First, it must always be explained that it may need to be changed either temporarily or permanently for reasons above indicated. Second, it must be made clear that each farmer must adapt it to suit the particular conditions on his farm. Third, individual farmers must be shown how to make this adaptation.

PROJECT 13. An Agricultural Program for a "Problem Area".

OBJECTIVE: To develop a plan for an area where agriculture is retrogressive and farmers are not prospering.

(By H. R. Tolley and M. L. Wilson.)

This project may be looked upon as a special case of Project 12. Project 12 has been written to apply particularly to areas which might be classed as "better farming areas", i. e., areas where agriculture should continue presumably without violent major shifts in lines of production and farm organization. This project is written to apply particularly to areas where farmers in general have not been prospering, where the agriculture has been retrogressing and where presumably some major shifts in agricultural production and some major changes in farm organization are called for.

There are many areas where the farmers and those interested in farming believe some reorganization of the agriculture might be made which would increase the general level of incomes and make the community more prosperous. It is from such areas that requests for help often come to the agricultural colleges and to the United States Department of Agriculture. Such an area is sometimes characterized as a "pathological" area and the college or the federal department is asked to "diagnose" the case and "prescribe" a remedy. It is usually found that a considerable amount of research is pre-

requisite to any general conclusions and recommendations. Especially is this true if the conclusions and recommendations are to take the form of a plan or program for the area. As stated in the opening paragraph of Project 12, enough information must be obtained concerning the area so that one can determine the changes that promise to be most advantageous in the years ahead.

I. The area may be one where much of the land is poor and of low productivity and where topography makes its cultivation difficult. Areas of this kind are found in many parts of the Appalachian Mountain region and in the mountainous regions of the West. In such areas, inputs of land, labor and capital per unit of product are usually high when compared to more favored areas, and one of the major problems of the investigation must be to determine whether all or parts of the area might be used more advantageously for some purpose other than farming. The procedure here will be related closely to that outlined in Project 36 in the bulletin of this series dealing with research in Agricultural Land Utilization: *To determine a plan for an area in relation to desirable modifications of land utilization*. Land economists and possibly forest economists should cooperate with the farm management workers in the study. The transfer of land from agriculture to another use usually will be accompanied by a movement of population out of the area or a transfer of part of the population from farming to some other occupation, and this phase of the problem must receive consideration also; likewise the support and maintenance of roads, schools and other public institutions in the area.

Studies in a number of areas of this type have been made in recent years, but most if not all of them have not progressed to the point of developing a plan for the area under consideration. This has been due in some instances no doubt to a feeling on the part of those responsible for the study that the development and promulgation of a plan as contemplated in this project is not a function of a research agency, but more often it has been due to the fact that the research workers have not attempted to synthesize the results of the various phases of the study and focus them on a program or plan for the area.

II. Again, the area may be one where a recently introduced pest, such as the boll weevil, the corn borer, or the alfalfa weevil, has reduced the yields of an important crop to the point where major shifts in production or changes in farm organization seem to be necessary. The project in an area of this type will follow rather closely the procedures outlined in Project 12 above, except that special attention will be given to the crop or crops affected by the pest, and forecasts made as to the likelihood that the pest will be introduced into competing areas, the likelihood that effective methods of control will be devised, the cost of control and related items.

III. The area may be one where the demand for the principal product or products of the area has declined to such an extent that

shifts to other products and hence major changes in farm organization seem desirable. For example, the demand for timothy hay has declined so greatly in the past decade that marked changes have been necessary in the production programs of many of the areas in New York and other eastern states where timothy hay formerly was one of the principal sources of income. The research should be directed in such cases toward determining that the change in demand is not merely a cyclical phenomenon. Also the nature of the competition between the area under consideration and other areas producing for the same market must be considered. It might be that even though demand for the product has been reduced, it will continue to be produced in as large quantities as before in the area being studied—and that the reductions will occur in other areas.

IV. Or again the area may be one where changed prices of the products or changes in the technique of production or both are making necessary a reorganization of the farming, but where there are no alternative lines of production. This can be illustrated in the case of Montana:

In some parts of Montana, analysis indicates that areas which yield an average of 10 to 15 bushels of wheat on fallow per acre are best adapted to straight wheat and fallow farming. The rainfall in such areas, while sufficient to produce a crop of wheat, is not sufficient for diversification. Weed control in such areas is comparatively cheap. All such factors tend to discourage diversification and to induce straight wheat farming. However, in areas where the rainfall is sufficient for wheat on fallow to yield over 20 bushels, weed control becomes a factor, greater diversification becomes possible, and the tendency is for more livestock, inter-tilled crops and other measures of weed control. At the other extreme, where the rainfall is so slight that wheat on fallow yields less than 10 bushels, the land tends to go out of production and remain idle or go back to grazing crops such as sweet clover, crested wheat grass and similar forages.

The problem in the first of these types of areas, in a straight wheat farming area, becomes not so much one of forecasting what the price of wheat is going to do from year to year as of forming a basis of some minimum price to which production expenses must be adjusted. Such an analysis should indicate the price the farmer can pay for rent or purchase of land, for taxes in support of local, county or state government, to what extent the community can support improved roads and modern schools, etc., the amount which the farmer in such sections will have available for the purchase of agricultural implements, gas, oil, labor and other materials of production, and finally, the size of farm and management practices necessary to get the cost below the anticipated price level.

For an area of the third type, the problem consists in part of determining the minimum price at which wheat can be sold and how necessary costs can be reduced to a basis that maintains a reasonable

livelihood, and in part of determining the most advantageous system of grazing and wheat farming combined, that is the alternative to wheat farming and competitive with it. In the latter phase, it takes on the form of procedure indicated in Project 12 above. In areas of the second type, where there are several alternative systems of farming, the analysis clearly follows the lines indicated in Project 12.

Many other examples could be given. Basically, the procedure will be the same for all areas, but the points of emphasis will be determined by the characteristics of the particular area being studied. The objective is to develop the plan which will afford the best utilization of the resources of the area in the years ahead. The project will be completed only when this plan has been formulated and promulgated.

PROJECT 14. Testing Reorganization Plans.

OBJECTIVE: To test the applicability on individual farms of recommendations for improved farm organization.¹

(By Walter J. Roth and R. S. Kifer.)

Objectives of study.

1. To determine the farmers' reaction to proposed suggestions or recommendations for farm planning.
2. To determine the extent to which proposed plans for farm reorganization can be executed.
3. To determine a measure of the benefit resulting from farm replanning.

Value of project.

To research forces:

- (a) It will direct farm management research to specific problems both of limited and of widespread application.
- (b) It will point out the significant differences between individual problems and region-wide problems and their solution.
- (c) It should lead research workers to lay greater emphasis on the more significant farm management problems and to give less attention to those of minor importance.

To the extension forces:

- (a) It will demonstrate the effectiveness of this method of bringing the results of farm management research to individual farmers.
- (b) It will point out the barriers to the acceptance of generalized recommendations by individual farmers.
- (c) It will vitalize farm management extension by making the recommendations direct, concrete, concise and effective.

(1) Professor A. G. Black considers this project to be more largely extension than research.

To the farmer:

- (a) It will assist him in perfecting the method of planning in advance.
- (b) It will give him a method of utilizing more effectively the results of farm management research.
- (c) It will give a measure of the effect of proposed changes upon individual farms.

Scope.

This project should be carried on in an area for which general recommendations of the kind contemplated in Projects 8, 11, 12 and 13 have been made. It should be limited to one type-of-farming area in order that the general recommendations already developed will apply at least in some measure; and preferably a type-of-farming area in which one type is clearly dominant. The reorganizations contemplated will ordinarily be such as to leave the farm still in the same type-of-farming category. This may, however, require a rather broad definition of the type of farming. The findings of this project as regards methods of carrying on similar studies will be applicable wherever a similar background of information exists.

The number of farms to be included in the study will depend upon the funds and resources available for the project. The farms should be selected to represent all the varied conditions in the area or merely the particular conditions which exist in a section of the area. The selection will necessarily be from among those farmers who are willing to undertake (a) the effort of replanning the farm organization and (b) the execution of this plan once completed. It is quite conceivable that the payment of a monetary reward to the farmer for his time and effort might be a justifiable expenditure to be included in the research budget.

The study must usually continue for a number of years in order to attain conclusive results. The period should be long enough to give an indication of the influence on farming plans of weather variations from year to year, and cyclical and seasonal movements of prices.

Sources of information.

The information necessary for developing the reorganization plans for the farms included in the study is available in:

1. The trends of prices of the products grown in the area.
2. The forecasts of price variations from their trends for the same products and area.
3. The normal yields in the area and on the farms in question.
4. The generalized reorganization plans for the area, stated as systems of farming for typical sets of resources.
5. Budgets as a means of "advance estimate calculation" for the farmer.

6. A knowledge of effective practices, cropping systems and livestock combinations on the part of the research worker.
7. The background of knowledge possessed by the farmer based upon his experience and his records.

A rather detailed record of at least one year's operation should be available for each of the farms to be included in the study.

Method of analysis.

The method of analysis is primarily the case method. The measures used are in part of the informal quantitative or approximate type. The study requires a consideration of the resources of each farm and the idiosyncrasies of the individual farmer.

The procedure assumes a shift from the existing farm organization to a more or less different plan of organization. This stipulates the development of a plan of farm reorganization. The details of this reorganization will be developed from:

1. The general recommendations for the type-of-farming area.
2. The specific recommendations for the farm in question.
3. The compromise necessary between these recommendations and the farmer's personal preferences, i. e., his acceptance of and his ability and willingness to proceed with suggested plans.

These steps may be illustrated by the following:

Let "A" represent the current plan of operation as shown by the records of the farm "R".

Then "B" may represent the general farm plan suggested for similar resources in this area based upon the background of farm management studies in the region. This may be termed the "standard" farm organization or type of farming for farms with such resources in the area. There may be other types of farming in the area, but these are not included in the project.

With "B" as a guide, a farm organization plan is prepared by the research worker for the exact resources and conditions on the farm in question in terms of say a 10-year period. This plan, which may be called "C", is the long-time plan for this farm, representing "A" revised in the light of "B", taking account of the specific resources available in "A".

It is to be presumed that "C" is a departure of some magnitude from "A". A period of time is necessary for the consummation of this change. For this intervening period, several immediate plans of operation to cover the transition from "A" to "C" will be necessary. These intermediate or transition plans may be termed D_1, D_2, \dots, D_n .

However, it may be that the plan developed and proposed by the research staff will have features which cannot or will not be developed by the farmer. This resistance on his part may be due to physical or mental limitations, it may merely be a matter of "will", or it may be a result of his judgment as to whether it will "pay" him enough

more to overcome the inertia of doing business in the old way. These last two obstacles may be the same in the final analysis.

In so far as this opposition of the farmer exists and is a factor which must be considered, it will have an effect in modifying the plans "C" and "D". When the farmer's preference has been considered, plan "C" will be revised and termed "E". F_1, F_2, \dots, F_n represent plans for the year immediately ahead that will be prepared at the completion of each year's operations. In addition to the information used as the basis for plans "A" and "E", these year-to-year plans will take into account the accumulating knowledge of desirable adjustments on this particular farm during the progress of the study. These are the plans to be expressed as annual budgets which are put into effect—or which are attempted.

Circumstances, both those under control and those not under control, will militate against the complete execution of the plans, F_1, \dots, F_n , as conceived. This variation will appear in the annual records which may then be designated as R_1, R_2, \dots, R_n , thus correlating these actual achievements with the previous proposals F_1, \dots, F_n through the reconstructed farm plan entitled A_1, \dots, A_n .

These various farm organization plans may be listed as follows:

A=Current farm plan as per records R.

B=Standard plan for the type of farming in the area.

C=Standard plan for this farm.

D_1, D_2, \dots, D_n =Transition plans between A and C.

E=Revision of C to fit farmer's will to do.

F_1, F_2, \dots, F_n =Annual revision of D to fit farmer's will to do.

R_1, R_2, \dots, R_n =Actual operation of farm as shown by the records of performance.

A_1, A_2, \dots, A_n =Farm organization plans reconstructed from records R_1, \dots, R_n .

In elaboration of what has been outlined above, it may be pertinent to point out that "A" will present the details of the current farm organization, the information relative to its resources, type of farming, organization, operation—i. e., complete details as to the facts necessary to explain and interpret the farm business for each year.

The farm plan "B" involves a budget for the generalized or standardized plan of farm organization which has been developed for resources similar to the resources of the farm in question. This standard plan is the outgrowth of the farm management research in a region or an area and is based upon what may be termed "normal" relations. It represents a point of departure which shall be used in developing the budgets for the more specific plan of organization for an individual farm, for a given time period.

The modification of "B" to fit the individual farm evolves as a budget for the plan "C", the long-time plan for the farm. Whereas "B" is presumed to be a farm plan, already available, and the prod-

uct of previous research, plan "C" is newly computed to fit the resources of the farm in question, but still on the basis of the generalizations and recommendations of the research study previously made.

"C" is still an idealized plan and represents something to be achieved over a period of years. The physical difficulties of changing from "A" to "C", coupled with economic limitations on the feasibility of shifting quickly from one plan of organization to another, dictate the several intermediate steps involved in the transition. These intermediate steps, worked out as *annual* budgets for the farm, plans $D_1 \dots D_n$, are based on the annual variations in prices in so far as they can be foreseen), prospective yields and available resources. They represent the adaptation of "C" to the temporary conditions existing and mark the steps in the evolution of "A" to "C".

The procedure up to this point has been primarily the product of the research worker. Such test as has been made has involved the use of the farm budget as a means of farm planning, but only in so far as the research forces are concerned. No attempt has been made to determine the acceptability of these plans to the farmer or of the extent to which these farm plans can be executed in practice.

The next step in the procedure is to present the budgets for plans A, B, C and D to the cooperating farmer for his approval. Plan A is his current operating plan and presumably has his sanction. Plan B will ordinarily be recognized by him as having a relation to his own farm, but it may deviate enough from it so that he cannot accept it. Plans C and D should appeal more fully because of their direct relationship to his own resources. *It is at this point that the opportunity to determine the farmer's reaction to proposed suggestions and recommendations appears.* Plans C and D may be conceived as physically possible and economically feasible programs by the research workers. They will be based on what are considered to be attainable efficiencies for the farmer and his resources. Despite this, the research workers may find the farmer unwilling to accept these plans as proposals for farm reorganization.

The inertia on his part may arise from real or imagined inability to carry out the proposed plans. In so far as this inability is real, it represents an error in the planning developed by the research staff. The detection of this error is of value in itself. In so far as the inability of the farmer is imagined, this may perhaps be overcome by explanation. Determining whether this can be done will be of value. Since the farmer is the last court of appeal the acceptance or rejection of the plan depends in the final analysis upon his judgment. This determination is in part the objective of the study.

The farmer's reluctance to accept the proposed reorganizations "C" and "D" may also arise from a judgment as to the lack of economical feasibility in the plans. This may similarly be real or imagined. In so far as the non-feasibility is real it represents an error on the part of the farm management research staff and is of value

as a determinant. In so far as the lack of economical feasibility is imagined, this also may be overcome by explanation and guidance. Here, as above, the degree to which the real can be distinguished from the imagined will be open to question. This determination is also in part the objective of the study, and at this point is obtained a measure of the farmer's reaction to suggestions and recommendations proposed for his farm organization.

Plans E and $F_1, F_2 \dots F_n$ evolve out of the presentation of plans C and D, and the farmer's response to them. Plan F, the finally accepted plan for the first year, represents "C" and "D" corrected to fit the farmer's idiosyncrasies and his judgment.

Plans $F_1, F_2 \dots F_n$ are now put into operation in successive years in an attempt to achieve the ideal "E". Due to controllable and uncontrollable forces, plans $F_1, F_2 \dots F_n$ will not be achieved in their entirety. Changes in acreage will be encountered due to failures occasioned by insect, disease, or weed pests, climatic forces as freezing, winter killing, etc. Livestock numbers will be altered due to similar causes and their effect upon rate of birth, death losses, rate of gain, etc. These deviations from the proposed plans $F_1 \dots F_n$ will appear in the books of record for the year's operation $R_1 \dots R_n$ and may be reconstructed into the farm plan actually achieved, $A_1, A_2 \dots A_n$.

The comparisons between plans $F_1 \dots F_n$ and $A_1 \dots A_n$ will represent the determinations sought as one of the objectives, i.e., the extent to which proposed farm plans can be carried out.

To summarize the foregoing it may be helpful to present graphically the steps involved and the objectives to be achieved:

A=The original farm plan as revealed by the records R

B=The standard plan for the general type of farming as a long-time plan

C=The standard plan for the specific farm as a long-time plan

$D_1 \dots D_n$ =The intermediate plans for the specific farm as transition plans between the current plan and the long-time plan

E=The plan C as modified by the farmer

$F_1 \dots F_n$ =The plans $D_1 \dots D_n$ as modified by the farmer in the light of E and the forces dictating it

$R_1 \dots R_n$ =The farm records resulting from the operations of Plans $F_1 \dots F_n$

$A_1 \dots A_n$ =The actual operative plans as reproduced from the records $R_1 \dots R_n$

From the preceding will be available as determinants for each farm and farmer:

1. (a) The discrepancies between the budgets or the proposed long-time plan "C" and the accepted long-time plan "E."
- (b) The discrepancies between the budgets of the proposed short-time or annual transition plans $D_1 \dots D_n$ and the accepted plans $F_1 \dots F_n$.
- (c) The discrepancies between the budgets of the accepted plans $F_1 \dots F_n$ and the achieved plans $A_1 \dots A_n$.

2. The changes in plans "C" and "E" as shown by the budgets for these based upon revisions induced by the experience of the years during which the study is in progress.
3. The discrepancy between the budgets for both plans E and $F_1 \dots F_n$ as actually worked out in $A_1 \dots A_n$ and as this would have appeared if unexpected (1) natural factors and (2) price factors had been considered. This would leave the farmer's response as the sole variant.
4. The proportion of these discrepancies due to
 - (a) Managerial ability or lack of it.
 - (b) Conscious replanning after budget of plan was accepted.
5. The effect of weather on departures from the figures computed as normal crop yields.
6. The effect of unexpected price changes on organization, operation, and farm earnings.
7. The effect of plant and animal diseases and weed pests on physical and economic returns.
8. The same for accidents and other influences.
9. The effect of 5, 6, 7 and 8 on farm earnings or income.

Thus in a period of say 5 years during which the projects were kept active the available data would include:

1. A test of long-time farming plans for an area.
2. The same for a specific farm.
3. A record of the modifications of the long-time plan through the intervening short-time or annual farm plans.
4. An historical record of all the variations from the original plan first proposed, through the modifications to suit farmer, and modifications made necessary by weather, unforeseen price changes, etc.

Possible variations in conduct of the project.

In practice, expediency may dictate certain variations in procedure. Thus, given "A", the current plan, based on the records of the past year, the research staff working jointly with the farmer may proceed directly from "A" to "E", the long-time plan, and "F", the plan for the year immediately ahead. This obviously eliminates the opportunity of recording the farmer's reaction to proposed recommendations except as these are reported by the research staff from impressions and from memory.

In similar manner, one might determine which method of replanning yields reorganizations that are most favorably reacted to by the farmers.

1. In order to determine "the farmers' reaction to proposed suggestions" a measure of the farmers' acceptance of the preferred farm organization plans will be necessary. This will not appear as a definite quantitative measure such as 75 per-

cent, or 3 out of 4, but rather as an approximate statement representing the degree of acceptance under various types of suggestions. The entire plan may be refused due to one or several items even though the major aspects of the plan are satisfactory. Thus, "the plan is not acceptable because the acreage of wheat proposed is larger than it is deemed wise to handle in view of the reduction in forage and the resulting curtailment of livestock feeding." Here the acceptance hinges upon one item, which when altered, brings the entire plan into line with the farmers' personal and economic makeup and represents the difference between acceptance and refusal. Listing the farmers' reactions under appropriate classification headings measures "the farmers' reaction to proposed suggestions" or his degree of acceptance.

2. The "extent to which the proposed farm organization plans can be executed" likewise falls into a listing of the results under appropriate classified headings in a descriptive manner. Specific items of deviation represent the elements going to make up the "extent" to which proposed farm plans were not executed, i. e., the extent to which farm plans can be executed may be measured by the extent to which failure in executing appears in different specific items.
3. The benefits from farm planning presumably are reflected in larger farm earnings. To measure how much larger these are, it is necessary to measure the returns which could have been achieved had the planning not played its part. This measurement is provided for in the analysis by the computation of budgets for the organization and operation of these farms if they had followed the former system, and the comparison of these results with those actually achieved under the new. The plan of having similar farms in the same neighborhood following the old systems and keeping records on them, to serve as "check farms", as outlined in Project 15 on "The Experimental Method", may also be used to advantage.

In addition to be reported here may be other items of return of an economic nature although not of monetary character. These will include the saving or releasing of time of the operator and his family, the farm power and the equipment. Many of these items presumably should show returns of a financial character by increasing the income. This may not always be the case, yet ease of work, freedom from drudgery and greater opportunity for effective effort on the current tasks may be objectives worth achieving.

Test of method of determining reorganization needed.

It will be obvious that this project may also furnish something of a test of the method used in forecasting the most advantageous plan of farm organization. To the extent that the new plans return

larger incomes than the old plans, the methods of analysis by which the new plans are determined are tested and proved useful, and by inference, probably sound. The project as outlined calls for use of the budget method for determining the most promising farm organization. It would be interesting to use other methods and see which new plans prove to be most advantageous in case there is a difference in the plans indicated. But this would be an additional objective of the project.²

Similar projects.

Past research in this field has not been conducted on the scale or in the detail presented in this project; however, a number of studies have reported the success attained by farmers from following the recommendations of farm management research. Illinois Bulletin 252 compares the earnings of 19 farmers who for 7 years had kept farm business records and during that time had the benefit of record analysis, farm demonstrations and exhibits. The analysis does not include a study of the degree to which recommendations were accepted nor does it measure specifically the results of changes in farm organization, but by comparing earnings on 19 farms with earnings on a group of "controls" in 1916, and again by comparing earnings of the same 19 farms in 1922 with a second group of "controls", a measure of the value of the service to farmers is obtained.

As a result of a 2-year study, general recommendations were made in Virginia Extension Bulletin 96 and Virginia Station Bulletin 255. The value of these recommendations to farmers adopting them is reported in Virginia Extension Bulletin 112 by making the following comparisons:

1. Returns from the group of farms in 1922 with estimated returns from the same organization but with prices for the year 1927.
2. The earnings of a select group of farms in 1922 with the earnings on these farms in 1927 after changes had been made.
3. For individual farms on which certain of the recommendations had been adopted, the organization of the farm and the operator's earnings in 1922 and in 1927 are compared.

Virginia Bulletin 272, reporting the results of a 3-year study, attempts to measure the effects of recommendations by comparing changes on individual farms from year to year. The analysis of the records obtained the first year yielded suggestions for changes to meet the immediate and the long-time situation. The advantage to the farmer was measured by comparing the difference between the operator's earnings for the two years with the difference on a similar farm on which similar suggestions were ignored by the farmer.

(2) C. L. Holmes in commenting on this project very properly remarks that although the new plans yield larger net incomes than the old, they may not be the plans that have *highest* comparative advantage; and that some additional procedure will be necessary for this. (Editors.)

In these studies effort has been to measure the benefits accruing from a change or a series of changes in the organization and management of the farm, but a measure of the extent to which the general or specific recommendations are applicable to certain conditions has not been attempted.

An incompleting study in North Dakota with a purpose similar to the type of study just discussed has deviated from the procedure (1) by omitting the budget for a system of farming generally recommended for a given size of farm in the area, previous studies having shown the desirable practices and the type of organization most likely to succeed in the area; (2) by omitting the standard plan for the organization of resources of a given farm. Instead, the records of the first year with the production and outlook information are the basis for a long-time plan of operation developed directly with the farmer. The long-time plan for each farm, the annual budget, and the records of operation of the farm are comparable to the stages "A", "E", and "R". The general suggestion now made to farmers in the area substitutes for the standard plan "B".

Similarly in Minnesota, research patterned after the outline here has deviated as follows: The project for testing the applicability of farm budgets in farm planning was set up as an integral part of the study in farm organization and not separate and apart from it. In this way the preliminary records, the suggested regional standards and the farm standards were computed as part of the going project. In addition, the intermediate, short-time plans were achieved with somewhat less formality than is outlined in the body of the text preceding. The response to these suggestions, the changes necessary due to the farmer's personal equation, and the rearranged plans are at present all a part of the current work; hence no significant results are as yet available for dissemination. This one conclusion is definitely an outgrowth of the study thus far: Farmer concepts of possible improvements and research worker concepts are rather far apart. This may be due to over-exaggeration on the part of the research worker and lack of proper information as to former limitations. Again it may be due to under-estimation on the part of the farmer or even to lack of knowledge as to facts, relationships and possibilities. Evident also is the trite psychological fact that human beings will exert themselves far more to achieve and carry out the plans of their own conceiving, be they good or bad, in contrast to the effort apparently forthcoming to support the plans of another. For this reason the final phase of the project must be definitely based on the development of a farmer-conceived and farmer-sanctioned plan if it is to be executed even in part. The farmer will often, if not always, put forth the needed extra effort to bring "his" plan through successfully. In many cases this extra effort involves items of small moment absolutely, but items which are of extreme significance relatively and items which mean the success of the venture. Timeliness, the care necessary to effect proper combinations,

or the application of special skill or technique all may contribute to the success or failure of the proposed change.

PROJECT 15. The Experimental Method in Farm Management Research.

(By Virgil D. Gilman and M. L. Wilson.)

Objectives.

(a) To set up and test out hypotheses of farm organization and management. This contemplates looking upon the farm as an organism in the sense expressed by Dr. Friedrich Aereboe,¹ and selecting and testing out prospectively advantageous combinations of the factors of production under field conditions in the area, the hypotheses so set up and so tested being based upon suggestions growing out of studies such as those outlined in Projects 8 to 13 of this report, and upon careful consideration of physical characteristics of the area, probable demand for its possible products, and possible applicable results of experiment station research in crop and livestock production technique.

(b) To set up and test out such prospectively advantageous combinations (or systems of farming), under such conditions and in such time as to anticipate the on-coming changes in farm organization and management in the area and to provide a basis for giving farmers definite concrete guidance in making adjustments for those changes.

(c) As a part of the above two objectives, to give experiment station workers dealing with crop and livestock production technique an opportunity to observe the behavior of their results as utilized in farm combinations in the area and to analyze the need for additional technical research which may be thus uncovered.

Value and uses.

Such a project provides a means whereby the research worker in farm management can test the systems of farm organization and management which, in view of existing trends, seem likely to develop in an area or which might be desirable in the area. He is thus able to make a scientific analysis of *anticipated* changes in farm organization and management, and of *proposed plans* for their redirection, in a concrete way. His science is no longer confined to a study of actual farms. He may thus combine the factors of production in new proportions, thereby peering into the future and scrutinizing

(1) See Friedrich Aereboe, *Allgemeine landwirtschaftliche Betriebslehre*, Chapter III "Die Betriebsorganisation oder die zweckmassigsten Verhältnisse der Betriebsmittel". Heinrich H. Stippler of Berlin Agricultural College in "Philosophy of Aereboe as Related to Scope and Method of Research in Farm Management," published in the *Journal of Farm Economics*, October, 1931, says: "(Aereboe) considers the farm as an inseparable organic entity and shows how this unit assumes and must assume different forms under the changing influences of external and internal conditions."

anticipated developments in much the same way that the research worker in production technique mixes a new feed or fertilizer combination which he anticipates will develop or be proposed and studies the use of it. The testing of proposed or anticipated systems of farming does not imply that any particular or "best" system be dictated to farmers, but simply that a body of facts will be developed which will be *ready and available* to farmers as an aid to them when they begin making choices necessary to adjustment.

Obviously this project also offers a method of testing proposed budgets, adjustments, and plans of farm organization and management such as would be indicated by Projects 8, 9, 10 and 11. Studies to determine the most economical rate of use of different input factors and the relative economy of different farm practices as outlined in Projects 17 to 20 in this report can often be included as a part of the experimentation in farm organization and management. It may not be possible to include the complete results of a study in an experiment; but the main features can be included. In either case, experimentation in farm organization and management provides a testing ground for results of these analyses.

In a somewhat similar way, workers at the experiment station engaged in technical production research are provided with means of testing and observing new adaptations and departures from orthodox or "standard" crop and livestock production methods. Peculiarities of the physical environment of the area, the combining of crops and livestock into a farm organism, and new developments in varieties, breeds, practices, and methods, all call for compromising and adaptation of so-called "requirements." Experimental farming offers an opportunity for the research worker dealing with crop and livestock production technique to identify pertinent and sometimes unsuspected problems worth including in his regular program of technical research.

Farmers of the area would benefit by having prospectively advantageous systems of farming, input-output relationships, and production techniques tested and the results *assembled and awaiting them* as they approach each problem of redirection or adjustment of their individual businesses. Such information being systematically tested, it could be more scientifically applied, and some of the waste resulting from individual trial and error experimentation by farmers would be eliminated.

Extension workers, specialists in both crop and livestock production and in farm management have in such research a source of information enabling them better to shape their extension programs to meet the oncoming problems of the area.

The formulation of public policies in such subjects as land utilization and credit, based as they are upon some estimate of future production, could well utilize results of research concerning the possibilities of probable or proposed systems of farming in an area.

Scope of project.

It will be well to begin the scope of this project by listing a few of the things which it is not:

1. It is not a demonstration.
2. It is not limited to a study of the existing situation.
3. It is not necessarily related to or dependent upon successful or representative farms now existing.
4. It does not involve manipulation of privately operated farms.
5. It is not primarily experimentation in the technique of agricultural production in the usual experiment station sense.
6. It is not coexistent with surveys or route studies.
7. It is not a type-of-farming study.
8. It does not contemplate the setting up of a model or "going concern" farm.

It assumes that information on the types of farming in the area, the methods of production, the historical changes and trends in types of farming and methods of production, the input-output relations in the various enterprises, the price outlook and many other items to be considered in planning a system of farming, have been or can be made available through economic, biological and technological research applicable to the area. In short, in this project the results of farm management research such as that outlined in many of the other projects of this report—and research in related fields as well—are considered as raw material. It attempts to carry the chain of research into a new phase—a stage beyond—combining experimentally techniques and factors of production into systems of farming and studying the interrelationships and results.

Such research is peculiar in that it concerns itself with bringing together unrelated or loosely related results of many lines of research, coordinating them in systems of farming, and observing the results. In the second place, it is peculiar in that it is concerned with "scouting" routes for the future rather than describing the past or present. In the third place, it deals with a highly dynamic problem and must be not too slow to shift its experimentation when necessary to conform to anticipated or possible changes in farm organization and management in the area. It is *not* peculiar in that it deals directly with problems which will confront the farmer of the area and about which he must make advance judgments.

In scope, then, the project concerns itself primarily with the proportioning of the factors of production probable or possible on farms in the area.

Below are a number of illustrations of clear-cut situations where in the near future farmers will likely redirect their farm organization and management, and where the results of a study of the kind here outlined would be very valuable.

A. *A farming area now in small specialized wheat farms.* Trends indicate two probable lines of adjustment, one toward large-scale

specialized wheat farms, the other toward more diversification on farms of the same acreage as now exist. Farmers will shortly begin making choices which will commit them to one or the other system.

B. *A range area, mostly range country, but with some farming land intermingled.* At present the land is owned in small tracts as a result of homestead settlement, and range grass, feed crop land, and stock water are in awkward, unstable combinations. Every indication points to eventual utilization of the area by large range livestock units. How should these be organized and operated?

C. *An area where corn is the crop of major importance.* The general-purpose tractor offers to each farmer the possibility of handling three times his former acreage of corn. Trends indicate that there may soon be more cattle feeding and less hog feeding. How are these new forces going to affect the farm organism?

D. *A truck crop or small fruit area.* Research studies of the experiment station have uncovered new techniques of production, which, if adopted in the area, mean reorganization of farms. How will they work out under actual farm conditions?

E. *An area where it is proposed to initiate new types of production through irrigation, or by the subdivision of estates.* How will proposed or possible systems of farm organization and management work out?

F. *An area where soil erosion or abandonment has left agriculture at low ebb.* What new systems of farming, if any, are suited to the area?

In each of these cases, reportioning of the factors of production is involved. New supplementary and complementary relationships will arise, redistribution of labor emphasis and new budgets and calendars of operation will be necessary, some old conflicts will disappear, new conflicts between enterprises will emerge, and the factors of production will have to be proportioned to form a whole new "front line" of margins.

In each case these oncoming changes cast some shadow, greater or less, before, and this should be, in fact must be, anticipated by research workers. In each case there are results of research and other facts available which have a bearing upon the anticipated development and which will provide the basis for a research project of experimentation in farm organization and management.

Many other illustrations in addition to those enumerated above could be given of situations where experimental research in farm organization and operation would yield valuable results. On the other hand, in many areas there may be a question as to whether the important farm organization problems or the impending adjustments are of such a nature as to lend themselves to experimental research that will be significant. Trends may be so mixed and developments move so cross-wise as to make systematic analysis seem impossible. (Yet it is in just such situations that farmers are most bewildered and most in need of research that will "scout" the way.) The pro-

duction of the area may be of some type such as orcharding with which experimentation, for the problems at hand, cannot deal. Again, some external force, such as residential land values, may overshadow and distort ordinary farm organization and management considerations. Furthermore, basic data upon which this project must be founded may be wholly inadequate. Finally, the temper of the farmers and other people of the area may be such as to render the development of the project inadvisable.

Organization.

It is contemplated that this project be organized under the administration of the experiment station, specific direction of organization and operation to rest with the department of agricultural economics. At every step in the project it must be kept strongly in mind that experimental research in farm organization and management has yet to develop much of its technique of investigation. This technique is in many respects peculiar, enough so that the mere dropping of such a project into the experiment station hopper of routine will not lead to any significant results.

The active cooperation of the experiment station divisions engaged in technical and biological research is a part of this project. The inclusion of new, forward-looking results, of "hunches" of the technical workers in crops and livestock production, and engineering, will often be essential to the experiment. The stake of these workers in the project is an important one in that the results and hypotheses emerging from technical and biological research can be injected into the systems of farming and tested out. Nothing in this close cooperation implies that the experimentation becomes a series of loosely or unconnected experiments or demonstrations in production technique. The central and dominant procedure is setting up and testing systems of farming. In farming systems, the "best" method of producing an individual crop or animal, "best" dates of operations, rates of input, rations, etc., are in part dependent upon the "requirements" of the other crops and livestock within the farm system. The research worker in production technology has a vital interest in such compromising of "requirements," because it is the practical process used by farmers.

Farm mortgage companies, life insurance companies, banks, farm implement companies, and merchants, often are willing or unwilling dictators of systems of farming through their control over land and equipment. In most cases they are as anxious as farmers are to discover the most advantageous proportioning of the factors of production for anticipated systems of farming. The project is hardly worth undertaking unless the good will and cooperative assent of such agencies can be secured. Often it will be possible and desirable to secure much more substantial support in the form of use of land and capital equipment for the experimentation.

While it is vital to the success of the project that the cooperation of such agencies be enlisted, yet it is just as vital that they clearly understand the experimental character of the project in farm organization and management and that the chips must be left free to fall where they may. For this reason it is essential that all contributions of equipment, supplies, use of land, etc., be covered by definite contract agreements wherein the experiment station is left with a free hand to use such factors of production as it sees fit.

Sympathetic understanding of the objectives of the project by farm and other business leaders is of course desirable. The danger is that experimentation will be mistaken for demonstration and that public opinion will become impatient and critical of negative results.

Responsibility for the conduct of the experimental work carried on must be very clearly defined and understood by everyone from the start. From within the department of agricultural economics responsible for the project, the definite channel of responsibility extends unbroken down through the farm manager or foreman to the laborers. The cooperative efforts of other departments and private contributors flow through this channel.

While delegation of responsibility and cooperation can be very definitely set forth before the project is started, the actual management of the project cannot be so predetermined. Those to whom responsibility for *management of the project* has been delegated must have considerable freedom of action in making decisions regarding the *management within the system of farming* being tested. This is essential since weather and price conditions cannot be foretold for the period of the experiment. Paradoxical as it seems, the research is much more scientific and systematic if operations are adjusted to varying conditions as they arise.

It will be noted that in this discussion there is no mention of the entrepreneur. Experimentation in farm organization and management will be most fruitful if the ever varying, elusive force of entrepreneurship is eliminated or held constant. This project assumes that it is feasible to set up and operate a system of farming, observing and measuring interrelationships and results in much the same manner as the animal husbandman sets up and observes a feeding experiment and measures the results. In both cases the results are interpreted in action in the area by individual entrepreneurs. In both, the difficulties arise in the use of results by entrepreneurs with varying ability rather than from the method of research.

Units and coefficients.

Since research in farm organization and management as contemplated in this project has not been developed to any extent, it is very desirable that no rigid system of terminology be set up. Consequently, in laying out the project it would be best simply to forget about the terminology commonly used in farm management studies.

The greatest mobility of thought will be maintained and the

greatest progress made if the problem and the project are set forth in terms of economic principles involved. Of course in each particular case carefully detailed planning and analysis is necessary. However, this particular procedure should not be jammed into the terminological compartments of other farm management research. Terminology will evolve out of experience.

Location and length of experiment.

The geographic location of the "proving ground" whereon systems of farming are to be tested will have to be in harmony with the objectives and the scope of the project, and the conclusions arrived at in the qualitative analysis of the situation. For the most part the principles determining the location are the same as those involved in the location of plots for agronomic experiments. The testing should be set up under physical conditions of soil, topography, etc., which will be representative of those under which the system of farming being tested might develop. The twilight zone of indeterminism at the edge of a type-of-farming area should be avoided. Not only factors of soil and climate, but also the relatively stable economic factors of distance to market, transportation, highways, etc., must be taken into account in so far as they influence representativeness of the location.

The length of time which the experiment should run needs to be considered from several angles.

The first is that of the biological cycle of production. Truck crops, corn-hogs, range cattle, orchards, all differ in this respect, the first completing a cycle each year, the last requiring many years. The length of the biological cycle will influence, although not necessarily rigidly determine, the period of testing for a given system of farm organization and management.

The next consideration, and a more important one, is that the project is dealing with a highly dynamic situation. The attempt is to test hypotheses of organization and management for *anticipated* systems of farming. After the project has been launched with given objectives and plan of procedure, a shifting economic situation may necessitate a redirection of the experimentation. Later developments may clearly indicate that farm organization and management in the area cannot advantageously move in the direction at first anticipated as possible or probable. *In such case, experimental research must redirect its testing activities to the new anticipated systems of farming.* No concept in the whole project is more fundamental to its success than this. It may mean recasting the experiment in terms of time and it may involve relocation geographically. In any circumstance, this mobility of the research machinery is vital to the development of a body of facts which will be ready and available for farmers as they begin making choices leading to new systems of farming.

The final consideration follows obviously from the above. It is to the effect that while *any given experiment* is redirected from time to time, *experimentation* in a dynamic agriculture should be continuous.

Recording and analyzing data.

At the beginning of the experiment a comprehensive plan of operation, expressed as a farm budget or series of budgets similar to those suggested in Project 14 of this report, should be set up companionate to the setting up of objectives and definition of scope of project. Within this budget, the hypotheses of the project are expressed concretely.

Records kept during the experimentation will verify these hypotheses expressed in the budget or provide the basis for this modification. Analysis and interpretation must follow closely upon the heels of recording, for crude figures and facts quickly become obsolete in a dynamic agriculture. There is little chance here, as in biological research, for long-period analyses.

Both the budget and records are much different from those kept by an ordinary farmer. The farmer's farm is a going concern, and as emphasized in Project 14, his budget and record are fitted to serve that given concern. On the "proving ground" of an experimental farm, on the other hand, there are likely to be more "enterprises," more equipment and more labor. Some testing is undertaken even when negative results are expected. Also because of the experimentation with variations in proportions of the factors, both budgets and records are much more detailed and voluminous. The experimentation endeavors to measure the effect of variations in production, in dates, in methods, in relation to farming systems, to reveal those most advantageous. Analyses must set forth these results with interpretation so that they become a body of basic "control" data which the farmers of the area can use in making up their farm budgets.

Although the emphasis in analysis will vary according to the specific objectives and scope of the project, the basic analysis will be concerned with the interrelationships in the particular system of farming being tested. For this *particular* case, the time relationships, the input-output relationships, the complementary and supplementary relationships can be worked out.

From this as a base the analysis can proceed to variations such as the effect upon the farm organization and management of one change in the proportion of the factors, for example, more land or less land, a larger power unit or a smaller power unit, more labor or less labor. Analysis is also needed from the viewpoint of calendar of operations, shifting "best" dates forward or backward, and use of night labor.

The data on numerous variations of farming systems may be set forth from the physical data secured and the probable results calculated, after the manner indicated in Projects 9 and 10 in this report.

But to avoid complications in both analysis and presentation, it should be limited to the more important systems.

Inferences.

These topics have been touched upon in preceding sections. The inferences drawn can be classified into three groups, those pertaining to the type-of-farming area, those pertaining to individual farmers of the area, and those pertaining to time period. The geographical location of the experimental ground is to be such that it will be representative of the type-of-farming area. As a consequence, the experimental results should be generally applicable for the area. The closer the physical environment in all parts of the area comes to being identical with that of the location selected as "representative," the more nearly will the results be applicable to all parts of the area.

Inferences as to individual farms must be based upon the variations in the abilities of the entrepreneurs. It must be recognized that farmers are of different capacities and efficiencies and all gradations between. To classify carefully all farmers according to these and then to match each grade of ability with research specially designed for it would be an impossible task, whether in animal husbandry or farm management. However, it is to be kept in mind that the experimentation with variations in the system of farm organization and management turns out an assortment of input-output techniques which farmers, particularly farmers whose proportioning of the factors does not diverge too far from that of the system being tested, can use in planning their own production. As a matter of fact, it is very likely that adjustments in the area will be initiated by a small minority of farmers with high ability who can readily utilize the results of experimental research.

Inferences as to period to which the results will be applicable are dependent upon the speed with which the anticipated development in the area is taking place.

Presentation of results.

The selection and presentation of material will be determined by the needs of the farmers of the area for data to guide them in their choices. Extension specialists in crop and livestock production will make valuable use of all material bearing upon the adaptation of the "standards" of production to the systems of farming being studied. These and other results of the experimentation logically flow out into the extension program and thence to farmers.

The concerns and agencies with special financial interests in the area should be supplied with results as fast as they develop. Perhaps most important of all are the leading farmers who are out in front of the procession in making adjustments. They will eagerly use the results of the research, and its development at their hands

will give opportunities for farm management and organization studies of the usual type to supplement experimental research.

The experimentation with probable and prospectively advantageous proportioning of the factors of production into systems of farming should be continuously ejecting up-to-the-minute data serving to guide the farm organization and management of the area.

Costs.

The costs of such a project will vary greatly according to the systems of farming placed under test and according to the proportion of the experimental set-up which can be secured by contribution. In general, the initial outlay is large, but from the standpoint of area served and significance of results in reducing the wastes of trial and error, it promises to be an extremely economical form of farm management research.

Comments. (H. R. Tolley.)

The foregoing statement has been written in the light of six years experience in farm management research by the experimental method at the Montana Agricultural College. Brief discussions of the project in progress there will be found in an article, "Experimental Method in Economic Research", by M. L. Wilson in the *Journal of Farm Economics*, October, 1929, and in the chapter on "The Experimental Method" in *Research Method and Procedure in Agricultural Economics*.

There are differences of opinion among farm management workers as to the use of the experimental method in research in this field. Some apparently hold the opinion that the method is not applicable to farm management research. Others feel that the difficulties involved in carrying on farm management research by this method are too great to warrant attempts to use it. On the other hand, it must be admitted that many promising hypotheses concerning possible improvements in farm organization and operation have been formulated which could be verified only by the experimental method.

For instance, many farm management workers have at one time or another, when studying the farm management problems of an area, formulated hypotheses that some form of farm organization or some method of management not to be found even on a single farm of the area would result in a better utilization of the resources of some or all of the farms of the area, than any of the existing organizations or methods. Since no facts are readily available to prove or disprove such hypotheses, they usually remain in the realm of the "theoretical" and "hypothetical" until some farmers "try them out" and provide the facts. Even if the researcher undertakes to study by the case method "innovations" in farm organization and management concurrently with the first trials by farmers, the researcher has placed himself in the position of a *follower* rather than a *leader* in the development of improved organization and management. When

we realize that now there are to be found in many parts of the country, systems of farming and methods of operation which were not in existence a decade ago, and that many of these newer systems and methods are better adapted to present conditions than were even the best of those in existence ten years ago, and that in most cases results of farm management research have *not* been used in the developments of these new systems and methods, we are compelled to admit that our work has *not* been as useful and helpful to farmers as it might have been. I venture to predict that in the next decade we will see even greater changes in the farm organization and management in most parts of the country than have occurred in the past decade.

A more general use of the experimental method would certainly help farm management research to "get at the head of the procession". To be sure, there are many difficulties to be overcome before "economic experimentation" becomes an established method for research. However, this project discussion shows that a good beginning has already been made in developing the technique of the experimental method in farm organization and farm management research. Probably it is as well developed now as the technique of the statistical method in our field was two decades ago. Even though use of the experimental method may be quite expensive, the necessary funds may in some cases be more readily available than for statistical research. Certainly the large funds that have been spent on "demonstration" farms could well be turned to this use.²

PROJECT 16. Prices to be Received by Farmers.

OBJECTIVE: To develop a basis for forecasting annual prices at the farm for the commodities produced in an area. (Joint with Prices of Farm Products.)

(By H. R. Wellman.)

Stated in more detail, the objectives of this project are to discover, measure, and explain the major factors that have caused prices at the farm for commodities produced in an area to vary from year to year, and to develop a basis for forecasting at the time of planting or breeding the probable level of prices of the various commodities at the time of marketing. These are the prices to be used in deter-

(2) Professor W. I. Myers's comments on this project are as follows:

"I am in complete disagreement with the suggested use of the experimental method as a means of verification of the results of research by other methods. Because of the grave difficulties involved in carrying on farm management research by the experimental method, it would seem to me that its value is very greatly over-rated in Project 15. Rather than using the experimental method as a means of testing the validity of hypotheses reached by a study of farms, it would seem to me more appropriate to say that the results of the experimental method might well be considered as hypotheses to be checked by farmers in the actual operation of their farms."

mining the most advantageous combinations of enterprises and methods of production in an area in the years ahead and the adjustments needed in the light of the outlook.

Value and uses.

In order to use the outlook reports issued by the federal and state agencies to the best advantage in making adjustments in their production program, farmers need to be able to translate the price forecasts for the nation or state into price forecasts for the sections in which they live. The federal and state outlook reports must of necessity be concerned primarily with the forces of demand and supply that determine prices in the central markets at the time the bulk of the product is being marketed. The farmer, however, is interested in the forces of demand and supply that determine the prices in his particular market place at the particular time his product is ready for market. Only if the forces that determine local market prices coincide with those that determine central market prices, and if the costs of transportation and handling from the local to the central market are known, can the farmer use the federal and state outlook reports directly. Similarly, it is only under these conditions, that the farm management research worker can use without modification the results of research in central market prices in studies such as those outlined in Projects 8 to 13 in this report.

Scope.

This project can be limited to a single commodity in a given area, or can include all of the commodities in a given area, or can include all of the commodities in all of the areas in the state or region. At least in the beginning, however, it is desirable to confine the research to a single commodity in a given area. When this is completed the study of a second commodity can be undertaken and so on.

Analysis.

Marshall points out "that in a perfect market there is a strong tendency for the same price to be paid for the same thing in all parts of the market," allowance being made for differences in the cost of transportation. The markets for many agricultural commodities, however, are not perfect markets. Consequently, prices in any given locality may vary considerably from central market prices, even after transportation and handling charges are accounted for.

Two methods of attack might be used in developing a basis for forecasting prices at the farm: (1) analyze the factors that have affected the year-to-year changes in farm prices and appraise the future positions of these factors; (2) forecast the annual prices in the central market or markets in which the product is sold and then forecast the spread between the central and local market prices. The second method is the one most likely to yield satisfactory results for the majority of farm projects.

Before starting the analysis, it is necessary to determine the time of the year that the specific commodities from the area under consideration are marketed. Potatoes grown in the Shafter district of Kern County, California, for example, are marketed during the months of May, June, and July. A forecast of the annual prices of potatoes at San Francisco or Los Angeles would not give Shafter potato growers adequate information. What is needed is a forecast of the prices of new potatoes at San Francisco or Los Angeles during the months of May, June, and July. This forecast of central market prices together with a forecast of the spread between the prices at the central market and at Shafter would, if reasonably accurate, give potato growers in that district reliable price information upon which to base their planting program.

The first phase of this analysis will be to develop a basis for forecasting prices in the central market in which the bulk of the commodity from the area is sold and at the time it is sold. The projects whose objectives are to explain the major variations in the price of a product in a given wholesale market, and to forecast the annual average price and the seasonal movement in the price for a given annual crop in a wholesale market, in the bulletin of this series dealing with research relating to Prices of Farm Products, provide the basis for this phase. The second phase of this project will be to measure and explain the spreads and changes in spreads between prices in the central market and prices at the farm in such a way as to have prediction value in forecasting future spreads. This is discussed in a later project in the same report. Although considerable progress on the first phase of this project has been made, there has been very little work done on the second phase. To explain and measure the influence of the various factors that have caused the fluctuations in price differentials between local and central markets is a difficult task.* Until this is done, a possible procedure is to use spreads based upon transportation and handling charges in estimating prices at the farm from the forecasts of prices in the central markets.

PROJECT 17. Proportional Combination of the Factors of Production.¹

(By A. G. Black.)

EDITOR'S NOTE: The discussion in Project 17 is general, intended to introduce the more detailed analysis outlined in Projects 18 and 19, the first of which is in terms of the experimental method, the second in terms of the statistical

(*) "It will always be impossible to forecast local price variations from central market variations because in general the spreads vary because of non-predictable local causes. Local price variations can be explained; but not forecasted." (A. G. Black.)

(1) See Analysis 45 in *Methods in Social Science Research—a Case Book*, for an outline of the research relating to this subject.

method. Such a project as this can confine itself to purely physical and biological relationships. However, it will then be only a fragment of the whole analysis needed; and it will not really be a project in economics. As outlined, the necessary economic analysis is included with the other, which requires that the whole farm business be brought into the analysis. But the concentration is upon one set of relationships, those of inputs to outputs, the rest being brought in to supply the background, in the manner indicated in the statement in the introduction under "Suggested Procedure for Specific Research Projects."

One of the fundamental problems met in farm management research is the proportional combination of the factors of production. The study of this problem is not only of extreme interest to the economist interested in the theoretical aspects of production but is of interest as well to the farmer who faces the day-to-day task of combining the production elements with which he works. A thorough understanding of this subject is necessary to guard against a blind acceptance of production "standards" and "unit requirements" which have so often been presented in farm management bulletins of the past (and unfortunately of the present).

The term "proportional combination of the factors of production" has a most formidable appearance, but it means merely the proportion of the various "raw materials", be they acres of land, hours of labor (man or horse), amounts of machinery, seed, fertilizer, feed, etc., used in combination to produce a bushel of wheat or a hundred-weight of beef, or some other product. It might easily be concluded that the amounts of the various raw materials combined to produce a bushel of wheat, for example, are quite constant, that one hundred-weight of beef must contain about the same amount of raw materials as another. If only the finished product is examined, this conclusion would appear quite valid, and in a certain sense is quite valid. A bushel of wheat will contain about so much protein, carbohydrate, moisture, iron, phosphorus and all the other elements found in wheat. There may be considerable variation in these from year to year or from place to place, but on the whole there will be a reasonable degree of constancy regarding the physical and chemical constitution of the wheat.

Although the final product may contain a relatively fixed amount of its constituent elements, the amounts of these elements used in producing the product may vary widely. The finished pairs of shoes will always contain about the same amount of leather. But there may be a considerable variation in the amount of leather that was used up in making these shoes, depending upon whether the cutters were trying to save leather or save labor, according to how much work was done by machinery, etc. If machines are run at maximum speed, more spoilage will result than if operated at moderate speeds. Similarly, there is a wide range in the amount of feed that is fed in producing a hundred pounds of milk, depending upon the type of cow, the ration, the skill of the feeder, the detailed attention given to the feeding. This variation is due in part to the possibility of substituting one production element for another within limits. If a

large number of shoes are produced per hundred pounds of leather, we would find that a large amount of labor has been used. In a sense, therefore, labor has been substituted for leather. Similarly, gasoline power may be substituted for horse-labor and man-labor in producing wheat. Or a large amount of wheat or cotton per acre may be due to lavish use of labor or fertilizer. These factors have been substituted for land. When we have a large return per man, we frequently find a small return per acre. This represents a sacrifice of land and is in a sense a substitution of land for labor.

Statements of "unit requirements" or "standard requirements" do not recognize the possibility of varying the amounts of production elements used. They are therefore poor guides to follow if the most profitable combination of the factors is the objective.

It is obvious that the principal reason for varying the amounts of cost factors used is the relative prices of those factors. When raw materials are low priced, they are used more wastefully (physically), and labor and the other factors are economized. When raw material prices are high, the reverse is true.

Research work in farm management which attempts to throw some light upon the proportional combination of the factors of production must be planned to bring out the differences in the amounts of the physical factors used under varying combinations of the factors in production. With such basic data at hand, it is comparatively simple to calculate expenses of production under various price situations.

It should be evident that the final objective of a project of this nature is *the lowering of costs and increasing of net incomes*. We hear much these days of the need for lowering costs in agriculture. Research is needed as a basis for it. Higher yields are commonly assumed to be a most important means of lowering costs. Sometimes they are, and sometimes not—less often not than commonly supposed. Were this not so, we would have made more progress in lowering costs by increasing yields. The fact is that on very many fields under very many circumstances, the extra inputs needed to increase yields will not pay for themselves; or will not reward the farmer sufficiently to induce him to put forth the extra effort. (As explained in Project 8, the usual correlation analysis of yields and net incomes are spurious in considerable measure.) A project such as this if properly conducted should indicate what increments of what production factors will lower costs, on what kinds of land, with what sorts of livestock; and what increments will reduce costs to their lowest possible figure. But it should also show how and where incomes may at times be increased by increasing the volume with costs rising.

Such information is essential to the study of intensity problems. It should be noted that "intensity" is one aspect of "proportional combination of the factors of production." Land, for example, is used more intensively when larger amounts of the other factors are

used in combination with a fixed or constant amount of land, and less intensively when labor and capital are applied more thinly to the fixed amount of land. The relative intensity with which land or labor or equipment is worked is always closely related to the relative prices of the input factors and to the price of the product. Which is cause and which is effect; is a question we need not discuss here. Given a set of prices for his input factors and for his product which he cannot change by his volume of production, any farmer can increase his profits by increasing his intensity to the point where the last unit of the production element added just equals the returns received from the unit of product which may be imputed to the additional increment of the production factor. This is of course the familiar marginal productivity analysis.

Objective.

A project set up to study the proportional combination of the factors of production will have for its objectives the following: *To determine and analyze the methods of production of the leading enterprises in the important type-of-farming areas, such analysis to take the form of determining the most effective combination of input factors both with respect to qualities and amounts, and the relative importance of the input factors in the enterprises, from the point of view of both physical and economic returns.* The final step is to construct tables or graphs showing the physical amounts of the input factors used in varying combinations required to produce the final product.

Scope.

Such a project may be limited to only one of the products produced on the farms in an area, such as cotton in the South, and to one of the input factors, such as fertilizer; or it may be expanded to include all the input factors used in producing one product, and all of the products in the type of farming followed. If it is limited to one input factor and one product, then the other input factors must be held constant, as they may be in large part by experimental procedures; or they must have the effect of their variations removed (in so far as possible) by statistical methods. In the latter case, they are therefore really included in the analysis, and one might as well in most cases attempt to measure the effect of variations in them on the product the same as of the input factor that has been put in the foreground.

If a type of farming could be found consisting of enterprises that are almost completely non-conflicting, non-supplementary and non-complementary, then one could analyze the input-output relationship for any one of the products separate from the others. There are cases where this situation is nearly enough realized so that one can abstract one product from the combination and determine its input-output relationships separately. In most cases, however, there are

too many interrelationships between enterprises to make this possible. (See Project 8 for further discussion on this point.) One can get the relationships between the pure physical inputs and physical outputs for each product; but one cannot determine from these the most economical combination of inputs. The amount of labor which it pays to devote to a given product depends upon what other demands there are for the same labor at the same time; the same thing may even be true for some types of feed for livestock, particularly pasture feed. Under such circumstances, it is necessary to analyze the input-output relationships for all the products, and at the same time determine the supplementary, complementary and joint-product relationships with considerable care. Data must be collected for each farm that will enable the investigator to determine the effect on the receipts, expenses and net incomes of the business as a whole of varying the amounts of any input factor for any product; in other words, to set up various budgets each representing different amounts of some input factor. The variations may take the form of hiring extra labor; or of taking labor away from other products. It is also obvious that combination of enterprises is a major factor in the problem. Reducing the acreage of one crop will make more labor available for others, or for a livestock enterprise. The more livestock, the more manure available for the crops, etc. It is clear from the foregoing that *any input-output analysis that is to be put to use under actual farming conditions must be supported by data and analysis for the farm business as a whole*, unless the enterprises are almost completely independent of each other. The fact that two enterprises receive attention of the farmer at entirely different seasons of the year does not make them unrelated—the operator makes a larger income from having two enterprises supplement each other in this way.

Methods of procedure.

Either the statistical or experimental methods may be used in carrying such a project to completion. In certain cases, perhaps both methods may be used in conjunction. Data for analysis by the statistical method may be secured from farm surveys, supervised records or from experiments. The physical and economic phases of the problem must be given careful separate consideration. The results should be first stated in physical terms; that is, the amounts of product resulting from the use of successive physical increments of input factors should be determined. In theory, once such results are tabulated for all reasonable amounts of the production factors in combination, cost rates (expressed in money terms) may be applied, and the costs so determined of the several elements used in combination may be added, and the resulting sums will constitute a series of unit costs under varying combinations of the elements of production. The combination resulting in the smallest total unit cost is known as the least-cost combination. In practice, however,

usable cost-rates are not available for many of the input factors—commonly not for most of the man-labor, horse-labor and machine labor, for much of the land, and even for a considerable part of the feed. Even if labor is hired, it is commonly hired for a period and to work on several different products. One does violence to the facts if he charges the same rate per hour for labor on chores and field work, on oats planting in April and haying in June, etc., in case a man is hired by the season to do both. Land in different uses in a crop rotation cannot be properly valued at the same rent. Many farm-grown feeds have no real market value—they are worth what each farmer can get out of them at his most valuable use. The concept of least-cost combination is therefore purely theoretical under most actual farming conditions.

However, this is a matter of no great moment. Farmers are interested in producing at the highest profit rather than at least cost, unless the two happen to coincide. Usually it will pay to carry production to some point beyond least cost. The highest-profit point may be determined by comparing the cost of producing an additional unit of product with the selling price of that unit. The two are equal at the highest-profit combination. Stated somewhat differently, it is profitable to add increments of input factors to a fixed factor up to the point where the value of the added product is equal to the added costs.² Even this procedure, however, is not possible in case no values can be determined for the marginal increments of the input factors; and as explained above, this is the case with many of the input factors. The actual procedure which must be followed is therefore that of balancing against selling price only those for which values can be obtained. *For the others, the results take the form of statements that these marginal increments of input if added to this product will increase by so much the net income of the farm* (net income being calculated so as not to include deductions for non-cash items such as family labor). One can then decide if this addition to the net income is the largest that can be obtained from any possible use of it. The operator may finally decide that it is not enough of an addition to net income to warrant trying to use it.

a. *Statistical method.*

If the data for such analysis are to be obtained by surveys, a special effort must be made to secure as detailed and accurate information regarding methods of conducting the enterprises as possible. If the combination of factors in a beef cattle feeding enterprise is involved, the data collected should include the number, weight and age and grade of cattle when put on feed; the amount of labor, man and horse, used per day; the ration fed in as detailed form as possible, including period for which each ration was fed, total length of feeding period, pasturage and weights of cattle, as frequently as

(2) John D. Black, *Production Economics*, Chapters IX and XII. Henry Holt & Co., 1926.

possible. Such other data as size of feedlot, type of buildings, whether or not cattle are confined to dry lots, size of farm, crop acreage, pasture acreage, other livestock enterprises (sizes, etc.), and amount of labor available, may be found useful in a study of this kind if special phases of the problem are considered. Such data are helpful in explaining unexpected deviations in some of the major characteristics of the enterprise. *It must be remembered that the enterprise is not isolated, but is an integral part of the whole farm business; hence the other enterprises with which the one under consideration is combined are important in determining results within any one enterprise.* The more supplementary, complementary and joint-product relationships there are in a type of farming, the more the results for any one enterprise will be influenced by the others.

When methods of production change, the amounts of the factors also change. For example, the factors used in a dry-lot steer-feeding enterprise are not strictly comparable with those used in a pasture-feeding enterprise. There is a different amount of land used, to be sure, but the significant change is in the nature of the land use. The two methods cannot be compared on the basis of the mere amount of land used. This same illustration suggests that the form in which feed is supplied will give widely different results. Thus the gain per pound of concentrates or per pound of roughage will differ under the dry-lot and pasture systems of feeding. Similarly, when crop production is highly mechanized there are differences in amounts of factors used; but there are also differences in the quality or character of the factors. The quality of labor will probably be quite different when combined with power machinery than when combined with horse-drawn equipment.

Enough illustrations have been given to suggest that the input-output relationships should be determined for each of the different types of farming and techniques of production, and for the variations possible under each technique or method.

It will be apparent that a considerable number of records is needed for a statistical study of this problem, especially if the data are collected by survey. There is likely to be a considerable scatter about the line of regression for some of the input factors. The extreme cases will exert a smaller influence relatively if part of a large number of observations than if part of a smaller number of observations. This involves the whole question of sampling as it applies to economic data, which has been discussed at length in *Research Method and Procedure in Agricultural Economics*. The complexity of the problem as evidenced by the number of products and of cost factors involved is a further reason for a large number of cases. The standard method of measuring the influence of the various factors is by multiple and partial correlation. With such a method, the number of observations needed increases with the number of variables. Inasmuch as the addition of increments of input

factors to another factor results typically in diminishing returns, the results will usually show a curvilinear relationship.

b. *Experimental method.*

The so-called experimental method of studying the proportional combination of the factors of production involves more direct procedure than does the statistical method. All the input factors are held constant in fact except the one which is varied; likewise the other enterprises are eliminated. In the statistical method an attempt is made to eliminate the effects of the variations of the other factors, with an uncertain prospect of success. The experimental method is slower, does not, in general, require as many observations, is probably more accurate, but is conducted under conditions not found in actual farm operation, and is probably as open to question regarding the adequacy of the sample as is the case with the statistical method. This is because in experiments with plants and animals, not all the conditions are under complete control. In effect, therefore, statistical procedure needs to be used even in experiments. Enough observations must be made so as to furnish a basis for calculating averages, thus tending to eliminate the effects of experimental error (due to measurements or to uncontrolled factors) upon the results as finally published; or to make possible various correlations and adjustments for the uncontrolled factors.

Experiments should be an effective way of determining the effect of different practices with respect to feeding, applying fertilizers, spraying, cultivating, preparing soil, date of planting, etc. Many of these experiments will show diminishing returns clearly.

Most experiments now being conducted in animal husbandry, soils, crops, etc., are not planned to provide data necessary to determine the results needed in work of this kind. They could be easily planned, however, to yield such results and at the same time fulfill the purposes for which they are now being conducted.³ They should wherever possible be planned and executed jointly by economists and agronomists, animal husbandry men, soil or other specialists who might be interested in the technical side of the problem.

Although most of the published results of experiments have not been in form to use in this work, it would no doubt be profitable to inspect the original data from experiments that have been conducted. In many cases a different method of analysis will yield usable data. Much effort could no doubt be profitably expended in such work. Any results from this source would reduce the necessity of considerable lengthy and expensive experimentation. The analysis of the results of the use of fertilizer on tobacco discussed in Project 18 of this report illustrates this point.

(3) W. J. Spillman and Emil Lang, *The Law of Diminishing Returns*, World Book Company. Also see Project 18 following.

Results.

The results from either the experimental or statistical method of analysis can be presented in tabular and graphic form. It would appear that tables setting forth the results obtained from various combinations of the production elements would serve as useful a purpose as have feeding standards in the past. The usefulness of graphic presentation will, however, be limited to those cases where two or three variables enter the problem. More than this number cannot be shown graphically. The alternative procedure is that outlined in Projects 8 and 9, of setting up typical farm budgets as illustrations. The pioneer study in this subject is U. S. D. A. Bulletin 1277, *Input as Related to Output in Farm Organization and Cost-of-Production Studies*, by H. R. Tolley, J. D. Black and M. J. B. Ezekiel. Research workers are advised to study this publication carefully before beginning work in this field, as well as the other references cited in Projects 18 and 19.

As previously indicated, this method of analysis is rather technical. The individual farmer, county agent or extension specialist has neither the data nor the technical training necessary to develop a study of this type. The research worker, therefore, must analyze the problems completely, and must then put his results in such form as to be easily understood and applied. A tabular statement giving the variations in the output of gains or yields resulting from variations in the amounts of the input elements used is one method of presenting the results of research in this field for the use of farmers. When all the input factors have definitely ascertainable values, tables can also be constructed showing the effect of price variations—such as in Table 26 from the United States Department of Agriculture Bulletin 1277. Where some of the input factors do not have such values, the presentation had better be in the form of budgets.

PROJECT 18. Dr. W. J. Spillman's Project for Experimental Determination of the Most Eco- nomical Rate of Use of Fertilizer.¹

OBJECTIVE: *To determine by the experimental method the most economical rate of use of fertilizer in the production of a specified crop. (Joint with Soil and Plant Sciences.)*

(By H. R. Tolley.)

*(This project outlines methodology proposed
by Dr. W. J. Spillman.)*

At the time of Dr. Spillman's death in July 1931, his investigations of the Law of Diminishing Increments (or Diminishing Outputs) in

(1) Including this project in this report does not, any more than in the case of all of the other projects, carry with it the complete endorsement by the Committee of all the details of the analysis outlined or of its underlying assumption.
(Continued on Page 190.)

agriculture had progressed to the point where he had outlined in detail and put in manuscript form a method of obtaining by experiment the data on the relation between the yield of a crop and quantities of fertilizer applied that are needed to determine the most economical rate of use of fertilizer of different kinds, on different soils, in the production of different crops, at varying prices of fertilizer and varying prices of the product. The Bureau of Agricultural Economics is planning to publish this manuscript entitled *Use of the Exponential Yield Curve in Fertilizer Experiments* at an early date in substantially the form in which Dr. Spillman left it.

In his earlier work on the subject Dr. Spillman had concluded that the increments in yield due to additional applications of fertilizer form a decreasing geometric series. With this conclusion as a basis he had developed a mathematical expression of the Law of Diminishing Increment (as he called it) which he believed expressed the underlying relationship between the quantity of output and varying quantities of one input factor (when all other input factors remain constant) for a wide range of agricultural commodities.² Dr. Spillman recognized, of course, that the case with one varying input factor, all others remaining constant, represents the most simple statement of the Law of Diminishing Increments, and proceeded in his studies toward the development of a mathematical expression of the law when two or more of the input factors vary at the same time.³

In the manuscript referred to above, he developed a mathematical expression for the relationship between the yield per acre of a crop and the varying amounts of each of three fertilizer ingredients (assuming, as in the earlier work, that the increments in yield associated with additional units of each fertilizer ingredient, form a decreasing geometric series), and presented a method by which, if the proper experimental data are available, the yield to be expected on a particular soil from any specified quantity of each of the three fertilizer ingredients—nitrogen, phosphoric acid, and potash—alone or in combination can be computed.

(Continued)

tions. The Committee is in agreement, however, in the opinion that experimental work with fertilizers, feeds, etc., can be planned in such a way that mathematics can be brought to its aid in the general manner outlined by Dr. Spillman, and thus make such experimental work achieve more valuable results at less cost. Its disagreements with Dr. Spillman's presentation would have to do with the question as to whether one mathematical function, the geometric one, always will give the best fit, or one function will fit best all parts of any series, and hence as to whether safe results can be obtained with as few plots as Dr. Spillman has thought. Agronomists have commonly disagreed with Dr. Spillman on this same point. Unfortunately, some of them have not stopped with this, but have wanted to reject the whole method. (Editors.)

(2) See Spillman and Lang, *Law of Diminishing Returns*, and review of same in *Journal of the American Statistical Association*, by J. D. Black. Also see especially "Analysis 45" by J. D. Black in *Methods in Social Science—a Casebook*, prepared by the Social Science Research Council. This relates the statistical to the experimental method of research upon this problem, and states some of the underlying assumptions.

(3) An analysis of this problem in non-mathematical terms is given in *Introduction to Production Economics* by J. D. Black, Chapter II, "The Principle of Diminishing Physical Outputs."

The equation which Dr. Spillman used to represent the relation between yield per acre and the quantity of each of three fertilizer ingredients is:

$$Y = A(1 - R_1^{n+a}) (1 - R_2^{p+b}) (1 - R_3^{k+c})$$

Where Y=Yield per acre

A=Theoretical maximum yield of the crop as the quantity of three fertilizer ingredients applied is indefinitely measured

R_1 =Ratio between increments of yield due to application of additional units of first fertilizer ingredient

R_2 =Ratio between increments of yield due to application of additional units of second fertilizer ingredient

R_3 =Ratio between increments of yield due to application of additional units of third fertilizer ingredient

n, p and k are the number of units of the respective ingredients available in the unfertilized soil

a, b and c are the number of units of the respective ingredients in the fertilizer applied

On a series of experimental plots, the yield per acre (Y) on each plot and the quantity of each fertilizer ingredient applied (a, b and c) will be known, and Dr. Spillman's method enables one to compute from these data the values of the seven constants or parameters (A, R_1 , R_2 , R_3 , n, p and k) for the crop and soil in question.

Using the results of this computation as a basis, Dr. Spillman developed formulae for calculating, for specified prices of the product and specified prices of the fertilizer ingredients:

1. The most profitable fertilizer analysis for a particular soil, and
2. The most profitable quantity of this analysis to use.

Experimental data needed.

Dr. Spillman's formula for determining the relation between the amounts of each of three fertilizer ingredients (say nitrogen, phosphoric acid, and potash) and yields contains seven constants, or parameters. Hence the yields from at least seven plots suitably fertilized are necessary to determine the values of these constants. A larger number of yield plots with suitable check plots and replications would probably be necessary for accurate and reliable results.

All three fertilizer ingredients are to be applied in varying proportions to all plots, at least one plot to have one unit of each ingredient, one plot to have two units, one plot to have three units, and so on. The accompanying Table I of six alternative series of plots which was prepared by Dr. Spillman illustrates some of the ways in which the fertilization of the plots might be made.

*In a paper, "A Plan for the Conduct of Fertilizer Experiments", published in 1921, Dr. Spillman pointed out the desirability of planning fertilizer experiments so that the results will show the "influence on yield." "... of the various fertilizer elements in different combinations", and presented a plan of plots for fertilizer experiments with varying applications of each fertilizer ingredient.

(By W. J. Spillman.)*

A. 7-Plot Series

Plot No.	Units of		
	N	P ₂ O ₅	K ₂ O
1	1	1	1
2	2	1	1
3	3	1	1
4	1	2	1
5	1	3	1
6	1	1	2
7	1	1	3

B. 10-Plot Series

ch. 1	1	1	1
2	2	1	1
3	3	1	1
ch. 4	1	1	1
5	1	2	1
6	1	3	1
ch. 7	1	1	1
8	1	1	2
9	1	1	3
ch. 10	1	1	1

C. 19-Plot Series

ch. 1	1	1	1
2	2	1	1
3	3	1	1
ch. 4	1	1	1
5	4	1	1
6	5	1	1
ch. 7	1	1	1
8	1	2	1
9	1	3	1
ch. 10	1	1	1
11	1	4	1
12	1	5	1
ch. 13	1	1	1
14	1	1	2
15	1	1	3
ch. 16	1	1	1
17	1	1	4
18	1	1	5
ch. 19	1	1	1

N—nitrogen

ch—check plot

P₂O₅—phosphoric acid

K₂O—potash

D. 9-Plot Series

Plot No.	Units of		
	N	P ₂ O ₅	K ₂ O
ch. 1	1	1	1
2	2	1	1
3	1	2	1
4	1	1	2
ch. 5	1	1	1
6	3	1	1
7	1	3	1
8	1	1	3
ch. 9	1	1	1

E. 13-Plot Series

ch. 1	1	1	1
2	2	1	1
3	3	1	1
4	4	1	1
ch. 5	1	1	1
6	1	2	1
7	1	3	1
8	1	4	1
ch. 9	1	1	1
10	1	1	2
11	1	1	3
12	1	1	4
ch. 13	1	1	1

F. 17-Plot Series

ch. 1	1	1	1
2	2	1	1
3	1	2	1
4	1	1	2
ch. 5	1	1	1
6	3	1	1
7	1	3	1
8	1	1	3
ch. 9	1	1	1
10	4	1	1
11	1	4	1
12	1	1	4
ch. 13	1	1	1
14	5	1	1
15	1	5	1
16	1	1	5
ch. 17	1	1	1

*In a paper, "A Plan for the Conduct of Fertilizer Experiments", published in the *Journal of the American Society of Agronomy* in 1921, Dr. Spillman pointed out the desirability of planning fertilizer experiments so that the results will show the "influence on yield." "... of the various fertilizer elements in different combinations", and presented a plan of plots for fertilizer experiments with varying applications of each fertilizer ingredient.

The amount of nitrogen, phosphoric acid or potash to use as a unit in each case is more or less an arbitrary matter. The units should be large enough or the number of plots great enough that diminishing output will be plainly in evidence with the heavier applications of each ingredient. Unless something is already known of the response of the crop and the soil to the fertilizers used, it may be necessary to conduct a preliminary test before deciding how many pounds of each ingredient per acre shall be taken as a unit. It is not at all essential that the unit of nitrogen be the same as the unit of phosphoric acid or potash. The number of units of each ingredient to be used on the various plots of the series is also a more or less arbitrary matter.⁴

Dr. Spillman has provided detailed directions for computing the constants and determining the curve of diminishing increments for additional applications of each ingredient.

An example.

A series of experiments begun several years ago with varying quantities of fertilizer applied to tobacco at Tifton, Georgia, was so planned that the increments in yield due to additional quantities of each fertilizer ingredient can be determined by Dr. Spillman's method.

The arrangement and fertilization of the plots and their yields for the six years 1924 to 1929 are shown in the accompanying table.

TABLE II. TOBACCO EXPERIMENTS AT TIFTON, GEORGIA

Plot No.	(Rate of fertilizer application, 1000 pounds per acre.)			Yields, lbs. per acre					
	Analysis (%)			1924	1925	1926	1927	1928	1929
	NH ₃	P ₂ O ₅	K ₂ O						
1	5	8	5	1235	1571	1219	1329	1182	1452
2	4	8	5	1281	1572	1224	1201	1051	1262
3	3	8	5	1206	1499	1157	1252	975	1073
4	2	8	5	1094	1398	1092	1351	930	972
5	0	8	5	867	1129	914	1427	693	966
6	0	0	0	519	769	484	593	401	501
7	3	12	5	1115	1653	1236	1306	973	1133
8	3	10	5	1214	1670	1150	1165	1065	1134
9	3	9	5	1237	1550	1047	1236	979	1163
10	3	7	5	1214	1797	1173	1256	1057	1086
11	3	6	5	1223	1629	1091	1226	928	1276
12	3	4	5	1285	1669	1098	1206	895	1100
13	3	0	5	1219	1407	935	559	509	445
14	0	0	0	785	770	729	630	495	518
15	3	8	8	1293	1733	1239	1441	1132	1039
16	3	8	6	1156	1735	1187	1318	1040	1138
17	3	8	4	1199	1752	1064	1211	1026	930
18	3	8	3	1115	1518	1102	1249	943	1190
19	3	8	2	1184	1347	1074	1166	856	909
20	3	8	0	590	1018	697	981	576	834

(4) Mr. Einar Jensen, formerly of the Royal Agricultural College, Copenhagen, Denmark, states that in recent years it has become general practice in Denmark to conduct experiments in such a way as to measure the effect of increasing quantities of each fertilizer and thus ascertain the input-output ratios

A preliminary analysis of these data by Dr. Spillman gave the results shown in Tables III, IV and V for varying quantities of each fertilizer ingredient with fixed quantities of the other two ingredients.

TABLE III. YIELD OF TOBACCO PER ACRE WITH VARYING QUANTITIES OF AMMONIA (NH_3) AND 80 LBS. OF PHOSPHORIC ACID (P_2O_5) AND 50 LBS. OF POTASH (K_2O) PER ACRE.

Ammonia (NH_3) per acre	Yield per acre	Increments in yield due to addition of 10 lbs. of ammonia per acre
0	887	—
10	1019	132
20	1111	92
30	1175	64
40	1220	45
50	1251	31
60		

TABLE IV. YIELD PER ACRE OF TOBACCO WITH VARYING QUANTITIES OF PHOSPHORIC ACID (P_2O_5), AND 30 LBS. OF AMMONIA (NH_3) AND 50 LBS. OF POTASH (K_2O) PER ACRE.

Phosphoric acid per acre lbs.	Yield per acre lbs.	Increment due to 10 lbs. of phosphoric acid per acre
0	504	—
10*	—	—
20	—	—
30	—	—
40	1067	—
50	1110	47
60	1143	31
70	1163	20
80	1176	13
90	1185	9
100	1191	6
110	1195	4
120	1197	2

*Yields for 10, 20 and 30 lbs. per acre were not computed by Dr. Spillman.

TABLE V. YIELDS PER ACRE OF TOBACCO WITH VARYING QUANTITIES OF POTASH (K_2O) AND 30 LBS. OF AMMONIA (NH_3) AND 80 LBS. OF PHOSPHORIC ACID (P_2O_5) PER ACRE.

Potash per acre lbs.	Yield per acre lbs.	Increment due to 10 lbs. of potash per acre
0	732	—
10	908	176
20	1021	113
30	1094	73
40	1140	46
50	1170	30
60	1190	20
70	1202	12
80	1210	8

needed for determining the economic limit of application. For methods employed and quantities tested, see Annual Reports on Plant Industry Work of the Federated Danish Farmers' Societies for the different sections of the country—for example, *Beretning om Planteavlssarbejdet i De Samvirkende Jydske Landboforeninger*, Aarhus; *Planteavlssarbejdet i de Samvirkende Fynske Landboforeninger*, Odense; *Landboforeningernes Virksomhed for Planteavlten paa Sjælland*, København 1930, Aug. Bang.

In the complete analysis of these data the yield of tobacco for all combinations of the fertilizer ingredients would be computed. From the results of this complete analysis, a series of tables similar to Table III could be prepared, one showing the yield per acre with varying quantities of ammonia and 80 lbs. of phosphoric acid and 40 lbs. of potash (instead of the 50 lbs. as in Table III), another with 30 lbs. of potash, another with 20 lbs. of potash, and so on; also a series of tables similar to Table IV; and a series similar to Table V.

In a complete analysis, the cumulative effect of continued heavy fertilization year after year would also be taken into account. The difference in yield between a lightly and a heavily fertilized plot after a test has run for several years is due partly to difference in current application and partly to unequal accumulations of plant food elements in the soil. Dr. Spillman recognized this difficulty and suggested ways of planning experiments to overcome it.

Further, a complete analysis would take into account the effect of fertilizer on the quality of the tobacco produced as well as upon the quantity. This involves developing measures or indexes of quality that can be used in arithmetic computations.

Economic analysis.

The data used thus far in the analysis are entirely in terms of quantities of fertilizers and quantity of tobacco. Hence up to this point the work under a project such as this would be entirely in the field of the plant and soil sciences. The final step in the problem of determining the *most economical* rate of use of fertilizer on tobacco will be made by combining the quantities of fertilizer used and the quantities of tobacco of different qualities produced with prices of tobacco, prices of fertilizer and prices of other cost goods used in the production of tobacco.

This can be done in one of several ways:

1. By finding the selling price of the increments of tobacco produced as shown in the last columns of Tables III, IV and V, and by finding the purchase price of additional quantities of fertilizer required to produce the increments, and from this, the points, with different prices of tobacco and fertilizer, beyond which the price paid for the *additional* fertilizer will be greater than the value of the tobacco produced, having due regard for the additional other expenses incurred in producing the additional quantities.⁵

(5) As explained in Project 17, the input factors for which valuations cannot be made, such as family labor, should not be included in the formula for determining highest profit combination, nor in any tables such as those indicated in Project 17. The additional physical product due to increments of such labor should be determined, and the value of this product; but from this point on the analysis should consist of comparing this additional value of product with other additional values of product that might be obtained from other uses of this increment of labor.

2. A series of tables similar to the illustrative table shown in Project 17 of this report could be constructed, all the other input elements entering into tobacco production being taken into account in the computations.⁵ Dr. Spillman in the manuscript referred to at the beginning of this statement gives a method by which he believed the other cost elements could be considered along with the fertilizer, and the most profitable amount of each fertilizer ingredient determined in a given case. His analysis provides for determining not only the fertilizer formula (the proportions of the different ingredients) that will give the largest return per dollar expended for fertilizers for any given amount of plant food, but also the most profitable quantity of fertilizer to use.⁶
3. The data on quantities of fertilizer and tobacco, as in Tables III, IV and V, together with prospective prices for fertilizer and other input factors and the prices of tobacco, can be used, along with similar data pertaining to other enterprises⁷ in the farm organization, as cotton, corn, etc., to determine by the *synthetic* method as described in Projects 8 and 17 the most advantageous methods and practices, as well as the most advantageous combinations of enterprises for the farms of an area.⁷ This assumes, of course, that the results obtained from the experimental plots are fully applicable to the farms of the area under study. Some careful study would usually be required to substantiate this assumption, or to provide the information needed to modify the results obtained from the experiment so that they would be applicable to actual farm conditions.

PROJECT 19. Statistical Determination of Economical Rate of Feeding Dairy Cows.

OBJECTIVE: To determine the effect of variations in the quantity and quality of the ration and on the physical and economic feed costs of milk production. (Joint with Dairy Husbandry.)

(By George A. Pond.)

EDITOR'S NOTE: The project as stated assumes that the dairy enterprise can be abstracted from the farm business as a whole, and that feed inputs can be analyzed separately from other inputs. Such analysis is helpful because feed represents so large a part of the values entering into milk production, and because dairying occupies a dominant position on many farms. In practice, however, it

(6) The method for the case with one variable input factor, all others remaining constant, is discussed in Spillman's *Farm Management*, Chapter 22.

(7) This will require, as explained in Project 17, that data be obtained for the farm business as a whole. The experimental method may provide the physical data needed; but it will not provide the data needed for economic application of the results.

will usually be best to collect data for the farm business as a whole and analyze profit combinations in terms of the effect on the net income of the farm. (See Project 17.) In the Minnesota study to which Professor Pond refers, detailed data were obtained for all the enterprises.

Present feeding standards do not provide allowance for all the variations in the inputs involved in milk production. They permit of allowance for size of cow, for fat test of milk, for quantity of feed input as measured in total digestible nutrients or net energy value, and for quality of ration as measured by digestible protein content; but not for variations in feed input at different levels of production. There are other important variations in the feed input such as source of nutrients (number and kinds of concentrates, dry roughages, succulent roughages and pasture, and their relative importance as sources of nutrients), and the proportion fed on pasture. The time of the year that a cow freshens is also a factor affecting the feed input. It is the purpose of this study to secure the best possible measure of feed input factors and their effect on milk production in order to compute as closely as possible the highest-profit combination of feed factors for any given situation. The other input factors involved in milk production—labor, shelter, sire—are left out of the analysis.

Previous investigations with similar objectives.

Previous studies of a similar nature are reported in Chester County, Pennsylvania,¹ in the Shenandoah Valley of Virginia,² in Illinois,³ in Walworth and Washington Counties, Wisconsin,⁴ and in Pine County, Minnesota.⁵ In these cases, however, the data were collected primarily for other purposes and were used only incidentally for this type of analysis. The data of the studies in Pennsylvania and Virginia as well as much of that in Wisconsin were collected by the survey method. The Illinois study and a portion of the Wisconsin study were based on dairy herd and improvement association records. A portion of the data used in Wisconsin and all of that in Minnesota were collected through supervised accounting projects. Only herd records were available except in the dairy herd improvement association records. Not only is it difficult to secure the required degree of accuracy of individual reports by some of

(1) Ezekiel, Mordecai, *Factors Affecting Farmers' Earnings in Southeastern Pennsylvania*. U. S. D. A. Bulletin 1400, April 1926.

(2) Ezekiel, Mordecai, and Vernon, J. J., *Factors Affecting Returns from the Dairy Enterprise*. Bureau of Agricultural Economics, U. S. D. A. and Virginia Polytechnic Institute, Preliminary Report, May 1, 1926.

(3) Gaines, W. S., and Davidson, F. A., *Relation Between Percentage Fat Content and Yield of Milk*. Illinois Agricultural Experiment Station Bulletin 245, 1923.

(4) Ezekiel, M. J. B., McNall, P. E., and Morrison, F. B., *Practices Responsible for Variations in Physical Requirements and Economic Cost of Milk Production on Wisconsin Dairy Farms*. Wisconsin Research Bulletin 79, August 1927.

(5) Pond, G. A., and Ezekiel, Mordecai, *Factors Affecting the Physical and Economic Cost of Butterfat Production in Pine County, Minnesota*. Minnesota Agricultural Experiment Station Bulletin 270, December 1930.

these types of studies, but it is practically impossible to get sufficiently detailed information regarding some of the factors that merit careful consideration. Although there is a fair degree of correspondence between the results of these various studies, there is some question of the adequacy of the data on which they are based, and they lack the comprehensiveness that should be possible in a study set up for this particular purpose.

Information needed.

This project necessitates the securing of the records covering at least 500 dairy cows for one year. It would be highly desirable to have at least double this number. This statement assumes that the 500 or 1000 cows are made up by taking whole herds. With 15 cows on the average per herd, this would mean from 33 to 66 herds. If only a few cows were taken from each herd, and these by random methods, fewer individual cow records would be needed, say for 300 cows from 100 different herds. The sampling theory which is involved in this is that all the cows in one herd are subject to many common conditions—particularly, they are under the same management. In consequence, a small number of cases, say 100, from a few herds does not afford anything like a normal frequency distribution for conditions like management. The results in such a case would not be sufficiently applicable outside these few herds. In spite of the need for getting a reasonably representative frequency distribution of such conditions, however, it is not wise to attempt to include herds handled under widely different systems of dairy management, unless one wants to make the project large enough to get a sample of each and compare the results. Neither should too widely different systems of pasture management or types of pasture be included, because of difficulties of measuring the feed value of pastures, and because of the great danger that pasture variations will be intercorrelated with other factors. It will have to be recognized that these limitations restrict the application of the results to systems of management and types of pastures similar to those included in the study.

Records covering an experiment station herd, even though they might be highly accurate, would hardly be satisfactory for this study. Most experiment station herds are too small. Furthermore, they are not usually kept under representative conditions, and in many cases, most if not all of the herd is already being used in other experimental work.

It is highly desirable that records be secured for individual cows. If only herd records could be obtained, at least 100 herd records should be secured, but these would not lend themselves to the type of analysis as satisfactorily as individual cow records. It would be well to include in the study representatives of different dairy breeds in order to get a satisfactory range in both weight of cow and fat content of milk. The records might be taken all in one year, but there are advantages in taking them over a period of at least three

years in order to get a fairer sample of pasture conditions. But this will increase somewhat the number of records needed, since it will increase the deviation. If the records are for one year only, the results will not be sufficiently applicable in other years when pasture conditions are different. An average of three years comes much nearer to giving results that are generally applicable in this or any similar area.

The records should include a report of—

1. The quantity of each kind of feed received by each cow during the 12 months.
2. The amount of time on pasture.
3. Some measure of the quality of the pasture.
4. The proportion of concentrates, dry roughage and succulent roughage received while on pasture.
5. The age, weight, lactation period, and breed.
6. The date of freshening.
7. The production in terms of milk and butterfat for each cow.

It is desirable to have an accurate weight of each individual cow in order to eliminate those showing a wide variation during the year. Since stock scales are not available on most dairy farms, it is probable that a careful estimate would have to suffice.

All feed records should be carefully checked with records of purchases, sales, inventories and yields as well as of quantities of feed used for other stock on the same farm in order to secure sufficient accuracy. Because of the amount of detailed record involved, it would probably be necessary to make this a special study. There would be some advantage in using the records of a detailed route study covering all livestock on the farm in order to secure a more accurate feed check. The records of dairy herd improvement associations might be used if a special check was made to insure accuracy in the feed reports.

This study should be made in a locality in which dairying is an important enterprise and in which the system of dairy management as well as physical conditions affecting production are representative of an important type of dairy farming.

Analysis of data.

The first step in the analysis is a multiple correlation study of the physical factors. Enough work has already been done with this problem so that the correlation procedure, including the statement of the variables, is known in advance. With milk production per cow per year as the dependent variable, it is possible to study the effect of each independent variable as—

1. Total digestible nutrients per cow annually in addition to pasture.
2. Nutritive ratio.
3. Percentage of protein from "good" sources.

4. Proportion of total digestible nutrients fed during the pasture season.
5. Percentage of digestible nutrients from succulent roughage.
6. Age of cows.
7. Weight of cows.
8. Dates of freshening.
9. Percentage of butterfat in the milk.

If there is considerable variation in the quality of management, this may also be included as an independent variable, provided it is found possible to obtain a quantitative measure. (See Minnesota Agricultural Experiment Station Bulletin 270.) Curvilinear regressions should be determined for those independent factors showing significant relationships with milk production. Factors showing little or no significant relation to the dependent variable may be discarded. The importance of each of the factors retained for consideration should be studied with respect to the proportion of variance in milk production apparently associated with it and with respect to the reliability of the slope of the regression line from the linear solution. The "part correlation" between each factor and milk production should also be computed. A "net regression equation" or a series of net regression curves can then be set up to show the approximate milk production per cow per year that will result from any given combination of the factors considered, under the conditions included in the study.

The second step is an analysis of the economic returns from the various combinations of feed factors with different prices assigned to these factors, assuming that all of these feeds have market values. Problems such as these may be worked out:

1. The relative economy of ratios with high- and low-protein content at different price levels for these feeds.
2. The value of succulent roughages as a source of nutrients.
3. The relative advantage or disadvantage of fall freshening.
4. The relative economy of cows producing milk with a low fat content as compared with those producing high-test milk at different price levels for the product.
5. The advantage or disadvantage of supplementary feeding during the pasture season.
6. The economic balance between concentrates and roughages as sources of nutrients at different price levels.
7. The highest-profit combination of feed input factors for any given set of conditions.

A further discussion of both the statistical technique and the economic analysis may be found in Minnesota Agricultural Experiment Station Bulletin 270 and in Wisconsin Research Bulletin 79, above cited.

Application of results.

The results of such studies as outlined can be applied safely only to dairy herds maintained under conditions prevailing in the area studied or similar thereto. Such studies as this need to be conducted in different areas to determine the uniformity of the relations disclosed and their general applicability. Only after a good many are made will we have a basis for determining how much variation in the results is introduced by the varying conditions in different areas. These results should serve as a valuable supplement to established feeding standards for the dairyman attempting to secure the most effective set-up for his dairy organization and to keep it adjusted to changing price conditions. They will reveal the variations from the experimentally determined results (represented by the feeding standards) that are needed to fit them to the actual conditions on dairy farms, and the variations in these from area to area.

PROJECT 20. Relative Economy of Different Farm Practices.

OBJECTIVE: To determine the relative economy of different methods of production and practices. (General statement.)

(By J. D. Pope.)

EDITOR'S NOTE: Five project statements, 20, 20A, 20B, 20C and 20D, dealing with the studies of the economy of different methods of production, farm practices and the like, are presented following. *Economy* is to be interpreted here as including savings in costs in the first instance, but also increases in net income, since management must be economized, by getting good use of it, as well as the other factors. Projects of this nature, however, are commonly looked upon as projects in cost analysis, designed to reduce costs. Project 20 is a statement applicable in a general way to all projects of this type. The four projects immediately following present in more detail methods of studying the economy of specific methods or practices. These four projects do not by any means cover the entire scope of studies of this kind. Research of this type may include such problems as harvesting grain with the combine as compared with other methods, the use of horses for power as compared to tractors and trucks, the use of multiple-row tillage machinery as compared with smaller machines, the use of hand tillage methods as compared with machinery methods, the use of the milking machines as compared with hand milking, and two or three cultivations of cotton as compared to four or five cultivations.

Objectives.

Such studies are designed:

- A. To determine the most profitable methods and procedures in conducting farm operations where the opportunity exists for making a change from present methods and practices.
- B. To determine the relation of the practices studied to the business organization and income of the farm as a whole.

In all of these problems, the farm operator must form a judgment with respect to a modification of his present practices. These studies seek to provide the farmer with a sound economic basis for arriving at a decision in the matter; and extension agencies with the facts

and analysis needed to enable them to help the farmer in making his decisions.

Collection of data.

The usual types of data which will be needed in making a study of this type are:

I. Background data.

A thorough understanding of the problem and its setting is needed. This will consist in determining:

- a. The conditions which have led to the adoption of the practice and which are associated with its use, including the physical and economic conditions surrounding it, the labor supply, the physical conditions of soil and surface, and climate, and the price elements, which have led to the introduction of the practice.
- b. The trend in the practice—the history and evolution of the practice and the rate of growth in its use over a period of several years.
- c. The distribution of the practice—the conditions under which the practice is followed and the number and proportion of farmers employing it in different areas and localities.

Among the sources of information for the background data for the problem may be mentioned federal and state censuses, crop and livestock reports, special economic and natural science data collected by departments of state colleges and bureaus of the United States Department of Agriculture, farm machinery dealers and farmers. Some of these preliminary data may be collected through mailed questionnaires. In some cases a preliminary field survey may be advisable. (This point is discussed in Project 5 of this report.) In other cases data collected through records may prove of considerable value.

II. Detailed data on practices.

- a. *Technique of the practice*, in much detail ordinarily, supported by facts as to the enterprises and operations in connection with which the practice is used, the man, horse and machine hours per acre or other units for each operation, and adequate description of the types and models of machines with accessory equipment.
- b. *Comparison with alternative practices*—which will require data on the labor and material inputs and outputs in physical terms for the different practices. In a cost analysis, costs should be expressed in physical terms wherever possible. Costs which will not be affected by a change in the practice being studied need not be considered. Also costs that must be met currently (so-called cash or out-of-pocket

costs) should be analysed separately from deferrable expenditures (e.g. depreciation of equipment).

- c. *Relation to farm organization*—which will require adequate data on the different types of farm organization in relation to different practices—such data for each organization as size of farm, relation between enterprises, and relation to labor supply.
- d. *Special problems involved.* In many studies of this type, problems such as the effect of the practice on the quality of products, the effect of rate of production upon wastes involved will arise. Perhaps in some cases a pertinent problem will be that of financing the investment involved in the change of practice. (For a discussion of the relation between the purchase of a tractor or farm truck and credit needs, see Project 25 in the report on research relating to Agricultural Credit.)

Most of the data needed from farmers for this type of project will be obtained by the survey method. The schedule will cover in much detail the practices being studied, and enough general data for the farm as a whole to enable one to test out the effect of the alternative practices on the net income. While the optimum number of schedules will vary with the problem and the uniformity of the data, probably from one hundred to five hundred will be needed for most studies of this type. A smaller number of records might be sufficient in a study in a limited universe with homogeneous conditions. The mailed questionnaire has a very limited use in farm practice studies. It may occasionally be helpful in obtaining a larger background for the problem. Daily records of farm operations kept by farmers will, where available, be useful.

Analysis of data.

The quantitative statements of the physical and financial factors will need to be combined into summaries, frequency distributions and averages of the amounts and kinds of various materials and factors entering into production. In this form, the data can be used in making comparisons of the inputs and cost rates and rates of production between alternative practices to determine the potential economies in labor, materials and other input factors that would be effected by changes under consideration. The special problems involved in the proposed change in practice, such as the effect on the quality of the product and the effect of weather conditions on the efficiency of the practice, should be given careful consideration. The analysis of the relation to farm organization will involve a determination of such relationships as the optimum size of farm favoring the efficient use of the practice; the most economical crop acreage or size of enterprise, or the shifts in enterprises, needed to obtain economical use, and the effects of the adoption of the practice under consideration on human and horse labor requirements, on the capital

and credit needs of the farm, and on other phases in the business organization of the farm. A basis for recommendations as to the change in practice can be reached only after giving a thorough consideration to the various factors involved. Obviously it is not enough merely to measure the technical and physical requirements and accomplishments of a given practice. The workability of the practice under various conditions, the expense involved in adopting the new practice, and the effect on the farm income, are determining factors.

Cooperation.

Studies of farm practices usually may be made more fruitful by cooperation with various agencies which are interested in the problem, including not only the Bureau of Agricultural Economics, but such other federal bureaus as the Bureau of Agricultural Engineering, Bureau of Plant Industry and Bureau of Animal Industry; and likewise state college departments in such fields as engineering, agronomy, soils, and animal husbandry.

Utilization of results.

One of the principal ways in which the product of these studies will be put to use is by farmers themselves in deciding whether or not to change from present practices. Extension agencies can plan educational programs that will assist individual farmers in making such decisions. These will provide some of the detailed data needed in making farm plans and budgets in the manner outlined in Projects 8, 9, 10 and 11 in this report. Research agencies can test out the relative economy of the various practices under the more usual sets of conditions found on farms in their areas, and the extension agencies can adapt these conclusions to different localities, and instruct county agents in helping farmers to adapt them to their special circumstances.

Studies of this type in many cases will doubtless suggest new problems of farm organization in the region and provide a basis and background for further economic studies. They may also frequently suggest special technical problems for study by specialists in fields other than economics.

PROJECT 20A. To Determine the Economy of Using Tractors in a Specified Type-of-Farming Area. (Joint with Agricultural Engineering.)¹

(By H. R. Tolley.)

It is assumed that this project will be confined to a single type-of-farming area. Or, if it covers an entire state or several states, that each type-of-farming area will be considered to be a "universe," and the collection and analysis of data planned accordingly.

(1) See Project 20 for general discussion of this type of project.

Some of the specific objectives should be:

1. To determine the types or systems of farming in the area on which it would not be economical to use a tractor and on which power can be supplied most economically by horses.
2. To determine the types or systems of farming on which power would be furnished most economically by a tractor in conjunction with horses.
3. To determine the types or systems of farming on which power would be furnished most economically by two tractors, e.g., a general-purpose tractor in conjunction with a heavy tractor and horses.
4. To determine the types or systems of farming on which power would be furnished most economically by tractors only (without horses).

The above objectives can be stated concisely: To determine the most economical sources of power for the different types or systems of farming in a type-of-farming area.

Since size of farm has such an important bearing on the economy of the tractor as a source of power, the farms of each type in the area should probably be classified by size, and the economy of the use of the tractor on farms of various sizes in each type-group studied. In some type-of-farming areas, there may be so little variation in farm types within the area that grouping by size would be more important than grouping by combination of enterprises. In such an area the objective might well be stated: To determine the most economical sources of power for farms of different sizes in a type-of-farming area.

It might be that a preliminary investigation would show that clearly on certain types of farms in the area—for instance, 20- and 40-acre “general” farms—a tractor could not be used economically. In that case the small farms would not be included in the project.

Since the cost of a tractor, the prices of horses and the prices of fuel for the tractor and feed for the horses have a direct bearing on the relative economy of tractors and horses, this point might well be recognized in the statement of objectives in order that those who are to do the research would be informed that this point is to be investigated. The prices of the product are also involved, the advantage of a tractor usually increasing as the prices of products increase. The wages paid for hired labor also have a bearing on the problem. This point also might well be recognized in the statement of objectives.

In view of these two points, the objective could be stated: To determine the most economical sources of power for farms of specified types and sizes (or for specified systems of farming) with varying prices for the products and varying prices for tractors, horses, fuel, feed and labor.

The stated objectives of many of the studies of the new machines or sources of power which have been carried on by the state experiment stations and the United States Department of Agriculture have been: To obtain and make available information that will enable farmers in the area to decide whether the new machine will be economical. (See statement of objectives for Project 20C.) This is a somewhat more restricted objective than those stated above and has usually led to a somewhat narrower study than would be necessary to reach the broader objective of determining the most economical sources of power on farms of different types under varying price conditions.

In these narrower studies the assumption has been that the farmers in the area already have a knowledge of the use of the machines and sources of power in common use in the area, and that if they (the farmers) can be supplied with reliable information on the output of the new machines and sources of power in different operations and under different conditions, the inputs of labor, etc., used by them, the life and depreciation of the new machine, and similar information, each farmer will then be in position to reach a correct decision as to whether the purchase and use of the machine in question would result in an increased income from his farm.

The information obtained in these narrower studies is only a small part of the information that the investigator would need to reach the broader objectives stated in this project. A much more thorough type of analysis is needed also. If the objective is simply to make available information on the new machine, the analysis need proceed no further than determining input-output ratios in the different operations for which the machine is adapted, and similar information pertaining to the machine itself. This phase of research is largely in the field of engineering, and in such a limited study agricultural engineers would have a leading part. All of the information obtained and analysis made in such a limited study is essential to the broader study. Hence agricultural engineers have an important part in any broad study of this character.

Data and analysis needed.

For a complete analysis, to reach the broader objectives, a considerable range of data in addition to those pertaining specifically to the tractor would be needed. The analysis would be along the lines discussed in Projects 8, 9, etc., and all the kinds of data needed there would be needed in this project.

For the various types of farm (or systems of farming) or sizes of farms in the area, data should be obtained that would make it possible to construct budgets showing the returns of the farm business to be expected with the various combinations of power suggested in the statement of objectives above. The analysis should include the determination of returns to be expected with varying prices of products and of input factors, as outlined in Project 9.

Some of the principal lines of data needed in the analysis are:

1. The rate of doing work per day or per hour for the different operations for which the tractor is or can be used. This will include the rate with horses (possibly in teams and with implements of various sizes), and the rate with tractors of different types and sizes.
2. The amount of fuel and oil used per day or per hour by the tractor in various operations.
3. The feed used by horses—kinds and quantities both under conditions where all of the work is done with horses and under conditions where varying proportions of the work are done with tractors.
4. The quantities of man-labor used in the various operations when the different forms of power (horses, general-purpose tractor and heavy tractor) are employed.
5. The rate of depreciation and the expense for repairs and upkeep of the tractors; the rate of depreciation of horses and the expenses connected with their maintenance.
6. A calendar of farm operations for each type and size of farm in sufficient detail to enable the investigator to determine the number of horses and number of men that would be needed to do the farm work at various times of the year with the various sources of power.

Practically all of these data are physical data, e.g., hours, acres, gallons, bushels. They can be obtained in a number of ways—some from farmers who are using tractors, some from farmers who are using horses exclusively, etc. It may not be possible to obtain some of the data from farmers in the area. For example, it might be desired to study the economy of general-purpose tractors in an area where they have not come into use. In such a case the investigator would have to obtain the needed information from tractor users in other areas, or from the results of experiments as suggested in Project 15. Such data will of course need careful scrutiny and possibly some revision in order to make them applicable to the conditions on the farms in the area being studied. For example, the quantity of fuel used by a tractor is influenced by soil and topography, and the investigator should carefully appraise data from other areas to be sure that soil and topography are comparable with that in the area under study.

As another example, there is considerable variation between different types and makes of tractors in efficiency in use of fuel; and if experimental data are to be used, the investigator should examine the experimental data to determine if they are applicable to the types and makes of tractors that are being used or are likely to be used in the area under study. In fact, there may be such great variations in the efficiency of the different types and makes of tractors in the use of fuel and oil, in the rate of doing work, in the price and in

other items, that under some conditions a tractor of one type or make can be used economically whereas one of some other type or make would not be economical.

The efficiency of a tractor may be influenced considerably by the size and shape of the fields on the farm. In areas where many fields are small or of irregular shape, or where there may be opportunities for rearrangement of fields in such a way as to increase the rate of work of the tractor, attention might well be given in the study to field arrangement as discussed in Project 24 in this report.

The adaptability of the tractor to different farm operations must be studied, especially in projects designed to determine the economy of operating farms with tractors exclusively. Operations which seem quite simple and commonplace when horses are used for power, such as seeding winter wheat in standing corn, cultivating the garden or the vegetable patch, may be quite difficult to do at all or may require the purchase or construction of special hitches and implements if a tractor is used. The study of possibilities of using a tractor on different operations will logically fall to the engineers, while the study designed to determine whether it would be economical to exclude from the farm organization the enterprises which call for work that cannot be done readily with the tractor, will logically fall to the economist.

Information as to the reliability of the tractor as indicated by the amount of time lost from breakdowns or mechanical difficulties should be obtained if preliminary investigation shows that this is an important item for the types and makes of tractors being considered. Loss of time is often correlated with the skill and ability of the operator, and the collection of information on this point should be thorough enough to enable the investigator to determine, at least approximately, to what extent mechanical difficulties are due to lack of skill of the operator. Many improvements have been made in the design and construction of most tractors in recent years, and this point is not likely to be so important in future studies as it was in earlier studies.

Reliable information on the rate of depreciation of tractors will probably be very difficult to obtain. This is especially true for types of tractors which have been in use only a few years. The usual practice in projects where this item of information is essential has been to obtain the answers of tractor users to a question such as: "What in your opinion will be the life of your tractor?" or "How many years of service do you expect your tractor to give?" Answers to such questions are at best rather vague and unsatisfactory and do not furnish a very reliable base for determining the rate of depreciation. Yet depreciation is one of the most important items in determining the economy of using tractors. It seems probable that some experimental research involving the operation of tractors under controlled or semi-controlled conditions for considerable periods of

time, and the appraisal by engineers of the wear and tear on the machines due to use in different kinds of work, would afford a more reliable basis than do the opinions of farmer-users for estimating the rate of depreciation.

The information needed on prices of products and prices of input factors involves forecasting the trend of prices or the average level of prices of each product and each input factor. Of course if the study is confined entirely to determining the most economical sources of power under certain specified price conditions, it will not be necessary to use forecasted prices; but as pointed out in the discussion of Project 9, it will involve the preparation and presentation of a long series of comparative tables based on a wide range of possible prices of products and input factors.

The following table illustrates for a very simple case—wheat farming in an area in Western Kansas—the type of analysis involved in this part of the project. The table is based on data contained in a paper by Dr. C. L. Holmes of the Division of Farm Management and Costs, *Farm Production Costs as Affected by Mechanical Farm Equipment* (Mimeographed publication of the Bureau of Agricultural Economics, 1931).

RETURNS TO OPERATORS ON TYPICAL HORSE-POWER FARMS
AND TRACTOR-POWER FARMS IN AN AREA IN KANSAS AT
VARIOUS PRICES FOR WHEAT

	Horse farms	Tractor farms
Acres in crops	280	640
Acres in wheat	200	500
Operator's share of wheat crop	1450 bushels	3625 bushels
Power unit	10 horses	20-h.p. tractor
Hours of labor hired in the year.....	356	140
Cash outlay:		
Hired labor at 30c per hour.....	\$ 107	\$ 42
Machinery and power.....	350	1650
Threshing	198	—
Total	655	1692
Wheat at 40c per bushel:		
Value of operator's share of crop....	\$ 580	\$1450
Less cash outlay.....	655	1692
Returns to operator's labor and capital.	—75	—242
Wheat at 70c per bushel:		
Value of operator's share of crop....	\$1015	\$2538
Less cash outlay.....	655	1692
Returns to operator's labor and capital.	360	846
Wheat at \$1.00 per bushel:		
Value of operator's share of crop....	\$1450	\$3625
Less cash outlay.....	655	1692
Returns to operator's labor and capital	795	1933

The example applies to 280-acre farms with 200 acres in wheat operated entirely with horses and to 640-acre farms with 500 acres in wheat operated with tractors entirely. On the horse farms, har-

vesting is done with binders or headers and custom threshers. On the tractor farms it is done with combined harvesters. Both the horse farms and tractor farms are rented farms. The normal yield of wheat in both classes of farms is 12 bushels per acre, rent is one-third of the crop—4 bushels per acre—and three-fourths of a bushel per acre is deducted for seed, leaving seven and one-fourth bushels for sale. All the feed for the horses is produced on the horse farms, and hence no expense is involved. These farms are typical with respect to size, cropping system, power units, and tenure of a considerable number of farms in the area. The table shows (1) the number of hours of hired labor needed in a year of average yields on these farms, (2) the expense for the hired labor at 30 cents per hour, (3) the cash outlay for the year for power and machinery including fuel and oil for the tractors and combines and a calculated allowance for depreciation,¹ and (4) the returns to the operator's labor and capital (the difference between the value of the operator's share of the crop and his cash outlay) with wheat at 40 cents, 70 cents and \$1.00 per bushel.

The table shows not only the type of analysis to be followed but also illustrates how the advantage of the tractor increases as the price of the product increases. With wheat at 40 cents per bushel, the value of the operator's share of the crop on the horse farms is enough to cover the cash outlay, while on the tractor farms there is a marked deficit. With wheat at \$1.00 a bushel, the returns to the operator's labor and capital are nearly \$2000 on the tractor farms, but only about \$800 on the horse farms.

A complete analysis would involve computations similar to the above for farms of the various sizes found in the area, with various combinations of enterprises—some producing crops for sale in addition to wheat as well as livestock products. The expenses would have to be computed for each size and type of farm when operated with horses exclusively, with a combination of horses and tractors, and with tractors exclusively. Computations would be made for various sizes and types of tractors; also for various prices for hired labor and fuel, and various allowances for depreciation. A number of additional items would enter into the calculations for farms operated by their owners.

(1) While strictly speaking, the allowance for depreciation is not a cash outlay during the year, it must be included if the object of the computation is—as in this case—to show the returns for the farmer's resources.

PROJECT 20B. To Determine the Relative Economy of Harvesting Small Grain with a Combined Harvester-thresher and a Binder, or Header and Stationary Thresher. (Joint with Agronomy and Agricultural Engineering.)

(By R. S. Kifer.)

A study of this type would usually be directed toward, first, determining the practicability of the new unaccepted method of harvesting with the combined harvester-thresher in the particular area and for the crops under consideration, and second, determining the conditions under which the economic advantage of the new method is sufficient to justify the replacement of the established method by the new one.

The study should give to farmers in an area basic information as to (1) the rate of harvesting by each method, (2) the quantity of man-labor, fuel and other input factors required, (3) first cost and upkeep of machines, (4) the effect of the method of harvest on the quality of grain, (5) the effect of a change in harvest methods on the following crop or on the operation of the farm.

From these basic data and a knowledge of the acreage to be cut, the kind of crop, and alternative uses of his labor, the operator should be able to judge the relative economy of harvesting by various methods, and to anticipate the adjustments in farm organization which would follow from the adoption of a new method.

Collection of data.

Records of the performance of the combine and of the binder or header and stationary thresher should be obtained from farmers in localities in which both methods of harvest are feasible and during a harvest season normal to the locality. The records obtained from farmers should report (1) the size and type of machine, (2) the number of men in the crew, (3) the rate of operation per day, (4) the number of days of harvest, (5) the time lost and causes of delays in harvest, (6) the power used, (7) quantity and cost of fuel and oil, and (8) repairs on the machine.

The record should include the acreage and variety of each crop harvested, the yield, and the manner of disposing of the crop. A statement of labor and equipment hired and wage rates is an essential part of the record.

Data as to the normal repairs and as to the reasonable charge for replacement of the combined harvester-thresher are difficult to obtain in a region where the machine is not in general use and where the durability of the machine has not been proved through experience. Also in a case of this kind some allowance for difficulties due to inexperienced operators must usually be considered.

Daily records kept by the farmers showing the hours in the field, the size of crew, fuel used, acres cut, and the bushels threshed will,

if well kept, furnish data more accurate than can be expected from the survey method; but as a rule these records are difficult to obtain.

A check on the performances of the combined-harvesters can best be obtained through cooperation with agricultural engineers. Records of the effectiveness of threshing with certain adjustments may be made from observation, but information regarding the adjustments that will give best results under specified conditions of moisture and ripeness of the grain can be best obtained through controlled experiment.

The effect on the quality of the product of harvesting by different methods under particular conditions can be obtained through cooperation with marketing and production specialists. Records of the moisture content of grain at different stages of ripeness, and with varying degrees of humidity, and the effect of this moisture content on the keeping quality or marketability of grain, may be obtained from samples taken under observed conditions, and sent in to the laboratory for analysis.

Since the later cutting with the combine involves some risk of grain loss from weather not incurred by binding and shocking grain, some measure of this added risk should be considered. The weather records of the season or seasons in which the observations are taken should be compared with records of other seasons to test the variation from the usual with respect to total rainfall, distribution of rainfall, and degree of humidity. If the season is distinctly abnormal, no definite conclusions may be drawn.

The length of the season in which grain can be safely harvested depends somewhat on the weather and on the variety of the grain. Varieties adapted to a locality and which stand up best for combining should be studied through cooperation with the agronomist.

Records should be obtained on unusual methods of handling either machine, or on methods employed to meet unusual conditions. The records should include a description of the methods and the additional cost of harvesting by these methods. For example, windrowing unevenly ripened grain or weedy grain may give the combine an advantage over harvesting standing grain, or the added cost may detract from the advantage of cheapened harvest as compared to the binder. The use of the combine in lodged or in weedy grain, the advantage of scattering straw or the added inconvenience of saving it under certain conditions may be significant.

Records of the amount of custom work done, the rates obtained, and the acres of other crops that can be cut with the combine are a necessary part of the study.

Analysis.

The analysis of the data should be in sufficient detail to provide basic information as to the merits of alternative harvesting methods. The information needed is:

1. Acres cut per day by each machine.
2. Size of tractor, number of horses, and number of men in the crew.
3. Quantity of fuel and oil used per day or per acre.
4. Influence of variations in yield on acre costs.
5. First cost of machines.
6. Rates of depreciation and average repairs.
7. Rate for threshing with stationary thresher, and custom combining.

From these can be computed at prevailing cost rates the comparable charges for harvesting and threshing for different methods. To supplement the charges for harvest and threshing, information should be given on—

8. Loss of grain by the different methods.
9. Effect of method on quality of the grain.
10. Dates of completion of harvest.
11. Added risk from standing grain.
12. The effect on the value of the straw.

With this information the individual farmer can develop for his own situation the approximate cash outlay, the amount of unpaid labor and the value of permanent investment used in harvesting different acreages by the alternative methods, and with the associated influences be able to judge the advantages of harvesting by the different methods.

The summary should indicate the changes in typical farm organizations necessary to make the best use of the harvest equipment. In this way the study, although directed to comparative costs, would include the information essential to obtain some measure of the relation of each method of harvest to the farm organization and to the other farm enterprises.

The analysis of cost proceeds from the different effects which cash costs (for instance, extra hired labor) and non-cash costs (as regular labor on the farm) have on the choice between two different harvesting methods. A further classification into fixed costs (those resulting from the investment in the machine) and the variable costs (those entirely proportional to the acreage cut) will aid in estimating the significant cost of harvesting a given number of acres. A large part of the costs of using the combine is the charge for depreciation which is not likely to be in direct proportion to the acres cut. Owner's estimates of depreciation and normal repairs as well on machines which are relatively new are, at best, only guesses not based on the experience of the operators. Furthermore, in attempting to draw conclusions from the data, one must remember that a flat annual charge for depreciation accentuates the economy of harvesting large

acreages, whereas a flat charge per acre for depreciation would minimize the advantage of full use of the machine.

A second classification which will be useful to the farmer in making his choice, is that separating the cash from the non-cash items. On a farm with relatively small acreage of grain, the binder permitting the operator to cut the small crop early, to use his own labor, and the power of horses, and to thresh possibly with exchanged labor, would probably be preferred to a combine with higher cash outlay, although with distinctly less total hours of labor per unit of product as ordinarily computed. With some crops a difference in the quantity of seed lost by one method would be sufficient to balance even a higher harvesting cost. In harvesting grass seed, soy beans, and similar crops, the extra product saved may be the deciding factor in a choice between two methods.

The value of cost figures as a basis for choice between methods of harvesting is limited by the usual shortcomings of the cost analysis. The annual cost of the machine is strongly influenced by the assumed rate of depreciation, and the operating cost is influenced by the rate applied to hours of man-labor or horse-work. Only in the infrequent cases in which these are hired would the charge to the operator be definitely known; otherwise the applied rate would be only arbitrary and contain a certain margin of error. Interest, often included as an element of cost, must be applied not only at an arbitrary rate, but also to an estimated valuation incapable of being tested. The annual charge for depreciation of a machine is either an estimate based on expected life of the machine or an estimate made year by year of the decrease in value. The going rate for hired labor usually applied to unpaid labor may or may not represent the use value of the time in question. The charge for horse-work per hour is determined jointly with the charge for horse-work on other enterprises from feed grown on the farm, shelter, and labor to which arbitrary rates are applied; and a charge so determined may not be comparable to the use cost of a tractor based on known fuel and oil consumption, estimated depreciation, and repairs shared jointly with other activity. Any composite unit cost figure therefore represents a sum of known items plus a sum of estimated and apportioned items not all of which operate in an equal way to determine choice between methods. Operators are in nearly all cases more sensitive to cash than to non-cash costs, particularly in those periods when the margin is narrowed between selling price of grain and the immediate costs of operation.

In the final analysis, the economy of a machine is determined by the effect which its use has on the net income of the farmer. The cost to be charged is the added farm expense due to the use of the machine, and the credits are the saving in expense or additions to the farm income. The accompanying table adapted from Table 19 of Indiana Experiment Station Bulletin 349 illustrates this type of analysis:

**DIFFERENCES IN THE FARM INCOME RESULTING FROM THE
SUBSTITUTION OF THE COMBINE FOR THE BINDER AND
THRESHER ON A 360-ACRE LIVESTOCK FARM. (59
ACRES OF WHEAT AND 71 ACRES OF OATS.)**

Savings	Increased costs
Labor (hired)	Picking up straw, 30 tons.....\$ 60
One man shocking.....\$ 30	Increased depreciation and re-
One man threshing..... 54	pairs, \$167—\$30 137
Board 35	Increased taxes 12
Twine for 130 acres..... 40	Increased shelter 7
Threshing bill 182	Increased fuel, oil and grease .. 36
Grain saved: wheat 33 bu. 33	Increased depreciation, tractor.. 30
Horse feed saved..... 20	Increased grain loss (oats 57 bu.) 20
Total\$394	Total\$302

Net cash advantage of combine, \$92

Other advantages	Other disadvantages
Convenience to housewife	Possibility of damp grain from weedy fields
Operator and men have two weeks more to devote to other work	Difficulty of cutting because of weeds
Opportunity to increase income by doing custom work	Risk of leaving grain standing
Easier work	Heavier investment

There is in this analysis a question as to the inclusion of interest as a cost, and of deducting depreciation on the binder from the depreciation charged to the combine. Expected repairs on the binder should, of course, be deducted; but unless the binder was disposed of at the farm value, the farm would still have to bear the charge through obsolescence. The table does show an admirable method of balancing advantages and disadvantages of a new machine on a particular farm, provided the quantities of the cost factors and the cost rates used in the computation are the quantities and rates prevailing on that particular farm. Similar analyses for each of the farm types (systems of farming) prevailing in the area (See Project 2 of this report) will give the research worker the basis needed for reaching a conclusion concerning the conditions under which each method being considered would be the most advantageous.

In practice, such analysis must also provide for variations in cost rates and prices, after the manner outlined in Project 20A.

Summary of similar research.

Studies of the relative economy of different methods of harvesting have been completed in nearly all of the major wheat-producing areas. Reports of surveys in the Great Plains region are contained in United States Department of Agriculture Technical Bulletin 70, Oklahoma Experiment Station Bulletin 162, Montana Experiment Station Bulletin 230, Texas Experiment Station Bulletin 373. Reports of studies under conditions directly competitive with binders are United States Department of Agriculture Technical Bulletin 224, United States Farmers' Bulletin 1565, Minnesota Bulletin 256,

Missouri Bulletin 286, and Indiana Bulletin 349. These bulletins discuss use of adjustments in combines, uses on crops other than small grain, and particularly in North Dakota Bulletin 225 the relation of combine harvesting to weather loss and deterioration of grain. A comparison of methods of harvesting grain sorghum is made in United States Department of Agriculture Technical Bulletin 121. Kansas Circular 142 is a study to show the acreages of crops to which a combine is suited, and the adjustments in farm organization likely to be profitable following the adoption of the combine and other power machinery on the farm. The methods of analysis suggested in this discussion differ in certain particulars, especially in the matter of handling costs, from those used in some of these published reports. Progress in methods is evident in research of this type as well as elsewhere.

PROJECT 20C. To determine the Relative Economy of Different Methods of Husking Corn in the Field.

(By Kenneth H. Myers and H. C. M. Case.)

The purpose of this project is to secure and analyze data on the different methods of husking corn in the field, and to present the results in such a way that the individual farm operator may determine the most economical method of husking under the particular circumstances on his farm. This will involve:

1. An analysis of the elements of costs involved in husking by hand, with a one-row mechanical husker and with a two-row husker, and of the relative economy of these three methods as reflected in farm incomes.
2. An analysis of the relative importance of these cost elements in relation to their supply on the farm, and the bearing of this on incomes.
3. A study of the various factors affecting¹ the costs of husking by the different methods, such as the size of farm, the acreage of corn and other crops, the average yields of corn, the kinds and numbers of livestock, the types of power available, supply of regular labor, etc.

Value and uses of project.

The acreage and value of corn in the United States indicates the relative importance of the crop. The high percentage of the crop which is husked in the field, especially in the most important corn-growing regions, indicates the importance of this method of harvesting in the farm labor program. Mechanical corn huskers have been used for 25 years in the United States. Improvements in the husker, development of the power-take-off attachment, and the high rates

(1) See Project 20 for a general discussion of this type of project; also compare this project with 20A.

of pay for hired labor for husking, have caused a great increase in their use since 1925. The two-row huskers were first used in 1928.

The most satisfactory approach to the problem is to estimate the net effect of the method now in use on the annual farm income and then add to or subtract from it an appraisal of alternative uses for labor, capital, and power. Final decision may be based on the operator's appraisal of the value of the easier work or more leisure time. Some knowledge of the operating capacity of machines under average conditions, of the quantities of labor, power, and materials which may be required, and of the factors affecting machine capacity and cost, are important to the farm operator if he is to select the method best fitted to his conditions.

Scope of project.

This project is limited to areas where corn is an important crop if data on a sufficiently large number of machines are to be secured. It is believed, however, that the data will be equally applicable to other areas if important factors such as climatic conditions and yield of corn are considered.

Records should be secured on the operation of enough machines to give a reliable average or frequency distribution of the quantities of labor, power and materials used and to make cross-classification of the records possible in studying the factors affecting those quantities, and to show variations in performance under different conditions. The records should cover more than one year if possible, to show the effect of differences in climatic conditions.

It is the purpose of this project to present and analyze the factors which are important in determining what method of husking corn in the field is most economical. The question of whether the corn should be husked in the field, cut for fodder or silage, or hogged off is not considered, since many questions pertaining to cropping systems and livestock production and feeding methods would be of greater importance than the cost of the harvesting operation. The acreage of corn which can be harvested per unit of labor by different methods may be calculated from data secured in this study. The relation between the kind and numbers of livestock and methods of harvesting corn is often an important factor.

Since the costs of husking corn depend to a certain extent on the organization of the farm, some data concerning the size of farm, the acreage of crops grown, and the kind and numbers of livestock produced are important. The supply of regular labor on the farm, as well as the wages of hired labor in the area, and the equipment available are important.

The data collected should be as complete as possible as to the time required in husking, the number of men used, the number of horses and wagons used, the kind and size of tractors, the amount of fuel and oil used, the time spent in repairing and caring for the machine, and the expense of repairs.

Some measure of the effectiveness of the different methods of husking should also be secured from the farm operator. This may be in terms of cleanliness of husking and of the amount of shelled and ear corn left in the field. In many cases corn left in the field is picked up by hand after being husked by machine and the amount is known. In others this must be purely an estimate. Where corn is picked up by hand, the costs of this operation should be secured.

Few one-row huskers with power take-off, and practically none of the two-row machines, have been used long enough to determine the probable life of the machines. After one or two years of operations, however, the average farmer usually has some idea as to what he expects the life of his machine to be. From these estimates some basis for determining the annual depreciation and interest charges on the huskers may be secured.

The records should cover the entire operation of each machine during a season. In many cases, custom work may be performed, thus lowering the overhead expense of husking a small acreage on the home farm.

Sources of information.

1. Records kept by cooperating farm operators on the quantities of man-labor, power, equipment, and materials used in husking by hand and by machine.

2. Available data from detailed supervised records or other records from which the quantities of labor, power, and material used in husking may be taken.

3. Additional information on the size and organization of farm on which huskers are used, the supply of regular labor on the farms, and other important factors.

Organization of project.

Little organization work is required before actual work on this project is started. Contact should be made with equipment manufacturers or sales agencies to secure lists of men in local areas who own machines. State agricultural colleges or county agricultural agents should be consulted concerning the number of machines in an area, their adaptability to local conditions, etc. It is not believed necessary to make any contact with the farm operator until the field man makes his first visit.

Better cooperation may be secured if the prospective cooperator is promised a report of the various costs on his farm so that he can compare them with the average of these costs in the area.

Sampling and choice of period.

If sufficient numbers of records can be secured, they should be representative of as wide a variation of conditions as possible. The type of corn grown, the yield and quality, climatic conditions, and soil conditions all have a distinct effect on the relative advantages

of the different methods of husking. However, if sufficient numbers cannot be secured, which will usually be the case, it will be well to limit the study to a smaller area with more uniform conditions.

Where less than a hundred records are secured each year, it is advisable to hold as many of the physical factors constant as possible. But the data should cover the important types of mechanical huskers, one-row huskers, two-row huskers, huskers mounted on the tractor, machines with tanks to receive the corn, and any others. If possible, moreover, the data should be secured over two or more years to eliminate variations due to seasonal conditions. A year with normal climatic conditions provides the best records for determining reliable average performance. However, records during years of adverse conditions and good conditions are valuable in determining the adaptability of the machines to changes.

Collection of data.

In most states sufficient data are available on hand husking from supervised records of various types. If no records are available, the data may be collected in the same manner as will be described for collecting those on machine husking. The best method of collecting the data on machine husking is to have the operator keep a record during the husking season. Forms for recording the data should be left with the farmer at the beginning of the husking season, preferably just after husking is started rather than several days before. The field men may then make some entries in explaining the purpose and method of keeping the records. At this visit it is also advisable to get data on the kind of machine, the size of farm, acreages of the principal crops, and other supplementary data which will be needed. After the husking is completed, the field man will again visit each cooperator, check the records over with him to see if they are complete, and bring them into the office. The number of records which one man can secure in this way will depend on the distance which he must travel. In the important corn-growing regions, he should be able to get 75 to 100 records during the season with a total expenditure of time not to exceed four weeks for field work. It is believed that such records give the best results in securing this type of data. In many cases the operator may not keep an actual record during the season, but will have the data well in mind when the field man comes to collect the records. Data of this sort, however, may even be collected by survey if the farmer is visited soon after the husking is completed.

Errors in records.

Data collected in this way should be as nearly correct as it is possible to get them, particularly in so far as the amounts of time, labor, and other materials are concerned. In many cases the amount of corn husked is estimated, but this error should be small. The greatest error is likely to be in the estimates of the probable life of

the machine, and the basis for determining depreciation and interest charges. These estimates will be more reliable after the machines have been used a longer period.

The average age of a random sample of one-row huskers will be higher than that of two-row huskers, since they have been in use a longer time. This should be considered in showing the annual repair and upkeep costs.

Schedules and forms.

Four schedules and forms are needed in collecting and summarizing the data. The data in each of these forms may be summarized as follows:

1. A record of the size of farm, or farms, if the machine is owned jointly, the acreage of crops grown, the numbers of livestock, the make, type, age and original cost of the picker owned, and other general information. If filled out by the field man at the first visit, this form provides a record of the type of machines and the kind of farms on which records are being secured.

2. A record of the acreage and amount of corn husked, the time used, the number of men on the crew, the quantities of fuel and oil, and other material used; the number of horses, wagons, and other equipment, and other such information. These data may best be recorded by fields rather than by days.

3. General information on acreage of corn harvested by other methods on the farm, repairs on the husker, rate paid hired labor, prices of materials used, and the general conditions of the corn and ground as they affect husking.

4. A summary sheet for each farm. This will show total quantities of labor, power, equipment, and materials used in husking during the season, and will also provide space for calculating the total machine costs per acre and per bushel.

Method of analysis.

The following points need to be developed in the analysis:

1. Average quantities of labor, power, and materials used with the common methods of husking and the variations around these averages.

2. The general effect of changes in yield of corn, acreage husked, etc., on the amounts of labor, power, and materials used, and on the cost, measured in terms of effect on annual farm income.

3. The relation of the cost, measured in terms of changes in the annual farm income, to particular conditions on the individual farm.

4. Typical conditions under which one method of harvesting is particularly advantageous, and the crew organizations best fitted to these conditions.

Some analysis of the initial cost of huskers and the estimated life must be made in order to arrive at some method of determining the rate of depreciation and interest charges. For this type of equipment, it is believed that depreciation should be based on the acreage of corn husked rather than on an annual basis. Some machines are used two or three times as much as others, and it is believed their life in years will be cut down proportionately, at least within certain limits.

Hired labor charges should be on a uniform basis to eliminate differences in costs due to bargaining for cheap labor. An average figure can be arrived at from data secured, and applied to all farms employing hired labor, with such allowances as may be needed for the grade of the labor hired.²

Summary of similar research.

The methods outlined here are similar to those used in Illinois in 1928 and 1929 in the cooperative study conducted by the United States Department of Agriculture and the University of Illinois, as reported in Illinois Bulletin 373.

This project was continued by the University of Illinois in 1931 to obtain information relative to changes in practices and costs.

A preliminary report on the use of corn huskers in the Dakotas was made in 1926 by the Bureau of Agricultural Economics, United State Department of Agriculture. The data for this report were secured by the survey method on 100 farms in the fall of 1925. Only one-row machines were covered, however, and nearly all of these were the bull-wheel driven machines, a type little used today.

A similar survey was made in Ohio by the Experiment Station in 1929. Records were secured on the operation of 51 one-row machines and 14 two-row machines. The results were published in Mimeographed Bulletin No. 24, Department of Rural Economics, Ohio State University and Ohio Agricultural Experiment Station.

Studies of all types of huskers were made in Indiana in 1929 and 1930. The results of these studies were published as a progress report on the *Study of Mechanical Corn Huskers* by the Agricultural Experiment Station.

PROJECT 20D. To Determine the Relative Economy of Having Dairy Herds Freshen in the Fall or in the Spring.

(By J. D. Black.)

This type of problem in determining the relative economy of different practices is introduced merely as an example of a problem

(2) "This discussion would be improved if it provided for differences in make of machines and for variations in cost rates and prices, and if it covered the matter of sampling." (A. G. Black.)

somewhat different from the foregoing; and method and procedure for it will be discussed only in brief outline.

Three general types of analyses have been applied to the problem:

- A. Determining the relative costs of production per hundredweight of milk in summer and winter and comparing these with summer and winter prices.
- B. Determining the annual costs of production per hundredweight of herds freshening mostly in the fall and mostly in the spring, and comparing these with the average annual prices received.
- C. Estimating the effect on net farm income of having cows freshen at different seasons, using the method of substitution (or budget method).

A. Comparing seasonal cost and seasonal price.

Nearly all of the early analysis following this line, and much of the later analysis, took the herd as a unit and charged the milk produced each month or season with the feed consumed by the herd during that season; and likewise for the labor and other costs.

If the herd was one freshening more largely in the fall, the heavier winter milk flow was charged with the relatively high cost of barn feeding, including frequently a considerable amount of bran and other concentrates, and the lighter summer milk flow with the relatively lower summer feed costs, commonly with very little purchased concentrates included. When the cattle were turned out to grass, the milk flow usually increased considerably, and this lowered costs still more. Nevertheless, since the herd was largely due to freshen in the fall, the milk flow was light during July and August, and the feed cost per hundredweight was high. Consequently for herds of this type, the winter production commonly appeared somewhat more profitable than the summer production even though the feed cost was higher.

If the herd mostly freshened in the spring, the heavy milk flow of spring and summer was balanced against the low pasture costs, and the lighter winter flow against the heavy winter feed costs, with the result that summer costs per hundredweight were very much lower than winter costs, and spring freshening appeared much the more profitable.

If the herd had cows freshening throughout the year, with no pronounced concentration any season, as in many of the market milk sections, the summer production always appeared the more profitable because of the lower pasture costs charged against the summer production. The light summer flow from such of the cows as freshened in the fall was not enough to offset the very low unit cost in the summer for the rest of the cows in the herd.

If herds of all three of the above descriptions were found in an area, and the cost data were averaged, as was commonly the practice, the summer costs were almost surely to appear much lower than the

winter costs, and summer production the more profitable in spite of the lower summer prices for the product. Labor and shelter costs worked out in much the same way.

The defect of the method was of course that the cost of carrying the cows while dry or nearly so was charged against the other cows in the herd or area which were in full flow or nearly so at the time.

The logical procedure for remedying this defect is to separate the maintenance from the production ration month by month, charge the cost of the production ration to the milk produced each month, combine the monthly costs of the maintenance ration into a yearly total, and divide this by the total milk production and get a maintenance cost per hundredweight of milk which will be constant throughout the year; and then combine the costs of the production and maintenance rations month by month. Labor cost, shelter cost, etc., will similarly need to be separated into maintenance and production portions and then combined.

But even this procedure does not avoid the apparently insuperable difficulties pointed out in Project 27 of determining cost-rates for the labor that will reflect the relative value of labor used season by season, to say nothing of farm by farm and enterprise by enterprise, and similar difficulties as to cost-rates for pasture land and farm-grown feeds.

B. Comparing profits of herds freshening at different seasons.

This procedure is likely to lead to more valid conclusions than A above; certainly so unless the production and maintenance rations are computed separately in using the A method. It requires that a good many herds be included in the analysis; that is, if the results are to be sufficiently conclusive, and if the analysis is to be carried to the point of discovering reasons for variations between herds. These herds can then be sorted into groups according to the time of year when the majority of the cows freshen; and these groups can be compared as to production per cow, feed consumed per cow and per hundredweight, cost of purchased feed per cow and per hundredweight, labor and shelter inputs, average price received for the product, etc., and a decision reached as to which system of dairying in general seems to pay best in the area. Relative advantage will vary, however, between the farms in any group according to special conditions on each farm. It may well be that some of the farms with cows freshening at one season would do well to change to another practice. Hence additional analysis taking account of varying conditions affecting economy of production—types of land determining relative supply of pasture, forage and concentrates, available labor supply, barn room, skill of operators as dairymen, etc. This type of analysis is difficult to make statistically.

C. The Budget Method.

It is this difficulty with the needed statistical analysis that makes

the use of a *budget analysis* for a number of different sets of farm conditions very helpful. It would seem that the B procedure supplemented by this budget analysis will be most likely to lead to valid conclusions. This will mean essentially a combination of a statistically analyzed survey with case analysis of carefully selected individual farms.

In conclusion, it may be pointed out that the B procedure has more commonly indicated that the winter-dairy farms are the more profitable. But these results may be in part due to the fact that winter dairymen in many areas have the better cows and equipment and understand feeding better. The larger output per cow on such farms and the higher prices received are important contributing factors.

PROJECT 21. Case Study of Orchard Management Problems.

OBJECTIVES: To obtain detailed information as to the nature of important orchard operations and practices; use of labor, power, equipment, spray materials and fertilizer inputs; and complementary, supplementary, and conflicting relationships between enterprises.

(By H. C. Woodworth.)

Value and uses.

This project outlines the data essential to an understanding of the interrelationships between enterprises and the conflicting and supplementary demands of the different enterprises for the use of labor and equipment in the day-to-day operation of the farm. Careful observation and detailed records of some of the farm operations are necessary, while for other operations only general information is called for. This statement is for a particular type of farming—orcharding. It would need some modification to make it applicable to other types.

The result of a study such as this would be useful in teaching farm organization and farm management to collegiate students, would be helpful in the more intricate parts of studies of enterprise combinations by the budgeting method, and would throw considerable light on the reasons for variations in the amount of labor used on different operations. (See Projects 27A and 27B of this report.)

Method.

This project uses the case method as distinguished from the statistical. This means that it does not resort to averages and frequency distributions and other statistical devices. (See discussion of Case Method in *Research Method and Procedure in Agricultural Economics*.) It is not planned as a complete case study of the

orchards, but only of those aspects of their management that are mentioned in the statement of objectives.

Organization.

A fruit study of this nature should be a joint project in charge of an economist and a horticulturist, and both should take an active part both in the field work and in the analysis. A field man should be employed to give his entire attention to the work in order to insure the regularity of farm visits and data collection. While such a field worker should assume the responsibility of getting detail, the economist and horticulturist should spend considerable time in the field and in discussion of orchard management problems as developed in the field work.

Selection of farms.

Since this project is to employ the case method, the orchards will be selected, not chosen at random. Various possibilities are open as to the plan for choosing orchards, such as (a) singling out and defining several types of orchards and then finding several orchards that come as close as possible to these types; (b) defining these several types, but purposely choosing orchards that offer definite contrasts within the type; (c) choosing orchards with a view to approximating a representative frequency distribution for the major characters; (d) including all the different variations of importance in the area; (e) choosing pairs of orchards that are alike except for one major difference with possibly two or four additional orchards as check-orchards. Obviously these orchards can be only approximately alike. Differences in management alone makes this necessary. (See *Research Method and Procedure in Agricultural Economics* for other possible bases of choice.) The method here suggested is (b) combined with (c); that is, selecting several types, but choosing orchards within each that represent contrasting pairs with additional approximately similar orchards as checks. A group of 4 to 6 orchards might thus constitute the unit of the study. If 4 types are studied, from 16 to 24 orchards might be included. If size is to be a contrasting factor, one might want a small, a medium, and a large orchard within any type, which would increase still further the number of orchards needed. Obviously many combinations of the foregoing are possible. Obviously one will need to have made some sort of preliminary survey of the orchards in the area in order to determine upon the types and contrasts within the types to be studied. It is indicated above that differences in supplementary and complementary relationships are to be particularly represented in this study.

Collection of data.

The closely supervised route system of collecting data in which each farm worker daily records the time, amount of time and type of work done, has been commonly used in studies of specialized sys-

tems of farming such as orcharding. This may still be the best procedure in certain projects; but such procedure involves much record-taking and attention to detail in analysis, so much, in fact, that the larger problems of management may be lost entirely in the forced attention to a great mass of detail.

A route system modified to the extent of including less detail and less supervision may get all the essential details with less record-keeping and less expense. Important operations can be studied in detail, following the closely supervised procedures, but operations unimportant from the standpoint of management can be studied in a more general way. With this method the emphasis is more likely to be on the analysis of important management problems rather than on mere details.

The first step in securing detailed information under such a modified route plan is to study the general situation in orchard management by visiting and informally surveying orchards in the area to determine:

1. What operations are common.
2. What operations require skilled labor.
3. What operations must be done in a definite, limited time.
4. What operations represent peaks of skilled labor requirements.
5. What operations represent peaks in total labor requirements.
6. What operations can be done at any convenient time over a rather long period.
7. What enterprises are considered or should be considered complementary or supplementary to orcharding.
8. What are the operations in these enterprises that conflict with orcharding.

From this information determine:

1. What orchard operation should be studied in great detail.
2. What operations are of secondary importance in so far as management and conflict of labor is concerned.
3. What operations present no particular problems in management; that is, operations that may take some time but can usually be worked in between other operations by the regular crew without neglect to the orchard.

Detail concerning these operations can be secured by different methods to suit the importance of the operation to be studied. Thus spraying in New England represents an important operation. It must be done at definite short intervals. Skill is required. Expensive materials and costly equipment must be used. It must have first choice of the operator's time. The detail of this type of operation can be obtained by having the operator and his men keep complete records of the spray operation. Each day that spraying is done, the operator should report on special blanks the total time of man-

labor, horse-labor and spray equipment used; also spray materials used and varieties or orchard blocks sprayed and work on other enterprises done that day.

Pruning is an example of an operation of secondary importance. While a large amount of skilled labor is generally used, the work can be done at any convenient time over a long period. Estimates of the total labor on this operation can be obtained by the survey method at periodic visits of the field man. The exact amount of time is not so important, and labor could usually be distributed quite differently without affecting the farm income.

Fertilizing, at the other extreme, represents an operation of little importance in labor management. The work can usually be done at odd times by the regular crew. The time used can be estimated once a year, preferably soon after the operation has been completed.

Records of labor on supplementary and complementary enterprises can be secured by the same methods outlined above. Emphasis should be placed on those operations which compete with the important orchard operations.

The field worker

The field worker should visit each orchard farm periodically, probably once a month in winter, and perhaps once a week during the spray season and at other busy times. He should make observations and record what each man is doing when visited and how he is doing it, note differences between farms, check some details with stop watch, and obtain, by the methods outlined above, a record of all work done on the farm since his last visit. He should confer with the farmer to determine why he is doing this operation now, what other operations need attention, and how urgent is the need of attention to other farm operations or other enterprises. In the case of conflict of farmer's time, which will he take care of first and why? How serious is the conflict? Would a greater or smaller area of the competing crop fit into the organization better?

Analysis of the data.

The data from each individual farm should be summarized to show the use of labor, power, and equipment on each operation. For the most important operations the summaries should be by days; for the less important operations, summaries only by weeks or months. The summaries would be studied in the light of the non-statistical information obtained by the field workers as to the conflicting demands of the different operations for labor power and equipment to determine whether expansion or contraction of the complementary and supplementary enterprises would be advisable on each farm, whether more or fewer men could be advantageously employed at each season, whether the purchase of additional equipment would be advisable, and so on.

The general procedure in case analysis is first to study each unit itself—in this case, each orchard—learning all that one can

about its organic relationships and working out all its important details in so far as included in the project; then to write up the analysis for each project separately, the statement for each unit written up including a careful presentation of likenesses and differences between this unit and those already written up. The last description, or a separate summary at the end, points out what is common to all and to any two or more of the units, and also what is peculiar to each, in the nature not only of descriptive facts, but of internal relationships, and effects associated with differences in organization and practices, etc. This summary will ordinarily include a tabular presentation in which the important statistics for each unit in the case study are reported, and perhaps a certain amount of ranking is done. But this is all the statistical procedure that is in order, unless units enough are included so as to make certain types of averages and ranges significant.

This study will follow the foregoing general plan except that each set of orchards representing a type will be analyzed by itself first, and within each type the two or three farms that are included as checks on each other will be worked up together. The analysis of these two or three may end in selecting one of the three as best representing the type with the one variant that is to be contrasted, or it may end in a hypothetical set-up that combines certain features of each of the three. From this will result two orchards that are of the same type but differing in one important particular which has been made a special subject in the study. (There might be three sets if size was the subject of the contrast.) Next will come the process of developing fully the significance of this difference. The final step will consist of comparing the results thus obtained for the several types that have been chosen for study.

PROJECT 22. Variations in Labor Inputs.

OBJECTIVE: To explain the variations in labor used in the production of hay, oats, and corn in Eastern Connecticut.

(By Donald O. Hammerberg.)

This statement pertains to a study made in 1929. The results are given in Bulletin 172 of the Storrs (Connecticut) Agricultural Experiment Station.

The objectives of this study were:

1. To determine the physical units of labor used in the production of three crops: hay, oats, and corn. These data are a part of the basic material necessary for establishing efficiency standards and setting up new forms of adjustment to changing prices.

2. To determine what factors are responsible for the variations in the number of hours used by different farmers in the production of these crops.

The value of such a study consists largely in suggesting possibilities of reducing out-of-pocket costs if the farmer hires considerable labor, or handling a larger volume of business, or having more leisure time if the problem is one of making effective use of his own and his family's labor. Labor is one of the few variable costs in agriculture, and the use of more or less labor is therefore one of the directions in which adjustments can be made without drastic reorganization of the farm business.

The data were collected from 160 farms in eight towns in the Eastern Highland of Connecticut. Twenty farmers were selected in each of five towns, fifteen farmers from each of two others, and thirty from one. These numbers were roughly proportional to the number of farmers in the towns. The names of all the farmers in the town who had at least five head of neat cattle were obtained from the town clerk. A random selection was then made by drawing names from a hat. Each farm was then mapped with the use of an Army sketching case and pacing scale.

The input-output data on which the labor efficiency study was based were gathered during the months of July, August, September and October, 1929, during and immediately after silo-filling time, and therefore at a time most favorable to accuracy. All of the data were obtained from farmers' estimates (except in the silo-filling tests on the three farms reported in Project 22B where the operations were actually timed). Throughout the study, attention was concentrated on those operations which were known to come at the peak-load periods.

In the analysis, reliance was placed mainly on sub-sorting. Inferences drawn from such a method are naturally but rough approximations, but most farm businesses are not conducted with such a degree of nicety of adjustment that accuracy of a high degree is necessary. Recommendations should not be made on the basis of such data unless there is a preponderance of advantage indicated. The study indicates that there is such an abundance of different opportunities for marked savings of labor that further refinements in method of record-taking and analysis are perhaps not warranted until the farmers have taken advantage of the more outstanding of these opportunities.

Correlation analysis was used in a number of cases with more or less indifferent results. Some of the results obtained by sub-sorting were checked by this method, with what was thought to be some refinement in results.

The results indicate that it is not always possible to study an area and discover the best practices. Study of the practices in this area revealed an extreme amount of variation both in the methods that were followed and in the amount of labor used, but it did not reveal that there were other methods equally applicable and consid-

erably more effective than any actually in use. (See Project 22B as evidence on this point.)

This study required approximately two and one-half months of field work by two men, and about seven months of one man's time, with the assistance of a clerk for about half that time, for analysis. The expenses of the field work, not including salaries, amounted to about \$400.

PROJECT 22A. To Account for the Variations in the Amount of Labor Used in Performing Hand Work on Vegetable Farms. (A Study in Management as Distinguished from Organization.)

(By R. L. Mighell)

Studies of this type may be directed merely at discovering the reasons for variations in the amount of labor used in performing certain operations, or they may go further and seek to develop more efficient procedure. With these objectives in mind, the results of such studies should be of great practical value to farmers, particularly in types of farming in which much of the cash outlay is for hired labor. Such a project is closely related to research in farm labor in which the efficiency of farm labor is analyzed from the standpoint of possible lessening of the input of human effort. In so far "scientific management" is concerned with lessening the psychic cost to the laborer of certain kinds of agricultural labor, its study belongs with the problems of agricultural labor rather than with those of the farm entrepreneur concerned only with the profitableness of the labor used. Not infrequently, however, the interests of the laborer and the entrepreneur in this respect will be closely related, since the reduction of fatigue and effort on one task will enable the laborer to work more efficiently on other tasks. The following is the outline of a project now being carried on in Massachusetts in which the problem has been attacked primarily from the point of view of the farm entrepreneur interested in profitable technique.

The study is confined to an analysis of the more important farm operations on vegetable farms in three areas in Middlesex, Essex and Bristol counties in eastern Massachusetts. Operations involving horse or power equipment have in the main been excluded, and the study limited chiefly to those crops and operations in which significant amounts of manual labor aided only by simple tools and equipment are used. For example, some of the operations thus far studied are the following:

- A. Hoeing and thinning.
- B. Setting celery and cabbage plants.
- C. Cutting and collecting asparagus, pulling carrots and beets, and picking tomatoes.

- D. Sorting, grading and bunching asparagus, beets, carrots, celery and tomatoes.
- E. Tying bunches with string, rubber bands, and tying machine.
- F. Washing beets, carrots and celery.
- G. Wrapping celery.
- H. Packing and boxing asparagus, beets, carrots, celery and tomatoes.

Examples of tools and equipment used in these operations are various types of knives, hoes, dibbles, field boxes and baskets, sorting tables, bunching forms, box rests, hatchets and hammers. There is much variation in tools and equipment used by neighboring farmers for the same purpose. For instance, in one locality six different types of field containers for carrying asparagus were found in use.

Basic qualitative analysis.

Much of the basic research procedure for this type of study as applied to industry was first developed by Frederick Winslow Taylor¹ some thirty years ago in his work on *Scientific Management*. In the method used by Taylor and his followers, the job or task is studied in minute detail as to its nature, the materials used, the various methods which might be followed, and the type of man best fitted for the work.

Scientific management in industry has helped to revolutionize former methods and technique in many factories both in this country and abroad. Its application to agriculture has been slower because of such characteristics as the small size of the typical operating unit, lack of volume, discontinuous production, and the great diversity of conditions from farm to farm even among farms of the same type. Very little agricultural research along these lines has been carried on anywhere except recently in Germany where Professor Seedorf² of the University of Göttingen, Göttingen, Germany, and his co-workers have underway an extensive program of research on various aspects of farm labor problems. They have not only made studies under farm conditions, but have also set up controlled laboratory experiments to measure time and energy expended in doing tasks in different ways.

In the Massachusetts study here outlined, records were available from a previous crop survey in the same areas. These records con-

(1) For the history and present day status of scientific management in industry see the following: Taylor, F. W., *The Principles of Scientific Management*, 1911; Drury, H. B., *Scientific Management—a History and Criticism*, Columbia University Studies in History, Economics and Public Law, Vol. 65, No. 2, 1915; The Taylor Society, *The Principles of Scientific Management*, 1930.

(2) Seedorf, J. J. W., "Methods and Results of Research Work on the Efficiency of Human Labor on German Farms," in the *Proceedings of the International Conference of Agricultural Economists*. Second Conference 1930; v. Bismarck, L. und Buchholz, H., *Methodik und Technik der Arbeitsbeobachtungen in der Landwirtschaft*, Bücherei für Landarbeitslehre, Berlin, 1930.

tained data on amounts of man-labor by operations for the chief vegetable crops. Analysis showed wide variations in total amounts of labor used for the same crop by different growers. Labor on individual operations also showed a wide range of variation, but greater in some cases than in others. Hand labor without horse or power equipment made up three-fourths or more of the total labor on many crops. On the average, about half of the total labor came in connection with harvesting operations. Attention was therefore directed mainly to harvesting and other important hand operations in which the range of variation was apparently significant.

The more important causes of variations in labor input may be stated as follows:

1. The type of laborer, whether boy, woman, proprietor or hired man.
2. Efficiency of each type of laborer in performing specific tasks in terms of output per unit of time.
3. Sequence of operations and tasks in the hands of the worker and crew.
4. Crew organization which may take more or less advantage of differences in capacities and efficiencies.
5. Layout and equipment of the packing shed.
6. Weather, soil, size of fields and topography.
7. Yield, variety, stage of maturity, and amount of grading to be done in preparation for market.

Such causes of differences as soil and topography are entirely beyond the control of a farmer on a particular farm, and others, such as the type of labor available, may be fixed as far as a specific crop is concerned because much of it must often be hired for the season to care for all crops rather than for a particular one. Therefore the most significant part of the analysis for any given farmer is concerned with studying those causes which are subject to change and adjustment. [For the principles underlying the combination of capacities and efficiencies of different types of labor, see H. C. Taylor's *Outlines of Agricultural Economics*, 1925, Chapter XI; or Black and Black, *Production Organization*, Chapters VII and VIII. An understanding of the principles outlined in these references will greatly facilitate the process of working out improved combinations in the course of such a study.]

The essential procedure in studying the labor on each crop is to subdivide each operation into many elementary parts and carefully study and time the individual motions, the sequence of motions and tasks, the combinations of capacities and efficiencies, the kinds of equipment, and such other factors as are subject to control.

Selection of cases.

The method of study followed is best described as the "case" method, since a detailed study was made of the way in which

operations were performed on particular farms. These farms were chosen to represent the important types of producing conditions for each vegetable in the type-of-farming area, and an attempt was made to visit enough growers of each crop to make fairly certain that no important variations in methods practiced were omitted.

In this Massachusetts study, nearly complete lists of the commercial growers of each vegetable crop in the areas were available, and a large percentage of the growers were either visited by the investigators, or information concerning them was obtained from members of the extension staff who had visited them. The usual procedure with each vegetable crop was to make a preliminary reconnaissance visit to 15 to 20 farmers selected from our lists so as to include different-sized crop areas and crop combinations. A few minutes to an hour or more of observation of actual operations on each farm usually gave us some preliminary records and furnished a basis for the later selection of a few typical farm situations to study in detail. The preliminary visit was also of material assistance in securing cooperation from the farmers, as it gave an opportunity to explain the object of the investigation.

Collection of data and equipment of the field party.

The first season's field work on this project was carried on in June, July, August and September, 1931. The field party of two men worked out from a central point in each area with an automobile and studied each particular vegetable as it came into season. Asparagus was the first crop, and was followed by beets, carrots, celery and tomatoes. Some time was also spent with other crops. Since the labor on these vegetables is overlapping, it was possible at times to study several crops in the same period.

It is very important to have at least one member of the field party who has considerable familiarity with vegetable growing. Otherwise much valuable time is likely to be wasted in merely becoming acquainted with common practices. In this study, both members of the field party, Professors R. L. Mighell and R. H. Barrett of Massachusetts State College, had had some experience with vegetables, and Professor Barrett had spent the previous summer working in the same areas.

The major items of field equipment consisted of two stop-watches, a pedometer for measuring distances and counting steps, a camera for still pictures, a 16mm. motion picture camera, a motion picture projector, a standard text on vegetable growing, notebooks and permanent record forms. For taking records and making notes in the field, a cheap pocket notebook was found more convenient than any standard schedule form. This is inconspicuous, easily carried about, and notes can be made as desired. The field records were transcribed to simple standard forms, such as A and B following, at the end of each day for permanent record.

FORM A. *Operation sheet for asparagus (Farm 12)*

Operation	Workman	Time per box (minutes)	Explanation
Bunching	A	26.4	Small spears—second grade
Bunching	B	19.2	Uses both hands
Bunching	C	23.7	Woman
Bunching	D	28.3	Farm operator—supervises
Rubbers and labels	E	4.8	Has some spare time
Trimming	F	2.6	Dull knife in trimmer
Packing	F	1.0	Special crate—divided
Nailing	F	1.3	and papers

FORM B. *Operations of bunching asparagus subdivided.
(Farm 13; Workman M)*

Operation	Bunch 1 (minutes)	Bunch 2 (minutes)	Bunch 3 (minutes)	Bunch 4 (minutes)
Moving grass	0.1	0.1	0.1	0.1
Rubbers on form	0.2	0.1	0.2	0.2
Placing spears	1.1	1.5	1.3	1.4
Rubbers on bunch	0.1	0.1	0.1	0.1
Bunch out	0.1	0.1	0.1	0.1

Form A is suitable for recording over-all or gross time for operations which are not divided, and Form B is useful in recording time for elementary parts of operations when it is desired to study the process in detail.

Still pictures and motion pictures were taken to record especially good or bad technique as it was observed. Stills are more useful for some purposes of comparison than are motion pictures. Motion pictures, however, can be taken of actual operations which would be very difficult to pose, and which would require too many stills to illustrate fully the motions involved.

Analysis.

Much of the analysis in a project of this type must necessarily be made in the field at the time of observation. It is not a case of collecting a mass of data which can be taken back to the experiment station and later analyzed at leisure. Many preliminary observations must be made, and many ideas must be tried out and eliminated under actual conditions in the field at the time the crop is being grown and harvested.

Motion pictures proved to be of valuable assistance in certain stages of the analysis in which it was desired to break the operations up into small elementary parts for detailed study. Both the Eastman Kodak Company and the Agfa Corporation furnish quick development service so that motion pictures can be projected four or five days after they have been taken. By studying these films, it was

then possible to return to the same farm and try out suggested changes before the growing or harvesting season had been completed for the crop and operation in question. By taking slow motion pictures, it is possible to see motions that might escape the eye for a long time in ordinary observation. For example, a slow motion picture of several men bunching asparagus at the same work table showed important differences in the elementary motions they were using. One man had developed an efficient way of placing rubber bands on the bunches; another made a great many unnecessary and time-consuming motions in filling his bunch form. Stop-watch records showed differences in time, and the slow motion pictures showed why and how these differences occurred.

As the work progressed with each crop, and the investigators became more familiar with practices, suggestions were made to the farmers who were willing to try them out. Several growers increased their efficiency by building sorting tables from suggested plans. Another grower rearranged the sequence of motions in wrapping and packing celery. Numerous other suggestions were made and put into practice. Some of the suggestions were made as a result of comparisons with other farms. Many were not, however. Some improvements were suggested to fit peculiar arrangements of permanent equipment or to fit the particular abilities of the available kinds of labor. For example, it was found after timing and studying three men who were setting celery plants separately that it was more economical to have the slowest man drop plants for the other two setters. This type of adjustment would vary with the relative skill of individuals.

Other improvements were developed by the investigators after studying a particular operation and casting about for possible means of shortening the time. This sort of innovation is illustrated by an entirely new and more rapid technique for bunching and tying carrots with rubber bands. Almost no one was found using rubber bands for tying carrots, though many had tried it. Tying with string was faster. The reason was that one person was unable to hold a bunch of carrots with the tips close together in one hand and put the rubber band on the bunch with the other hand. If the bunch is held firmly by the tops close to the carrots the tips of the carrots will spread so far apart that the rubber band can be put on only with difficulty and with several motions. No other manner of holding the bunch in one hand is any more satisfactory. The problem was finally solved by arranging a crew of three men, one man on one side of a narrow table and two men on the opposite side. The one man does nothing except pick up rubber bands one at a time and stretch them open with both hands. The other two men each form the bunches and holding them with both hands pass them rapidly into the stretched rubber bands, and lay the bunches aside. This arrangement results in high efficiency and is flexible enough to take care of

variation in speed of different workers. For instance, if the bunchers are slower than the rubber man, the latter can lay the bunches aside. Or three bunchers may be used. The following table shows a comparison of actual time used in bunching and tying by common methods and the new method.

Comparison of bunching and tying methods—typical tests

<i>Method</i>	<i>Number of bunches</i>	<i>Man minutes per box*</i>
Common string method	60	5.3
Improved rubber-band method	51	2.9

* Eighteen bunches per box.

It will usually be impossible in the first year's work on a project of this sort to carry the analysis to its final stages—partly because the desired cooperation cannot be secured from farmers at once, and partly because many ideas must be tried out before the most economical synthesis can be achieved. Even if this point is attained, it will probably be too late to try it out because the crop may then be grown and harvested and one must wait another year for working material.

The final analysis with respect to a particular operation or set of operations for a crop will involve a forecast of results to be expected under typical sets of conditions. All the available data of the study concerning the most efficient ways of doing each elementary task and set of tasks must be brought together and combined into a complete and detailed statement for the typical set of operations as a whole. Farmers representing the typical sets of conditions will then be selected and the whole synthetic set-up planned and carried through under actual farm conditions. Careful time records, pictures, and motion pictures will be taken for both the old method and the new method. When such synthetic experiments are carefully planned, the data and pictures obtained furnish an actual test of the practical value of the forecasted routine and technique, and are also extremely valuable in providing educational material for extension programs along this line.

Generalizations with respect to the application of the results of these case studies to other farms must be made with care and in terms of similar conditions. Different situations may call for different methods. Nevertheless the principles illustrated by a carefully planned set of operations can be applied in many situations.

Presentation of results.

Results of studies in which the analysis has been successfully carried through to the final states should be published in the form of carefully detailed descriptions of the most economical methods developed for each operation under each typical set of farm conditions. Both the old and the improved methods should be described, and the net saving in time and other advantages in favor of the new method clearly shown. Pictures and sketches to illustrate differences in technique will be very helpful. Such published results

will be chiefly serviceable in calling attention to the real value of the work and in assisting farm management extension specialists and county agents in planning method demonstrations.

In presenting results to farmers, it is doubtful if much reliance can be placed on printed matter. Actual method demonstrations, film strips, or motion pictures are probably much more effective ways of showing farmers how to adopt improved technique. One or more common ways of performing a given task may be shown and contrasted with the improved method. Whether the motion picture or the film strip is the better teaching device will depend somewhat on the complexity of the operation being demonstrated. If there are many elementary motions following one another in rapid succession, motion pictures and perhaps slow motion pictures will be needed for an adequate presentation. If the significant elementary motions are few in number, the film strip may be equally effective.

Comments (H. R. Tolley.)

As stated in the early part of Project 22A, a comprehensive program of research on farm labor is underway in Germany. The following abstracted from *Farm Management Research Technique*, by R. McG. Carslaw, shows the scope of that program:

"Perhaps the most original farm management research in Germany at the present time is that having to do with labor organization (*Landarbeitslehre*). The research is developing along psychological and physiological lines and is aimed at increasing the efficiency of labor. Organized study of the subject dates from 1920, and covers a wide field, including the manager's duty in relation to general work conditions and total workers engaged, the foreman in relation to single tasks and individual workers, the worker in relation to his task, and the worker in relation to use of earnings.

"An experimental farm is devoted almost entirely to research in *Landarbeitslehre*. Comparisons are being made of the relative efficiency of different methods of accomplishing the same object. In operations involving gang labor, comparisons are made of results achieved with different types of tools, different arrangements of gangs, etc. Other studies are aimed at setting up standards of accomplishment for different operations under different conditions and the popularization of labor-saving devices."

**PROJECT 22B. To Develop More Efficient Methods
of Using Labor in Silo-filling—by the Experimental Method.**

(By Donald O. Hammerberg.)

As a sideline of the study of variations in labor input described in Project 22 above, an interesting experiment was conducted in the use of labor in silo-filling. After having studied the various methods

of silo-filling that were used in this section, and there was a different method used on nearly every farm, it appeared that none of them was effective enough to warrant its general recommendation. A plan of operation was accordingly worked out which synthesized certain features of all of them and perhaps included some ideas imported from outside the area; and in order to determine whether this plan would really effect economies in the use of labor, some experiments were arranged. To carry these out, the operator of one of the farms where the experiments were to be made had to be induced to purchase a corn harvester; this facilitated both the cutting of the corn and the handling of it afterward, since the bundles were all bound. Special low-slung racks, adapted from the illustration in New Hampshire Extension Bulletin No. 80, were constructed to effect a minimum of human effort in loading. One of the men working on the research project, who also worked with the men, organized the crew, and supervised all details, such as insisting that no more men or teams be used than needed to keep the cutter busy, that only two or three rows be loaded at one time, and that the horses be started and stopped at frequent intervals in order to eliminate carrying the corn long distances. The operations were in fact supervised on only one of the three farms, but the variations in the number of man-hours per ton of silage on the three farms were surprisingly low, indicating that the method did not require much supervision, and that it was adaptable to a rather wide range of conditions. There seemed to be no reason why it could not be used by most of the farmers in the area who were at that time producing silage corn. The results of the experiment indicated that the most efficient of the 50 farmers with silos studied in the same area used 65 percent more labor in silo-filling than the average amount used in the experiments, that the majority of them used 100 percent more, and that the average on the 50 farms was just about two and one-half times as high as the average of the experiments.

One noteworthy feature of these experiments is that they represent some attempt at synthesis, i.e., at putting together of different methods of operation and different types of equipment in use in various parts of the country, with rather striking results. The problem was one of management, that is, selecting and devising proper equipment, and attending to details in the operation itself.

PROJECT 23. The Economical Use of Family Labor.

OBJECTIVE: To determine how to organize a farm business so as to utilize family labor; and under what conditions it will pay better to utilize such labor on the farm, and under what conditions it should seek employment off the farm.

(By Emil Rauchenstein.)

The approach suggested for this project is merely an extension of

that outlined in Projects 8 to 10 in this report, to make it include specifically the problem of determining the most economical use of the family labor supply, either on the farm or off. It therefore requires the working out of a number of financial summaries, or budgets, in order to compare the probable net incomes for specified or typical farm families, using varying amounts of the family labor on the farm, with different combinations of enterprises, and having varying amounts of that labor employed off the farm.

To illustrate, let us assume a simple case of a farm family consisting of a farmer, his wife, and an 18 year-old son, the farm consisting of 50 acres of crop land and 50 acres of pasture, with three horses, ten cows, six head of young stock, and fifty chickens as livestock. The farm has been operated practically as a one-man farm, and so operated brings a \$1,000 net income for the family. The boy is able to earn \$100 more by working on other farms; hence the net family income is \$1,100. If the boy leaves home altogether, the net income of the parents will be \$900 because of having to hire \$100 worth of labor. Under these conditions, any net income which the son can make above \$200 will be a gain for the net family income. Leaving out all other considerations, one would conclude that the boy should leave home.

Often, however, there are opportunities for reorganizing the home farm if there are no personal difficulties. If additional land is available the number of cows might be increased to 16. This would probably decrease the outside labor return to zero, but should raise the net farm income by \$400, giving a net family income of \$1,400. This would be equal to a net income of \$500 for the boy off the farm, plus the net income of \$900 for the parents on the farm. If the alternatives off the farm offer less than \$500 net income for the boy, pecuniary considerations would lead him to choose to reorganize the home farm and stay at home. If the alternatives offer more than \$500, he would leave the farm, unless a more profitable system of farming can be found.

It need hardly be pointed out that non-pecuniary considerations may weigh heavily on all such decisions—commonly in the direction of keeping the boy on the farm, but also often in the other direction.

In order to reach conclusions of general applicability to the farms of an area, it would be necessary to make similar analyses for a considerable number of farms and farm families typical of those in the area. If a study such as that outlined in Project 2 of this report had been made, the necessary information concerning farming systems typical of the area would be available. This would need to be supplemented with a study designed to determine the typical farm families of the area, giving special attention to the members of the family who are in position to seek employment off the farm if they desire to do so. In some areas it would doubtless be found that there are one or more growing boys or young men in the typical farm family, and that a good proportion of the labor supply of the area is composed

of young people who could leave home and seek employment elsewhere at little cost without seriously disrupting the family life or disorganizing the farm business. In other areas, it might be found that only a small proportion of the labor supply is of this type. Of course, many variations in the make-up of families will be found in a single area, and the study should include analyses applicable to the principal variations from the typical that are found in the area. If the results of the study are really to be true for the area as a whole, some sort of a survey will be needed to determine how important relatively is each of the types and variants thereof, and thus to construct some sort of a frequency distribution out of them.

The applicability of conclusions to a particular farm will, of course, depend on a large number of factors concerning the farm family and the farm. For example, will the family get along together? Do the members have the skill necessary for conducting the various enterprises planned? Do they want the additional income badly enough to take pains to do the work right? As regards the farm, what effect will a certain change in the cropping system have on subsequent crop yields? Can the proposed cropping system and field arrangement be fitted to each other? If additional cows are planned, will the additional amount of milk be sold at average or at surplus prices? What effect will the application of fertilizer have on the feeding value of pasture and hay? Can the additional land to be broken up be handled with the same amount of labor per acre as the tillable land now in use?

The above questions are a few of the many that must be answered with a fair degree of accuracy before satisfactory estimates can be made of individual family net incomes with different uses of the family labor. Alternatives involving using the labor on the farm will need to be studied carefully in order to devise a workable system of farming that will really utilize economically the available labor and other resources. Bulletin 275 of the Massachusetts Agricultural Experiment Station by R. I. Mighell gives three good illustrations of farms that were replanned in cooperation with the farmers. They also show the variety of factors that need to be considered in replanning a farm.

But although the analysis of alternatives for various types of farms and farm families will not fit exactly any farms, they will come close enough to many of them so that only small changes in the analyses will need to be made; and these changes most farm families can make with little or no assistance. Even if none of the analyses fits some of the farms, the method illustrated will serve as a guide; and much of the information will be applicable.

Sources of data.

Primary data pertaining to the farm business, and forming the basis for analysis to determine the contribution which the family labor can make to the family income if employed on the farm, will be

collected from farmers by the survey method or by supervised records, by procedures similar to those outlined in Projects 8 to 13. Additional data will need to be obtained in regard to the specific work done by members of the family on the farm, the time spent and income received in working off the farm.

Data obtained from farmers should be checked and supplemented by data on wages in industries, steadiness of employment, opportunities for advancement, and costs of living. In some cases, the data compiled by the United States Bureau of Labor Statistics will be sufficient. Sometimes special surveys of local industries and living costs will be needed.¹

Projects 1 and 2 will be useful in the selection of areas and in determining the areas and conditions to which the results of this study will apply.

Field schedule and suggestions for obtaining data.

The schedule should provide for recording the kind, amount of family labor, time of year that this labor is available, unused barn space, and the basic data for determining the net incomes received by members of the family who have worked off the farm during all or part of the year included in the survey. To offset the cost of board and lodging in the city, estimates are needed of additional expenditures entailed by these items for members of the family that stay at home.

The peak loads of labor need to be considered in some areas; hence labor distributions on crops and livestock by months may be needed on some farms at least. Fairly accurate records can be obtained by means of a schedule which provides for recording the labor on each crop by operations, first the total and then the distribution by months or weeks. Labor on livestock can be obtained satisfactorily by hours per day for each season. In the case of cows, for example, the hours per day for the pasture season and the non-pasture season usually give a good picture of labor utilization. Much of the information needed is similar to that in Projects 8 and 21.

Some experimenting will need to be done in determining the amount of labor data that will actually be needed in a given area in order that sound plans can be worked out for the economical use of family labor. In many areas rather definite standards of performance, such as acres of corn that can be cultivated per man with a one-row cultivator and two horses, numbers of cows that can be milked by hand per man, etc., may be sufficient for replanning purposes. Such standards for field work are especially valuable, since they are based

(1) The kinds of work performed off the farms in the Appalachian region are listed by Mr. H. W. Hawthorne in the 1931 *Yearbook of Agriculture*, pp. 314-315, as follows: road work, farm work, work in woods, mining coal, carpentry, official work, hauling coal, dealing in livestock, selling, teaching, blacksmithing, painting, baling hay and straw, work in railroad shops, work in oil fields, hauling school children, auto trucking, housework, stenography, clerking, etc.

on the experience of daily performance and the time that is usually available for these operations in that area.

Similar data on the acreage that can be handled with each machine are needed. These will usually be obtained incidentally as labor standards are obtained, and will enable the investigators to determine how much machinery expenses will be changed as the amount of family labor is changed.

The time element.

The choice of various alternatives for use of family labor may vary within a short space of time. One cannot assume a fixed return that must be received in order to induce a certain member of the family to stay at home. From a strictly economic point of view, any net income is better than no net income, and situations even arise in which it is a question of living where expenses are the lowest when unemployment in cities has cut off all income. Under these conditions, any saving in living expenses would be an improvement even though no cash income is obtained.

The probable duration of a business depression is an important consideration. The farm boy may have in mind certain goals to reach in the city, but the opportune time may not have arrived. Shall the farmer and his boy launch some new enterprise on the farm which will take years to build up, or shall they start one that may not promise as much over a period of years, but can be discontinued without loss on short notice?

An example of the first came to the writer's attention in the summer of 1931 in Maine where a farm boy who had lost his job in the city was starting a rather extensive poultry plant on the home farm. Such an enterprise could not be abandoned without considerable loss. On another farm, several farm boys were growing $\frac{1}{4}$ acres of sweet corn, an enterprise which does not last more than 4 or 5 months, requires no permanent investments, does not interfere seriously with the dairy farming that prevails in that region, and can be discontinued next year without loss of investment.

This project is designed to give primary attention to the farm management phases of the problem. The results of other research in regard to business conditions and outlook for farm products, labor and materials, as well as personal preferences and abilities of the specific families, will need to be considered in working out plans to fit individual cases, which, however, should be typical of the largest possible number in an area.

PROJECT 24. Economical Farm Layouts.

OBJECTIVES: To determine the most desirable farm layout for farms of different types in an area.

(By R. S. Kifer and H. R. Tolley.)

Stated more specifically, the objective of a project of this kind is to study the farm layout—that is, the arrangement of fields—in

relation to the economical use of labor, equipment, and land with the aims of (1) defining the desirable arrangements of fields on farms of different types and sizes, and (2) comparing the advantage accruing from contemplated changes in existing farm layouts with the cost of making the changes.

The project will for the most part be outlined as a case study of individual farms, ending in separate conclusions for each individual farm. But if the farms analyzed are chosen because they represent types frequently occurring in the area, and the case analyses of these type farms are supplemented by a special survey designed to furnish a basis for classifying the farms in the area *from this point of view*, and to indicate most of the significant variations in conditions affecting layout in the area, then conclusions can be drawn as to the relative economy of various types of layouts for the area as a whole, and as to whether particular changes are to be suggested under various conditions.

A study so conducted would indicate to farmers under varying natural conditions, types of farming, and sizes of farms, the farm layout probably best suited to their particular situations. Such layouts can probably be achieved only in the case of newly developed farms in an area with few handicaps to cultivation. Therefore the study must consider in addition the expense incident to a revision of the existing farm layouts. A study of this kind is particularly useful in those areas where shifts in the type of farming are in progress or where the use of large machinery has increased the capacity of the individual to the extent that farms are being enlarged through consolidation.

Scope of the study.

The study of farm layouts is closely related to the study of crop sequences, efficiency in the use of field labor, and the uses of land on the farm, but in itself should be concentrated on the economic importance of changes in the physical features of the farm. Questions such as the following are considered: (1) the location of fields with regard to the farmstead arrangement, (2) the relation of the size and shape of fields to the efficiency of the use of labor and equipment, (3) the farm expenses incident to the changes in layout, and (4) the economic advantage of a revision in terms of additions to the farm income or of reductions in farm expenses.

Qualitative analysis.

Throughout much of the farming section of the United States, the sizes of farms were determined at a time when the acres that one family could handle were considerably less than now. When the field work was done with small teams and small units of machinery, and when the time of the operator and the members of his family was less valuable than now, such things as irregular or poorly arranged fields, obstructions to cultivation, and the loss of the use of small

bodies of land, had little economic significance. Now, when larger units of costly machinery are used, the handicaps offered to cultivation by stumps, irregular or small fields, time required to move from field to field, open ditches in the field and uncultivated terraces, have an appreciable economic significance. In certain areas, shifts in the nature of production, apart from the changes in technique, have made the prevailing farm layouts obsolete. A new cropping system may require a change in the arrangement of the fields, perhaps in the number of fields, if the farm is to be operated to best advantage.

Even on farms with an acreage large enough to justify the use of mechanical equipment, a farm layout which could be operated with horses with little disadvantage might need revision before it could be effectively operated with mechanical power and equipment. Tractors can not be used to best advantage in fields with short turns or containing obstructions. For the effective use of machinery, the fence lines may have to be straightened or removed. In those sections where terraces are necessary to prevent erosion, narrow terraces may have to be replaced with broad-based ones, as in certain sections of the eastern cotton belt, to permit of the use of tractor and power equipment. On the other hand, a shift from grain to livestock farming may require an adjustment of fields and fences to include temporary or rotation pastures, if not an entire revision of the farm layout. The consolidation of two or more farms into one requires a readjustment of the entire field arrangement, and also presents the alternative of either maintaining more than one set of buildings or of shifting and rebuilding one of the farmsteads.

In any case, the problem is that of balancing the disadvantage of maintaining present arrangements against the costs of making revisions. This involves a comparison of the time and expense now required to perform the work of the farm, with the costs of making a change and the estimated time and expense required to accomplish the same amount of work after the revision is put into effect.

Sources of information.

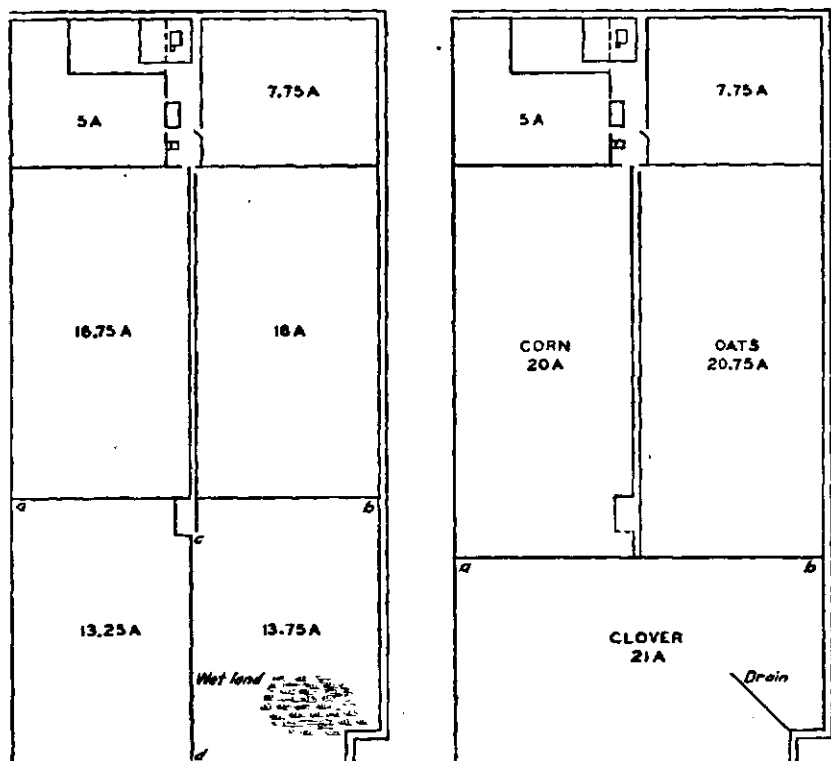
The information should be drawn from individual farms on which the change in method of operation or the combination of holdings has brought about a need for a change of farm layout. Records of the time required to perform work under certain situations, the time and expense of making a change, and the time required to do the same work after a change has been made, are not likely to be available and may not be obtainable.

The effect of shape of fields on the time required for different operations can best be secured from controlled experiment, as was done for a part of the data given in Cornell Memoir 34¹; but for an

(1) W. I. Myers, *An Economic Study of Farm Layout*, Cornell Memoir 34, June 1920.

LAYOUT OF AN 80-ACRE CORN BELT FARM AND A SUGGESTED REVISION

ADAPTED FROM USDA FARMERS BULLETIN 1421 BY H.W.HAWTHORNE AND LYNN ROBERTSON



The existing field arrangement is shown in the diagram at the left, the suggested revision in the diagram at the right. A three-year rotation is being followed on the four large fields, part of one of these fields being unillable. The two small fields near the farmstead are used for alfalfa and permanent pasture. The suggested rearrangement would provide three large fields of nearly equal size. A tile drain is to be put in to reclaim the unillable land. The cross fence, ab, in the existing layout is to be moved 18 rods toward the rear of the farm, and the fence, cd, between the two rear fields is to be removed entirely.

individual case the time required for making the number of turns due to point rows or irregularities may be computed for each replanned field before the actual change is made. Estimates will have to be made of time and costs for many contemplated changes.

Collection of data.

In general, the initiation of a study of farm layout of any farm will require a plane-table map of the farm showing the size and the location of each field with notes as to the topography, drainage, terracing, soil type and the condition of each field. The location of the fences should be accompanied by a brief description of the kind

of fence, the condition of repair, and the area of ground occupied. The map should show the farm buildings and the means of reaching each field from the farmstead. Obstructions to cultivation would need to be located and described.

Some record or close estimate of the amount of time used to do the farm work, particularly those operations which would be affected by a change of the physical arrangement, will be needed. Second, there should be an estimate of the time of the regular farm labor, the extra hired labor, and the costs of extra materials that would be used in making a change. Third, there should be an estimate of the time required to do the work after the change has been made, particularly if the change in the time required will affect the amount of labor needed on the farm. To the increased efficiency in the use of labor must be added the increased product from reclaimed land, the saving in materials used in production, or as in the case of the combination of farmsteads, the reduction or increase in the risk involved in livestock production, and the effect on the quality of the product. Some consideration too must be given to the advantage of increased timeliness of field operations.

Method of analysis.

As in the simple case shown by the accompanying illustration, taken from the U. S. Farmers' Bulletin 1421, the analysis begins with the comparison of the present layout with some of the possible alternatives. The alternative suggested in the illustration provides for a shift from a four- to a three-field system and for draining some wet land in one of the fields. This layout is suggested on account of a proposed change from a four-year rotation of corn-corn-oats-clover to a three-year rotation of corn-oats-clover. The questions are: What are the advantages of the proposed layout? are these sufficient to outweigh the cost of effecting the change? and would some other layout be more advantageous?

The change to the new field arrangement would provide for equal acreages of three crops every year. The larger fields would speed up field work somewhat, only one field would be distant from the farmstead, slightly more land would be occupied by a lane, but slightly less would be used for the fence, and the amount of fence would be somewhat reduced.

To compare the economic disadvantage of the present layout with the new, a balance should be drawn for this particular farm showing (1) the estimated cost of making the change, and (2) the estimated economic advantage arising from the change. This latter would include an estimate of the added product as a result of less waste land, or perhaps a better care of livestock, and a value of the time of men, machines, and power saved in operating the farm.²

(2) In this connection, one must consider the factors upon which an economic value cannot be placed as well as the others, although no definite weights can be given to them in the analysis.

In estimating the costs of making the change, to return to the illustration, the following data will be needed: (1) the time of men, machines, and power that would be used in removing the old fences and placing new ones, the rods of fencing material, number of posts, hours of labor, hours of use for machines, etc. The materials already on the farm should be separated from those that would be purchased. Similarly, the extra hired labor should be separated from regular farm labor which would not require an additional cash outlay. Use of farm machinery, unless direct costs would be incurred or the depreciation increased, would likely not affect the balance sheet. Fence posts supplied from the farm woodlot and cut with labor otherwise unemployed should be considered separately from posts purchased outright. For farm-produced posts, there is needed only a measure of time for cutting, and some estimate of the value of standing trees on the farm. The existing materials used in both systems would not need to be valued, since additional materials only would be charged to the new layout. In fact, only labor and materials in addition to those that would have been used for repairs and upkeep of present fences and drains would be considered. Thus, the comparative cost of a new system of fencing would be low if the old one was badly in need of replacement or repair.

Essentially the same order would be followed in estimating the cost of tile drainage. This change would involve greater cash expense, perhaps for hired ditching, for the tile itself, and a smaller proportion in non-cash items.

Finally the charges could be expressed as a series consisting of: (1) required cash outlay (2) a list of materials on the farm not to be purchased (3) use of regular man-labor, horse-work and equipment.

Unless all or a greater part of the materials must be purchased and most of the labor hired, it will be unwise to attempt to determine the cost of making the change as a single summary money figure. The man-labor needed must be considered in terms of the time of the year when it can be done with least conflict with other work and least interference with the farming operations, and whether or not it will require any extra hired labor, or add anything to the hired labor bill for the year. If it can be done at such a time as not to conflict with other work, and without entailing extra hired labor expense, it is doubtful whether any value should be assigned to it. The alternative is probably leisure, or some other work that is taken on merely as a substitute for leisure. Or if not, the satisfactions accompanying the results of such work may be sufficient reward. Even if these are not, there is no way of determining a value for such slack-season work. The best that one can do is to make a count of the amount of it, and balance this against the hours of man-labor saved by the revision, and let the farmer balance the two amounts, one of slack-season work and the other not, against each other, and decide for himself which he

thinks more important. Or some headway might be made in estimating the effect on the net farm income of having the extra hours saved by the new plan available at the busier periods of the year, to be used in expanding some enterprise needing labor at that time, or possibly in place of hired labor.

The valuation of the horse-work used in making the change will follow the same lines as for man-labor, with the exception that additional work may require somewhat heavier feeding at the time. For ordinary equipment used, there may be some slight extra depreciation and repair items.

The second phase of the analysis requires an estimate of the economic advantage resulting from the change to the trial layout. This would include:

1. An estimate of the area of land added to the cultivated area and the difference between the product expected under the proposed arrangement and that obtained under the existing system.

For example, the change that would take land out of pasture and put it into cultivation by draining would consider not only the product from its cultivation, but also the value of pasture lost through the change. Again, this value is not necessarily the total value of the product, but is the excess over the added production costs.

2. An estimate of the materials saved as a result of the change. In the illustration cited, some saving of posts and of wire would be effected. However, the value of salvaged material would be the use value or resale value on the farm, rather than cost of replacing the materials salvaged.

3. An estimate of the time saved and the added convenience. This estimate may be approached as in Cornell Memoir 34 and Ohio Extension Bulletin 85, by means of records reported from farms as to the time required to perform certain types of field operations on fields of different sizes. The valuations of the work done or saved by regular farm laborers, horses and equipment should, of course, be in terms of their relation to the net income of the whole farm business, rather than at any fixed rate per hour, etc. This means that information will be needed as to the time of year when it is done or saved, and the other work being done at the same time. Averages, moreover, are not likely to be applicable to the size or shape of fields or to the types of implements used on a particular farm. The varying sizes and shapes of fields and variations in the rate of travel will affect in different degrees the saving in time resulting from a change of field arrangement.

Two alternative methods of estimation are possible. First, data applicable to the case may be obtained from tests of the time required to do the major farm operations under controlled conditions. These tests would provide records for fields of known sizes, shape and soil, the time required to do tillage operations using given implements and units of power operated at known rates of travel. Observations

of this nature may be modified to suit conditions on the farm in question as these relate to rate of travel and size of implements. Second, for a particular farm and given type of machinery, the saving in time that would result from a new layout may be estimated in advance of the change by observing the time for turns and rate of travel with the principal implements in use on that farm. Then for both existing and proposed fields, the saving in distance traveled and number of turns may be computed for such key operations as plowing, harrowing, planting, cultivating and harvesting.

The probable advantages may then be expressed as a series consisting of:

1. Saving in cash outlay for materials.
2. A list for salvaged materials.
3. Saving in time of man-labor, horse-work and use of equipment.
4. Saving in cash operating costs.
5. Value of added product.

With these must be considered some items not readily evaluated, such as the advantage of facilitated farm work and the reduction of risk of loss by keeping livestock near the farmstead. Even in those rare instances in which the change made would involve only cash items, all the advantages would not be easily expressed as money terms.

The preceding discussion has been based on a very simple case, rearranging fields and reclaiming a small area through drainage. It has assumed no natural barriers to regular fields. Fields bounded by streams or by terraces following the contours of an elevation would present a more difficult problem. The rearranging or combining of terraced fields to make practical the use of large tillage or harvesting units might require the rebuilding of terraces and a change from a narrow to a broad-based terrace, as described in United States Department of Agriculture Bulletin 512 and United States Farmers Bulletin 1606. Some estimate of work involved and expense could be derived from a knowledge of the nature of the soil, the slope, and the work necessary. The summary would include among the expenses the time of men and machines to reterrace the land and to shift fences; and among the advantages, the economy of subsequent cultivation, value of the product from reclaimed land, and if a factor, the advantage of better tillage and conserved soil productivity. From such engineering bulletins as those on farm drainage, e.g., United States Farmers Bulletin 1606; on clearing land of stumps and brush, e.g., United States Farmers Bulletin 1526; and reports giving directions for stopping gullies, U. S. Farmers Bulletin 1234, some estimate of the work and expense involved in making changes of this nature may be obtained; but in using them one will need to separate the cash outlays from the work done with the regular farm labor force and equipment as explained above.

Rearranging the farm layout following the consolidation of two adjoining farms also presents a complicated problem. There is the question of either moving or abandoning one farmstead or of operating from two sets of buildings. Each plan would involve a different set of advantages and disadvantages. Fields should be rearranged without serious interruption to the cropping system among many other items. Ready access of fields to the farmstead, convenience to pastures, and elimination of inaccessible corners would be considered.

Although the procedure above described is in terms of the particular problems on an individual farm, as explained above, similar analyses of a number of typical farms in an area would yield many suggestions applicable to many other similar farms in that area; and in case a situation develops in an area that seems to suggest rather extensive changes in farm organization and farm layout, a combination of a survey and case analysis could be made the basis for some valid generalizations as to the need for the suggested changes. The increasing use of power is surely creating many situations of this sort in various parts of the United States.³

PROJECT 25. Layout of Farm Building and Farmstead.

OBJECTIVE: To determine the most desirable arrangement of farm buildings. (Joint with Agricultural Engineering.)

This would be similar to Project 24 above. Consideration would be given to factors such as fire hazard, sanitation on livestock farms and the comfort of workers and livestock in inclement weather, as well as to possible saving of time and cost of rearranging buildings. Non-economic factors would be important in connection with the location of barns and other buildings with respect to the farmhouse.

PROJECT 26. Standards of Performance or Operating Ratios, Etc.

OBJECTIVE: To determine certain rates or ratios that may serve as guides in farm organization and operation.

(By J. D. Black.)

These rates or ratios may take such forms as the following:

1. Acres plowed per day
2. Man-hours per acre
3. Man-hours per bushel

(3) Although possibly inferred, nowhere is it specifically stated that farm operations for a full crop rotation must be considered in the relative advantage of old and new systems with regard to shape and size of fields. In considering the added product value, a full crop rotation must be considered rather than just one year under changed conditions of added land, changes in size or shape of fields. No consideration is given to comparative advantages or necessity of major and minor rotation fields on livestock farms. (A. G. Black.)

4. Feed per hundredweight of milk
5. Crop-acres per man
6. Ratio of working to fixed capital
7. Yields per acre
8. Production per cow
9. Value of product per acre
10. Income per man-hour
11. Net earnings per man-work unit

The method of determining these various rates or ratios depends in considerable measure upon the uses which they are to serve. Following are some of the more important of these uses:

1. *As standards of good performance.* Examples: Acres plowed per day, tractor-hours per year, crop acres per man. Yields per acre and production per cow may also come under this head; also income per man-hour, and net earnings per man-work unit.

2. *As goals to be achieved.* This may be ordinarily something more than what is now considered "good performance". The Soviet government is constantly setting up such goals in its efforts to increase efficiency of production. This goal usually takes the form of output of work per man or machine or plant, or output of product per unit of raw materials.

3. *As input-output ratios to be used in determining least-cost and highest-profit combination.* Examples: Pounds of feed per hundredweight of milk or per pound of gain in weight.

4. *As quantities to be used in constructing farm set-ups and budgets.* Examples: Amounts of labor needed to care for a given number of cows or acres of tobacco; pounds of feed per cow.

5. *As guides to organization.* Examples: Percentage of working capital, investment in buildings per acre, animal units per acre or crop-acre.

6. *As quantities to be used in constructing indexes of unit cost of production.* These will ordinarily be in terms of actual performances.

7. *As "necessary" quantities of input in order to secure production.*

These rates or ratios must be thought of as something different than mere measures of relative performance on different farms. The essential idea is that *some definite quantity or amount is chosen in each case to serve as a guide or goal or basis for something.* Other quantities or amounts will in most cases be computed for the various individual farms, to serve as measures of relative performance between these different farms, perhaps even for the purpose of comparison with the "standard", etc. But this project is concerned only with establishing the *one quantity or amount* which is the *standard*, the *goal*, the *guide*, the *basis*, etc.

Several general explanations must be made for all these rates or ratios and all the different uses to which they may be put. First, no one rate or ratio can be considered as a guide, goal or basis independently of other rates or ratios. Thus the amount of fertilizer per acre chosen as standard, goal, etc., must be considered in relation to the amount of cultivation per acre, the amount of seed used and the amount of fertility already in the soil; the crop-acres per man must be related to amount of horse-labor and machinery used, the type of machinery, the system of cultivation, the size of farm, etc. It follows from the foregoing that the maximum (or minimum, as the case may be) possible rates or ratios can seldom be chosen either as guides or goals; they usually result from a misuse of other factors of production, using too much or too little of them as the case may be; and that any rate or ratio must be considered in relation to the accompanying conditions above mentioned.

Second, the choice must take account of the period of the performance. Very high rates of performance may be preferred if one is concerned with output only for a short space of time. In most cases, one is interested in output over a longer run.

Third, account must be taken of economic conditions. The sought-for performance when land is cheap and labor dear, and when feed is cheap and butter is high, is very different from what it is under contrary circumstances. Relative prices of goods and services used in production as well as relative prices of products must be taken into account.

In much discussion of standards and operating ratios in agricultural production, the phrase "unit requirements" is freely used. Such a phrase implies that a definite quantity of the various input factors is *required* in order that a unit of product be produced. It follows from the foregoing discussion that such a concept is wholly false—except in connection with No. 7 of the uses of such rates or ratios listed above, the necessary input use; and even in this case a careful definition of the word *required* is needed, as explained later. For all the other six uses, the size of the rate or ratio is a variable depending upon price, amounts of other input factors used, types of other factors, farm practices, period of performance, and a score of other circumstances.

Accordingly in this report on research in Farm Management, the editors have commonly substituted for "unit requirement" some term or phrase indicating more exactly the particular sense intended. In a majority of cases, the substitution has been "amount used", or "input" or "average amount used" or "average input", since the figure presented has either represented simply the actual use occurring on some farm, or the average use on the farms of some survey or some route. In other cases, some chosen amount, such as a "standard" of good performance, has been intended, and has been so indicated.

Perhaps it is helpful to point out that the phrase "unit requirement" came into use in the United States in the period of the War and just following when talk was common of basing prices on cost of production; and that it has lived on and has been carried into uses that have nothing to do with such a context.

It will not be possible to outline in detail the research methods involved in obtaining these seven types of measures. The methods involved have much in common, especially in so far as the mere collecting of the data is concerned. The data needed may be secured as parts of various projects already outlined—particularly Projects 8, 9, 14, 17, 18, 19 and 22. What follows will consist of a more ample explanation than given above as to the nature of each of the seven uses, and a brief statement as to the analysis involved, the data needed and method of collecting them, and as to the form and scope of the research project required.

Standard of good performance.

This type of rate or ratio has been in use longest in the United States of any in the above list. U. S. D. A. Bulletin No. 814 giving data as to a day's work at various operations is an early example. It is to be presumed that these workdays represent amounts of work that could be accomplished working continuously at a rate that could be kept up day after day under circumstances, favorable in general, but of the sort commonly prevailing in the area. They are thus good criteria by which any producing unit can judge its own performance. If it does not equal them, it needs to determine why, and make such changes as necessary in order to obtain them, unless the reasons are such as to justify a lower rate of performance. There are, of course, many such reasons; for example, it may be cheaper to have a boy get three-fourths of a day's work out of a team than to have a man to get a full day's work out of it; or to use a make-shift team occasionally than to maintain an extra first-class team for the sake of twenty days of team work a year.

The method of obtaining such standards is to have records kept of actual operations on a number of farms—50 or more preferably—and then select a smaller number of particular performances—possibly 10 to 15—that seems most nearly to conform to the above definition of a "standard" or "normal", and then study these carefully to see what accounts for the minor variations between them; and out of this derive some sort of representative figure, in the manner explained below.

It follows from the foregoing that rather full details must be collected as to the special conditions connected with each performance—the age and type of labor, the weight, age and condition of the horses, the type and condition of equipment, the type and condition of soil, the condition of the crop being cultivated or worked upon, the size and shape of fields, the rate of walking of the horses,

the temperature and other working conditions, etc. An important part of the analysis will be deciding which variants of the above conditions are "normal". The basis for this will be relative frequency of occurrence for the most part; but it is conceivable that some variant as "abnormal" as lodged grain, or poor equipment, might occur most frequently, in which case the mode would not be used. *Whatever condition is chosen as normal should be definitely stated in the report of such a study.*

Frequency tables of the performance on all the farms covered should be included in the report so that those using the standards chosen can see where in the different distributions the standards come. Such frequency tables will also be of some value in choosing the smaller group of farms for special analysis, but for the most part, this will need to be done, as above indicated, by making frequency tables of the accompanying conditions and taking the mode for each of these except as indicated. The performances selected will be those which combine modality most nearly with respect to all these conditions at once. These will ordinarily be somewhat above the mode for the whole group.

Even though the farms selected approximate modality as to many conditions affecting performance, there is likely to be a considerable range in the actual performance due to such things as the workmen, defects in equipment, poor technique, etc., that cannot be measured and reduced to frequencies. The average of the variations due to such factors probably includes much that is not up to good standards in these matters, so that one cannot accept it as a satisfactory figure. Two other procedures are possible, the arbitrary one of averaging the best half or some other of this group; or selecting as a matter of judgment a group of three to six performances that seem to represent a reasonable standard of good condition of equipment, technique, etc., and taking the average of these. The average in both cases has the effect of eliminating chance or compensating variations. No doubt in some cases a single performance may be chosen.

If certain variants, such as in type of equipment or method of cultivation, are repeated frequently enough in the area, it will be desirable to have standards of performance worked out for each of these. This will of course increase the number of records to be obtained.

The results of such analysis depend considerably upon weather and other related conditions that vary from year to year. Averaging data for 3 to 5 years corrects for this to some extent. A more adequate procedure is to use the variations found in different years and on different farms as a basis for estimating the performance in a given year of normal weather, etc. The data from a single year's records can sometimes be adjusted to normal with a fair degree of success.

It is apparent from the foregoing that the conventional route study does not include enough farms to provide the broad basis needed for selecting normal performance; or if it does, it covers the whole farm business in a general fashion, and does not furnish the detail needed for particular operations. The conventional farm business survey includes farms enough, but far from sufficient details as to particular operations. To be sure, standards of a sort can be derived from ordinary route data. An early example of such standards is found in Minnesota Bulletin No. 205 on farming systems in Southwestern Minnesota by G. A. Pond and J. W. Tapp. In this case the analysts simply took the best or near-best performance found in the small number of farms covered, excluding, however, any performance that was unusually good because of unusually favorable circumstances. How the results would have differed if a sufficient sample of farms had been taken, is difficult to say. Even within the small group used, two or three different cultural practices or sizes or types of equipment appeared for some operations; and of course very little accompanying detail had been collected. (The route had been planned primarily to provide unit costs of production.) Some of the later route studies that have included more farms and have had such standards in mind as one objective of the project have provided more satisfactory standards.

Project 22A above presents the difficulties involved in obtaining such standards from survey data. Mr. Hammerberg found a very wide range between performances on different farms, and was able to discern a few major reasons for these that were of value as a basis for extension work in reducing costs. But only such detailed analysis as represented by the silo-filling study (Project 22C) would furnish the basis for setting up any standards.

The most effective type of project for obtaining standards of good performance is a supervised record-keeping study of a single operation or group of related operations, following rather closely the lines laid out in Project 20B above (Tolley and Kifer). The field workers will begin the project by collecting certain data needed for the farm business as a whole, and at the same time getting the cooperating farms to agree to keep the daily records of the operations, and supplying them with the necessary forms and explaining their use. The field men will follow this by visiting the farms while the actual operations are in progress in order to check the records and get the necessary accompanying detail.

However, it is entirely feasible to combine such a procedure as just outlined with an ordinary farm business survey by putting route men in the field during the period of the operations being studied; or combine it with a route study by including a sufficient sample of farms and using an extra field man or two to get needed records and detail during the period of the operations being studied.

The standards which the foregoing analysis presumes are those of the simple physical types such as outputs of work done in a day. Economic factors affect these outputs only to the extent that they strengthen or weaken the incentive of the workers, and as they cause different proportions and types of the factors of production to be used with each other. This latter difficulty can be met if the standards set up are in terms of a given combination.

In practice, however, farm management workers sometimes have endeavored to set up standards of good performance of much more complicated types, such as crop-acres per man, man-hours per bushel, income per man-hour, and even unit costs of production. Let us consider briefly a few of such possible standards: first, *man-hours per acre*. Such a figure represents the composite effect of substitution of man-labor, horse-labor and machine-labor for each other; of the degree of care given the crop; of the yield per acre; of condition of soil, type of equipment, etc.; of diligence of the labor and skill in applying it; etc. The first difficulty is the complex of conflicting factors that is involved. More important is the question whether as one would suppose, "good" performance in such a case really represents a small or a large amount of labor per acre. It represents a small amount only if it is cheaper to use horses and machines largely in place of labor; or if such a sparing use of labor does not reduce the yield uneconomically. A given number of man-hours per acre can be declared good performance only if based on comparative cost-rates of production goods and on prices of product. No simple frequency analysis such as outlined for a day's outputs can determine it. It varies both in time and in place—even from farm to farm. Hence, while such figures as crop acres per man computed for each farm for an area may serve as measures of relative labor intensity and the like, to select one such figure to serve as a guide as to how much labor per acre is good performance is very difficult; and if such a figure is selected, it should be in such form that it can be revised readily. (See Chapters XI and XII in the writer's *Production Economics* for further detail.) At the best, conditions affecting good performance will vary so much from farm to farm that any one figure selected will need to be readily adjustable to fit these conditions; or else such wholesale allowance will need to be made for the special conditions on each farm that it will have little meaning as a standard.

As confused a mixture of influences as the foregoing is represented in *man-hours per bushel*, with considerably more emphasis on the relation of inputs of labor and other production factors to yields and to prices. Given, however, a certain producing combination—amounts of fertilizer, types of equipment, etc.—one can determine with any given set of cost-rates for labor and these other production agents, and any given price for the product, what amount of labor per bushel of product will give most economical production on one

particular farm under one particular management; or for that matter, on an average farm with average management, if such a figure would have value as a standard of good performance, which may be doubted; or on an average of several of the nearly best managed farms in the area. But as with crop-acres per man, the figure selected would need to be much qualified if applied to any one farm, and readily adjustable for changing economic conditions.

A figure for unit cost of production has the advantage over the foregoing that it combines all of the productive agents—labor with fertilizer, equipment, etc. The figure selected as good performance on this score would need to approach somewhat nearly the cost of producing a unit of the product that gave highest profit to the farm business as a whole. In practice, few farmers obtain their highest-profit combination, and one can hardly set up a figure representing this as just “good” performance. Needless to state, moreover, this is also a figure that requires a far more complicated analysis than normal day’s work, or even crop-acres per man. It is much more subject to changing cost-rates and prices and farm technique; and to variations from area to area, and farm to farm, the latter because individual capacity and efficiency in management are so large an influence upon highest-profit combination. Some farmers make their largest profits by combining very low unit costs with a relatively small output; others by combining moderately high unit costs with a large volume. The latter type of farmer would scarcely want to use the unit cost of the former as his standard of good performance. (See the writer and Professor A. G. Black’s discussion of this in Chapters VII and VIII of their *Production Organization*.) In agriculture, there is also the further complication that a large part of the labor and of the other elements entering into the production of a unit of product have no determinable cost-rates. Arbitrary valuations are frequently given them; but one does not settle any question by assigning an arbitrary value to some of the factors entering into it. It may be argued that if the same cost-rates are applied to all the farms in an area, any resulting figures are safely used for comparisons within that area. This statement entirely overlooks the important circumstance that it is the particular supply of a given type of labor (family labor, for example), or a given type of land (tillable, for example), on a given farm that largely determines how valuable it is for any given use. Economical utilization of any grade or type of labor or land varies greatly from farm to farm in any area.

In concluding this section of the discussion, it is needful to state that in practice the standard that is most commonly devised as representing good performance is simply an average of whatever farms happen to be included in the supervised route study or survey. Enough has been said to make clear the deficiencies of such a standard. It is entirely probable that indicating in this way to half

of the farmers in an area that their performance is above the standard may help to engender a feeling of self-satisfaction that defeats the very ends sought. If such a figure is ever used, it should be presented very emphatically as being just an average, *with as much bad in it as good.*

Another procedure still freely used, that of taking the average for a group of the best farms found in a survey, is also open to objection, if serving as standards that are a composite of several factors or influences, since even the best may have considerable in them that is bad or only fairly good. The procedure above outlined provides for analyzing separately each of the factors or influences and finding out what is "good" for each.

As goals to be achieved.

Amounts selected as goals to be achieved need also to be carefully considered. Such a concept, in the first place, is not suited to many operations, at least without important qualifications. It could be applied to day's outputs only in so far as the amounts of these could be increased by improved skill and techniques and possibly by more diligence and better tools. To set up a goal for these that required using more machinery and power would at once raise the issue as to whether the substitution was economical. The same would be true for crop-acres per man and man-hours per bushel. Unit costs are commonly set up as goals in industry, and in many cases very properly so, particularly if the qualification is attached that there shall be no reduction in total profit from the business. It must be remembered that definite volumes of output are also set up as goals, and these two goals may conflict. Industry also sets up goals requiring economizing raw materials; and these also may conflict with low unit costs for all cost factors combined, and with high total output. For reasons already indicated, unit costs are much less usable as goals in agriculture than in industry. Income per man-hour can be safely used as a goal on family farms, subject to certain limitations. For example, any increase that is attained by reducing the amount of such labor and employing the remainder at more important tasks is not valid, since the omitted task may represent the best opportunity for the labor not used. In general, net income from the farm business as a whole—in most cases net family income, in others net operator's income—serves better as a goal to be achieved than does unit cost or income per man-hour.

The goals that are set up in industry are commonly for single plants and take account of the special conditions at each plant. Farm management workers are frequently disposed to set them up for whole areas. This is probably feasible if emphasis is placed on the need of adjusting them to fit the various types of farms in the area, and to the special conditions on each farm; and some help is given to farmers in making these latter adjustments.

The method of determining proper goals to set up will need to follow the same general lines as outlined for standards of good performance, except that the figures selected will ordinarily be approximately the best obtained by anybody operating under any given set of conditions. In some cases nothing found in the area will represent high enough quality of performance. No doubt experimental procedures will be useful in determining goals in some cases. (See Project 15.)

As quantities of input and output to be used in computing least-cost and highest-profit combinations.

Individual farmers need to be able to determine how they should change their rates of using feed and fertilizer, the intensity of care given to an individual crop, and other similar rates, as costs of these production agents and prices of the products change from year to year, and even within shorter periods in the case of feeding. Extension specialists and county agents need to be able to help farmers to do this. As a basis for such determinations, data are needed as to what outputs accompany each input of the factors in question. These can if desired be reduced to input-output ratios. There is important advantage, however, in keeping these data in such form that receipts from sale of the additional product can be balanced directly against costs of the additional inputs. (See Chapter VI of the writer and A. G. Black's *Production Organization*; also pp. 203-222 of C. L. Holmes's *Economics of Farm Organization and Farm Management*.) The method of determining these relationships or ratios is outlined in Projects 17, 18 and 19 above. The methods of using them are discussed in Project 9.

Our concern here is with the use of such ratios as "standards". This involves selecting certain quantities as a basis for making the determination of changes needed. Can the individual farmer safely use standard figures for the area; or must he have a set for his individual farm? To begin with, the basic figures needed are physical. If they change from year to year for other reasons than differences in weather and the like, it is because of changes in technique, in feeding and cultural practices, in varieties and breeds, etc. If they vary from farm to farm, it is largely because of differences in soil and land types, in types and quality of livestock, etc. The skill of the manager and individual workmen also play a part. The answer really depends upon the extent to which the output-input curves for the different factors of production are parallel on the different farms in an area. (Nearly all farmers are operating somewhere in the downslope of the curves of either average or additional returns.) The facts as to this can be determined only by classifying the farms in areas studied and observing whether or not their curves are parallel. There is much to indicate that they do not deviate greatly from parallel in any fairly homogeneous area. If this is true,

then sets of average input and output figures for the area can be used to determine at least the direction of the needed changes, and probably roughly the amount of them. But changes in technique must be closely watched and the data revised to fit the new. Also no farmer who is using methods clearly differing from the ordinary can safely depend upon any average input and output figures.

As quantities to be used in making farm set-ups and budgets.

The use of standards in constructing farm set-ups is described in Project 8 under the "synthetic method"; also much is there said which bears on the procedure for obtaining such standards. If the problem to be solved is one of determining changes in combinations of enterprises needed in general on farms practicing a fairly definite system of farming in a reasonably homogeneous area, it is probable that average unit inputs—corn per hundredweight of pork, etc.—will indicate the direction of the needed shifts in enterprises, and roughly their extent. If the problem is one of working out adjustments for an individual farm, it will be well to have standard inputs derived for the particular farm, or at least for farms much more nearly like this one than the average.

As guides to farm organization.

It is customary in farm management analysis to say of a farm that it has too high a ratio of fixed to working capital, or too high an investment in machinery, or too low a ratio of livestock to crops. By what standards are such operating ratios adjudged too high or too low? As compared with the average? with the more successful farms? Neither of these will serve satisfactorily; the average will not because it has too much bad in it, the more successful farms because a number of things may have contributed to their success besides proper operating ratios. Any one farm may have some good and some poor operating ratios. A standard for operating ratios can be determined only by isolating by statistical or budget or experimental method, the effect of variations in each operating ratio on the income of the farm business as a whole. The values so determined cannot of course be taken to fit conditions on each farm; some farmers do best with a high ratio of livestock to crops; others not. The type of land makes a great deal of difference.

As quantities to be used in constructing indexes of changing unit cost of production.

Much interest has been expressed at times in constructing indexes of changing cost of production to accompany indexes of changing prices, it being assumed that a comparison of these two would point the way to the changes needed in combinations of enterprises. There can be no doubt that they would serve as warnings and suggestions; but further analysis would be needed to determine whether the time

had yet arrived for a shift, and how much of a shift was needed. A closely related use is that of determining changing costs by applying cost-rates to a formula of the physical inputs—as formerly in the Warren and the Pearson milk formulas. What input quantities should be used as inputs in such cases? Averages have been commonly suggested. These are what Professors Warren and Pearson each used. If figures so derived are properly understood as merely indicators of changes, not absolute indicators of cost, the average inputs may provide the basis for as representative figures as can be obtained.

If these indexes are to be related to actual shifts in production, however, the inputs wanted are those associated with the price-sensitive production. This production is found in two places—among those on the margin between producing or not producing at all, and among the regular producers at the margin of producing more or less. The unit costs of additional acres planted to cotton are either more or less than those of the earlier acres depending upon circumstances on each farm. Perhaps this price-sensitive production can be isolated by observing which producers are shifting with prices on either of these two margins, and input quantities can be obtained for this production. Such an index if it could be constructed would be a “sensitive index” of the same general nature as the Harvard Economic Society’s sensitive index of prices. One advantage of indexes of costs is that the difficulty of valuation of family labor and other input factors not purchased is evaded if not avoided, since it is assumed that the cost-rates for these factors change in the same amount as for the purchased factors.

In a period of changing technique the physical quantities to which current cost-rates are applied must be revised frequently.

The figures for cost of production published by the Bureau of Agricultural Economics in the *Yearbook of the Department of Agriculture* each year should be understood as being essentially indexes of changing costs. It would be well if they were expressed as relatives of some base year so that their nature would be at once recognized by all.

As “necessary” quantities of input in order to secure production.

The assumption in this case is that certain quantities of seed, fertilizer, labor, etc., must be paid for if the cotton is going to be produced, and that these quantities are therefore “necessary” amounts, sometimes called “unit requirements” as explained above. This idea must be handled carefully. Not at all infrequently, the quantities adjust themselves to changed prices rather than prices to fixed quantities, as they appear to be doing rapidly at present for wheat. Also some of the input factors—land in some cases—have no reservation prices—they take what they can get. Obviously the average inputs are not properly used as such required quantities,

since they would leave half of the production with less than the needed inputs. The inputs of the marginal or price-sensitive production are again what is wanted. Marginal must not be interpreted for this purpose as the very highest cost production; certainly not the highest cost in any one year. Any one year the weather may be bad. It ordinarily takes several years to force out a high-cost agricultural producer. (See "The Elasticity of Supply of Farm Products," J. D. Black, *Journal of Farm Economics*, 1924, p. 145.)

It has commonly been observed that necessary "money" costs obtained by applying cost-rates to marginal rather than to average production has produced costs clearly higher than prevailing prices. This, however, is because the cost-rates have been too high rather than the input quantities, particularly the cost-rates for labor and land.

PROJECT 27. Unit Cost of Production of Farm Products.

OBJECTIVE: To determine the cost of production (in money terms) of a unit of a farm product.

(By J. D. Black.)

The nature of any research product whose objective is to determine unit cost of production depends greatly upon the particular kind of unit cost of production that is desired. Cost of production may be, and commonly is, conceived of in different ways. It is also true that commonly these different concepts are badly confused, the researcher in some cases using a method suited to an altogether different concept. Let me begin, therefore, by stating the different concepts:

1. *Value of actual inputs*, the amounts of money actually spent upon producing the unit of the product plus the estimated value in money terms of the input factors not paid or bought. This is the cost figure most commonly sought in farm management studies of unit cost of production.

This cost figure is commonly historical, representing production consummated some time in the past, usually in the recent past; or it may be a forecast of what such a figure would be next year, or in the next five or ten years.

2. *Amount necessary to provide the producers of the product with a given content of living which is considered desirable*. This is the figure for unit cost of production which the farmer agitators have in mind when they say that "all these years the farmers have been producing for less than cost of production". What they mean is that the prices that have prevailed have not supported what they consider a decent standard of living for farmers.

The logical approach to determining such a cost figure is first to decide upon the content of living which you think farmers should

have, a task requiring the help of home economists and sociologists; then estimate what income in money will be needed to buy the parts of this content of living that must be bought; then figure backward to find what prices of the various products produced on typical farms in the area are needed in order to obtain such a net money income. If several products are involved, this may be difficult, since a higher price for one makes a low price serve for the others. The solution will necessarily involve a consideration of farm organization adjustments as well as price changes. All of the discussion in Project 10 above, "Adjustments to Obtain a Given Income", is pertinent.

The most notable attempt in this country at this kind of cost of production figures was made by a midwest agricultural organization a few years ago. The method used was not as above outlined, however, but rather that of allowing wages, land values, etc., which were considered proper or desirable, and then seeing what unit cost figures resulted. Probably little attention was given to what farm incomes would result. That the allowances for wages, land use, etc., were very liberal may be judged by the fact that the unit costs obtained for the different grains ranged from \$1.30 to well over \$2.00 per bushel; and had they been realized in price, our present agricultural surplus would have been very much larger than it is.

The most noteworthy attempt in such unit cost of production figures abroad is that of Dr. Ernest Laur of the Swiss Farmers' Union. His allowances for wages, land use, etc., are more reasonable than those of the midwest group above-mentioned; but they are high enough so that governmental aid in the form of restrictions on imports and various other devices is needed in order to get the costs realized in prices. Organized agriculture has great political power in Switzerland.

It is interesting that Dr. Laur outlined a similar procedure for the rest of the countries of the world at the request of the International Institute of Agriculture at Rome and that his report was solemnly accepted at a special conference called by the Institute and recommended for adoption to all the world.

It is obvious that the methods used by the midwest group and Dr. Laur represent a confusion of the first and second concepts of unit cost of production. This confusion makes it necessary to pretend that the cost-rates thus allowed for labor, land, etc., are based on correct valuations of these in place of being valuations thought to be desirable.

In the United States, the confusion of these two concepts has been mostly in the minds of those supposedly seeking unit cost of production according to the first concept. Particularly during and just following the World War, many farm accountants in this country were inclined to argue for higher cost-rates for family labor on the ground that young people on farms were entitled to the same returns for their labor as other people, and to allow them less was

imposing "sweatshop" conditions on American farms; and similarly to argue that rent should be figured as the same percentage of the land values as capital was earning in other lines of production.¹

This second concept of unit cost of production has a close relation to the medieval concept of *fair price* as a "just price".

3. *Amount necessary to cause producers to produce a given quantity of product*, the quantity assumed usually being average consumption or some similar quantity. This concept is very indefinite or confused in the matter of the quantity. Sometimes the quantity is expressed in terms of the supply-and-demand equilibrium. This kind of unit cost of production is commonly called "necessary cost". It relates to the concept of "fair price" in the *equilibrium price* sense. It answers best the cost question put in the form: What does it cost to get a unit of this product produced? Or: What must be paid to get it produced? But it also is a proper answer to the question: What is the cost of production of a unit of this product?—in fact, probably the most logical and most nearly correct answer that can be obtained.

There are two ways of deriving such a figure: the one consisting of applying suitable cost-rates to the input quantities of the marginal price-sensitive producers, these being determined by the methods outlined under heads 6 and 7 in Project 26; the other consisting of determining what production has followed various prices in the past, and forecasting from this what prices will be needed to bring forth various quantities of product in the future. The second is much the more promising of the two methods. The analysis it calls for is outlined under the head of "elasticity of supply" in the report in this series dealing with Prices of Farm Products.

This kind of unit cost of production is basic to all collective bargaining over prices of farm products. It should also be used by the Tariff Commission as a basis for its tariff duty recommendations. The ultimate objective of all import levies on farm products is complete elimination of imports. A necessary price analysis along the foregoing lines will indicate what custom duties would have accomplished this in the past, and will furnish a basis for a forecast as to what duties will be needed in the future. If the domestic producers have not yet got to the point of asking for complete exclusion of imports, and will take something less than this, as still is true with sugar and wool in the United States, the duties needed to secure this quantity can be determined in the same way.

The unit costs of production now obtained by the Tariff Commission are nothing more than values of actual inputs in the recent past—unit costs of the No. 1 type above. If they were worked out for a sufficient period so that a forecast could be made from them as to what such unit costs would average in the period to which the

(1) See U. S. D. A. Bulletin 994, *Methods of Conducting Cost of Production and Farm Organization Studies*. (F. W. Peck.)

tariff duties were being applied, they would give a figure that would closely approximate necessary costs *if nothing but actual reservation wages* (what must be paid or the work would not be done) were allowed for the labor used, and *actual reservation rents similarly for land*, etc., and *except for the circumstance that the cost-rates even on this basis reflect the existing custom duties, but with some lag, and hence are higher each time a cost determination is made after a new tariff duty has been in effect for a while.* The problem of determining necessary tariff duties will be discussed in the report in this series on Agricultural Policy.

Historical unit costs of production.

In practice, most unit cost of production analysis is in terms of value of inputs in some recent production operations. The significant uses to which any such unit costs can properly be put once they are obtained are as follows:

1. In theoretical analysis of the relation of normal costs to normal prices, of increasing and decreasing costs with volume of output, etc.

2. As measures for indicating the relative efficiency of use by different farmers of the combination of input factors used. Thus a farmer whose combined cost of labor, land, fertilizer, seed, equipment, etc. used in producing a bushel of potatoes was 60 cents would be said to be using these input factors more effectively than one whose combined cost was 70 cents, if we assume they had been evaluated on a comparable basis.

3. As standards of good performance, goals to be achieved, as outlined in Project 26.

4. In combination with prices to determine for any farm the profit per unit with the input factors combined as then; and relative profitableness of different enterprises for any farm with the enterprises combined in their existing proportions.

If, however, unit costs of production representing value of actual inputs are to be used successfully in these four ways, they must be reasonably accurate determinations. These can be obtained without great difficulty on farms where one crop or product only is produced, such as on a large wheat farm, or on one whose only product for sale is fluid milk or eggs; and where at the same time all the labor, equipment, and supplies are bought in the open market. There are thousands of farms in the United States where these conditions maintain. There is a larger group which can be handled as satisfactorily by treating certain minor products as by-products, and considering any cash income from their sale as by-product credit.

On a much larger group of farms, such determinations could be made with reasonable accuracy were it not that the labor is in large part performed by the farmer and his family. No one of the first three of the above list of uses of historical unit cost figures (the

fourth is not involved, since we are assuming only one product on a farm) is sound unless such labor is properly evaluated. To value family labor at what it costs to hire labor to do the same work will give normal costs which are higher than normal prices because in practice much work is done where family labor is available that would not be done if labor had to be hired for it. It is also impossible to determine with sufficient accuracy how much time a hired laborer would have taken to do the work. Labor cannot be considered by itself in such calculations—the boy may get only 80 percent use of the team and equipment. How much under the circumstances would be his net contribution to the product? If work is not pressing on the farm, as during a considerable part of the year, there may be no purpose in keeping the team working at 100 percent capacity; at other times, full use may be highly valuable. In practice, the services of family labor are overvalued on this score also, and again normal costs are higher than normal prices.

The decision as to what work would or would not be done if family labor were not available is almost impossible to make—the best guide would probably be a comparison of work done on farms with and without a given unit of family labor, and otherwise similar as to size, main product and side-lines, etc. On some farms, the feasible procedure if family labor were not available would be to hire a man for the whole year, or for the season, in which case part of the same work might be done anyway just to keep the hired man busy at slack seasons. On other farms, extra labor would be hired only at peak-load times and the farmer would adjust his production to such a basis. In the second case particularly, the cost-rate allowed for the family labor would vary with the season of the year.

If the use of the results is in a comparison of efficiency on different farms, and in setting up standards of good performance, the same difficulties arise. A farmer with much family help may be using it in the most economical way open to him, but unless the use of such labor is valued in such a way as to allow for the circumstances above indicated, he will be made to appear inefficient because of having high unit costs.

The writer and Mr. C. M. Purves² in 1923 made an attempt to collect some evidence on the foregoing points by collecting data from over four hundred farms in southwestern Minnesota as to the labor used at different seasons of the year, the work at which it was employed, the load of work on the farm, and the wages paid for hired labor. Our analysis of the data showed that the more family labor available relatively, the larger the relative acreage in corn and other crops requiring considerable labor, the more cows milked, and the larger proportion of cows freshening in the fall. More careful analysis would have shown less of the work on the corn done with

(2) Now in the Division of Statistical and Historical Research of the Bureau of Agricultural Economics.

machines or large-gauge machinery, and more cultivations and other operations. A further step in the analysis multiplied the number of acres of each of the crops and number of head of each class of livestock, by the average labor inputs for the area, determined by the Division of Agronomy and Farm Management in a route study in the same area, and related the results of this to the type of labor supply on the farms. The ratio of labor inputs computed to labor force ranged from distinctly the highest on farms where the operator did all of his own work except for hiring extra labor by the day at peak-load times, next lower on farms where extra labor was hired for a couple of months, to next lower on farms where extra labor was hired for the season, to next lower on farms where hand labor was employed by the year, to next lower on farms where only mature family labor worked at home all year, and to lowest of all on farms where one or more boys were the only help of the operator. The range between the two extremes was wide.

Valuing the proprietor's labor is beset with equal difficulties. If the costs resulting from such analysis are to be related to normal prices, the cost-rates allowed for proprietor labor must reflect the actual reservation prices of the proprietor labor—what the farm operators give evidence of by their decisions as to the income in money and goods needed to keep them producing the product in question. The best criteria for these are the actual decisions of farmers in the area. At what incomes are they shifting to other main lines of agricultural production? or from farming to other occupations? Obviously no one answer will fit all farmers. Several times as much income may be needed to keep some in production as to keep others. No farmer knows what his own reservation price is. Any figure he might give would depart widely from what his actual decisions would be as incomes were lowered. Commonly he would estimate too high a reservation price.

Valuing the use of land is not simple even if all is in one crop as assumed above. The figure wanted is the one which if not earned by the land in this use will cause it to be shifted to some other use—from wheat to ranching, perhaps; or to go out of use altogether if it is marginal for all agricultural uses. Where land is commonly rented for cash in the area, this figure may serve as a basis for such a valuation. Commonly land use is overvalued in such analysis.

A major difficulty if the unit costs are to be related to normal price is that in small units of the family-farm type requiring a large amount of managerial attention, some appreciable element of return for this must be included in costs; but there is no possible way of placing a valuation on such management.³ Commonly no allowance

(3) Management need not be allowed for if the second and third of the above uses of unit cost figures are involved. The variations resulting, however, may be due either to different amounts of managerial attention given to the business, as commonly on the smaller farms, or to differences in the ability of such management.

is made for it, and this is an element offsetting in part at least the over-valuation of labor and land.

Let us consider farms producing several products. If the determinations of unit costs of production are to be sufficiently accurate to serve the first three uses above listed, and in addition the fourth use of deciding the proper balance of enterprises, the following additional conditions must be fulfilled:

1. Wages of hired labor must be distributed between the different products using such labor according to the values of the alternative uses of it at the particular times of the year and of the day (chore labors, field labor). Otherwise the crops using labor at peak-load times will be made to appear more profitable than they should.
2. Allowances for family labor and proprietor labor must be similarly distributed.
3. Use of horse-labor must be evaluated in the first place—it is not necessary to evaluate it if only one product is involved, the cash outlays upon it being changed directly to the final product; and in the second place this valuation must be distributed between the different products the same as man-labor, and according to the same principles of valuation.
4. Use of all machines used on more than one product must be similarly evaluated and distributed.
5. Use of barns must be similarly evaluated and distributed on many farms.
6. Land use charges must be adjusted for the different types and grades of land in the farm and for the different crops combined in a crop-rotation system. The charges for the different crops depend upon the amount of plant food used by each, or contributed by each (in the case of legumes), the effect on the physical condition of the soil, on tilth and weed control, upon contributions received from other crops (nurse crops, etc.), and most important of all, upon value of land when used for other crops capable of substituting for it in exactly the same place in the crop-rotation plan.
7. Evaluations must be made for products or by-products of one enterprise or line of production that are used by another—feeds, forage, manures, etc.

Much attention has been given to the matter of evaluation of the input factors used in producing farm products. Below is a list of the principle sources of information on this subject. In none of them will the reader find adequate provision made for fulfilling the foregoing seven conditions. Much of the discussion largely evades such problems as the foregoing.

Hays, W. M. and Parker, E. C., *The Cost of Producing Farm Products*, Minnesota Agricultural Experiment Station Bulletin 97, 1906. (Bulletin 48, Bureau of Statistics, U. S. D. A.)

- Warren, G. F., *Farm Management*, 1913.
- Ladd, C. E., *A System of Farm Cost Accounting*, U. S. D. A. Farmers' Bulletin 572, 1914. Revised by J. L. Ball, 1920.
- Scovill, H. T., *Farm Accounting*, 1918.
- Report of the Committee to Consider Methods of Procedure in Making Cost-of-Production Studies*, U. S. D. A., Office of the Secretary, Circular 132, 1919.
- Adams, R. L., *Farm Management*, 1921.
- Peck, F. W., *Methods of Conducting Cost of Production and Farm Organization Studies*, U. S. D. A. Bulletin 994, 1921.
- Bennett, Merrill K., *Farm Cost Studies in the United States*, 1928.
- King, J. S., *Cost Accounting Applied to Agriculture, As An Aid to More Productive Farming*, 1927.
- Carslaw, R. McG., *Farm Management Research Technique*, College of Estate Management, London, 1931.

The last three on the foregoing list are critical in varying degrees of the results obtained by accepted farm cost accounting techniques.

The reader will find considerable analysis bearing upon the use of such techniques in such books as:

- Aereboe, Freidrich, *Allgemeine Landwirtschaftliche Betriebslehre*, 1923.
- Black, John D., *Production Economics*, 1926.
- Holmes, C. L., *Economics of Farm Organization and Management*, 1926.

The nature of the problem of distributing labor expense between different products is revealed by a special analysis of the data of a Minnesota route study made by the writer and Mr. C. M. Purves in 1923. First, the wage data obtained for the several hundred farms described above were used as a basis for determining separate winter and summer cost-rates for labor on eight farms taken for more intensive study. Using these rates made the enterprises using winter labor—principally the cattle enterprise—appear a little less unprofitable, and the corn enterprise a little less profitable. Substituting monthly cost-rates for season rates increased these effects somewhat; but did not make enough of a change to account for the existing type of farm organization. Tests made in terms of the effect on the net farm income of omitting or reducing the cattle enterprise, the oat enterprise and others appearing to be unprofitable, indicated that the accounting results even when using monthly cost-rates for labor, gave wrong indications.

As a next step, a method was used which was called the "specific cost" method. It can be explained most simply in terms of horse-labor. A tabulation was made of the number of horses working each day of the year. It was found that on Farm A, for example, all 9 horses worked only 12 days, 8 horses only 34 days, 7 horses, 40 days, etc. It was assumed for the sake of simplicity of analysis that all the horses were alike, and that the one particular horse actually

worked 12 days only and was idle 353 days. (The fact that in practice the work and the idleness were distributed more or less between all 9 horses does not affect the results appreciably.) Costs of keeping horses working 353 days, 351 days, etc., (production ration + maintenance ration) were then computed and divided by the number of days that each horse worked. The rate for horse No. 9 on this farm was around \$8 per day; for horse No. 1, which worked 300 days, around \$.50 per day. Then each farm enterprise was charged for horse labor according to the rates of the horses that worked upon it—in effect, at an average rate that increased with the number of horses working on any enterprise that day. All of the labor for horse No. 9 was charged to the corn enterprise except two days for threshing. The average rate for corn work in the 10 days when 9 horses were working on corn was an average of rates from \$.50 to \$8 per day. A good share of the labor for horse No. 1 was charged to the cattle enterprise. The theory at the basis of this method is that two enterprises made necessary the keeping of the ninth horse, and that these should pay the full cost of keeping it.

The method was used with both man-labor and horse-labor on the eight farms. The effect was to produce a very definite shifting in the results in the needed direction; but the corn enterprise still appeared to be clearly more profitable, and the cattle and oats enterprise, definitely less profitable, than other evidence indicated to be the fact. *Even this method overcharged for man-labor and horse-labor done at times when there was little else to do of any importance.*

The following year the writer and Mr. Roy M. Ballinger⁴ estimated the average unit cost of production over a 10-year period, using the specific cost method for man-labor and horse-labor, for each of the crops grown on these eight farms, omitting charges for land use; then reduced these to an acre basis and compared the results with the average sale value per acre of the different crops. This was an attempt to compare normal costs with normal prices. The differences represented a combination of values of land use, of returns to management, and of remaining errors in the cost-rates for man-labor, horse-labor, etc. It is also true that the value of the feed crops to the farm business may have been considerably more or less than the market prices that were allowed for them. The actual difference obtained ranged from around \$2 per acre for the oats enterprise to around \$8 for the corn enterprise. If the labor charges had been more nearly right, the differences would have been still wider. The results conform with the above discussion of rent charge in crop rotations.

The foregoing "experiments" with cost-rate procedures do not provide us with a satisfactory method; but they indicate the general form which such methods must take; also the very great difficulties involved.

(4) Now at Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma.

In the meantime at least, the purposes which such unit cost of production figures would serve can be realized with a fair degree of satisfaction—probably as high a degree as will ever be attained by cost accounting procedures on family farms with several lines of production—by simpler and more direct methods outlined in other projects in this report; balance of enterprises by Projects 8 and 9; combinations of input factors by Projects 17, 18 and 19, standards of good performances, etc., by Project 26; etc.

It should be made evident at this point that even though unit cost of production figures were obtainable in reasonably accurate form, to determine highest-profit combination of the input factors, one would need a series of unit cost and unit profit figures representing various input combinations; similarly, to determine highest-profit combinations of enterprises or lines of production on any farm, one would need a series of unit costs and unit factors representing various combinations of enterprises, since, as is frequently not recognized, unit costs of any product depend upon the proportion between this and other products in the total output of the farm. The cost of producing corn on a given farm with 40 acres in corn is almost certain to be appreciably different from the cost with 80 acres in corn on the same farm—it may be more or it may be less, principally depending upon the extent of conflicts in the use of labor and equipment.

As explained above, unit cost of production figures consisting of values of inputs are used by some people for other purposes than the four designated as appropriate. For example, also as indicated, they are sometimes used as a basis for determining necessary tariff duties to prevent imports. Suffice at this point to say that if they are going to be so used, they should be calculated accordingly. Unit costs for tariff-making purposes are definitely different from unit costs to be compared with normal prices or to be used as standards of good performance. (See report in the series on Agricultural Policy for further discussion of this.)

PROJECT 28. Developing Systems of Records and Accounts.

OBJECTIVE: To devise systems of records and accounts for use by farmers in analyzing and budgeting the business of the individual farm.

(By R. R. Hudelson and Ralph H. Cole.)

Stated in more detail, the objective of this project is to determine what are the best types and kinds of records which the individual farmer may use in planning the organization and operation of his business. The major emphasis is placed on the problem of developing systems and devices which will be of assistance to the farmer directly as distinguished from methods of securing research data.

This project is designed to develop and test systems of accounts and records for use under two different sets of conditions as described below:

- A. The case of the individual farmer working alone.
- B. The conditions which exist where the farmer works in cooperation with other farmers through an organization which provides assistance to the extent of analyzing the data and setting up standards. Examples of such organizations are agricultural college extension services and membership organizations in which the farmers as members employ a field secretary to supervise and analyze their accounts and records.

The extent to which the individual farmer working alone may analyze and budget his business will depend to a large extent upon his training and experience along these lines. In a community in which the general level of education is relatively high, the individual may be expected to keep records of classified income and expense, as well as records of physical relationships, that will make possible a simple analysis of his business. In all cases, however, the individual working alone will find it difficult to set up standards of performance. In drawing up a budget, he will find it difficult to estimate either physical inputs and outputs or money costs and income for any line of action other than that which he has actually followed. To supply this need, agricultural colleges or other agencies may find it advisable to develop standards based upon data secured from other records kept under similar conditions. (See Project 26 above.)

If supervision is provided, a more complete system of records and accounts may be used. The degree of completeness will depend upon the amount of help which it is possible for the field man to give to each farmer. Supervision and assistance are more important in the analysis than in the actual keeping of the records. Complex methods of analysis may be used, but it is important that the results be presented in such a way as to be readily understood by farmers.

Procedure.

In making investigations relating to accounts and records adapted to the conditions of the individual farmer who works alone, the following steps are suggested:

1. Review available literature on the subject of accounts and records. In addition to books which have been written on the subject, a number of circulars and bulletins have been published by state experiment stations and the United States Department of Agriculture.
2. Assemble farm account books and record forms which have been developed by agricultural colleges and commercial organizations.

3. Analyze the forms secured in order to determine their fitness for farmer use, and their ability to supply the data needed in planning the organization and operation of a farm business in the particular area.
4. Visit farmers in representative areas for the purpose of determining what kinds of accounts and records are being kept.
5. Draw up several tentative forms and place a number of each in the hands of farmers who express a willingness to use them.
6. Visit each farmer at the end of the accounting period, check the keeping and analysis of his records, and secure his reactions as to the adaptability of the forms to his methods of doing business.
7. Analyze the results secured by using the various tentative forms with a view to determining which is the most satisfactory for the conditions found in the area.
8. Draw up a set of forms based upon the results secured.

In making investigations of accounts and records which farmers may keep in cooperation with some organization, the procedure will be the same, except that the investigator will need to keep in mind constantly the way in which the account books and records are going to be used; and will need to give to each cooperator who is given a tentative form to use, such assistance and supervision as might be expected from an agricultural college extension service or a membership organization. The analysis of the results with the different forms will also need to be considered from the standpoints of their adaptation to the time available and capacity of farmers for keeping records, and the effectiveness of the results in answering management questions as well as supplying the data needed for budgeting.

Investigations for the purpose of developing budget forms probably can be most successfully carried on with farmers who have kept accounts and have thus secured information which may serve as a basis for their budgeting operations. If the individual farmer is to draw up a budget which will be useful to him in planning the organization and operation of his business, he must have certain basic information concerning his own business. This class of data may be secured from accounts and records kept by the farmer himself. He may or may not receive assistance in the analysis and application of the data secured. In addition to such data as he can secure for himself, the farmer who attempts a budget may have need for information showing input-output relations for enterprises which have not as yet been included in his farm organization and for methods of production which he has not used. He will also need information that will aid in judging the prices to be expected for the products to be sold and the prices that will be paid for the commodities and services to be purchased. Such data as needed for these purposes may

be furnished by agricultural colleges or other organizations equipped to do so. In developing budget forms, the suggested procedure is as follows:

1. Review available literature on the subject of budgeting.
2. Draw up several tentative budget forms.
3. Develop needed reference data which farmers will not be able to secure from their individual accounts. These data include input and output relationships, such as feed consumed per hundred pounds of gain, and relation of kind and quantity of fertilizer to crop yields. In addition, sources of outlook information which might aid in making decisions should be cited.
4. Make appointments with individual farmers and assist them in drawing up budgets based upon their own records and the general data prepared for the purpose.
5. Check the accounts of each individual at the close of the ensuing accounting period to determine how closely the budget has been followed, and at the same time, to record the reactions of each regarding the value of the budgeting system and its adaptability to his conditions.
6. Draw up a set of budget forms based upon the results of the study.

Survey of previous work.

While numerous agencies have developed farm account and record forms, little organized research in this direction has been undertaken. Such progress as has been made has been largely through the trial and error method. The forms of records and accounts which have been developed logically fall into three classes, as follows: (1) financial records; (2) records of physical inputs and outputs; and (3) farm practice records. Each of the three classes may include subdivisions, some of which are listed below:

A. Financial records.

1. Annual inventory.
2. Simple record of income and expense in addition to annual inventory.
3. Record of income and expense with varying degrees of classification, ranging from a very simple distribution to a detailed one.

B. Records of physical inputs and outputs.

1. Inputs.
 - a. Feed records.
 - b. Labor records.
 - c. Fertilizer records.
 - d. Machinery and power records.
2. Outputs.
 - a. Records of crop yields.

b. Records of livestock production such as milk yields, egg yields and others.

C. Farm practice records.

1. Records of seed treatment.
2. Records of tillage practices.
3. Records of numerous other practices.

The annual net worth statement has been used as a means of measuring financial progress and as an aid in establishing credit at the bank. The net worth statement, however, reflects expenditures for the family living and payments on capital investment as well as the net increase from business operations. For this reason it is not a satisfactory measure of the business success of the farm.

Coincident with the development of accounts and records, standards or indexes have been developed for the purpose of measuring the efficiency of management on individual farms. Although such indexes are in use in colleges of agriculture both in this country and elsewhere, a thoroughgoing research directed toward improving them has much to recommend it.

Sources of information.

Most colleges of agriculture in the United States have developed accounting and other forms. Membership organizations found in Switzerland and Denmark as well as in the United States have also developed such systems. The systems developed by farm implement companies and other commercial organizations which deal with farmers must also be mentioned. Some help can also be obtained from various bulletins and circulars dealing with accounts, records and budgets which have been published by the Bureau of Agricultural Economics and by agricultural colleges.

Personnel.

In the carrying out of this project, collaboration between the members of the research and extension staffs is desirable. The research worker is in a position to contribute a knowledge of research methods, whereas the extension worker may make his contribution through a more intimate acquaintance with farmers and a better knowledge of farmer reactions. Putting into practice the final results obtained is a responsibility of extension personnel and is likely to be done with more enthusiasm by one who has had some part in the development of the forms.

Methods of analysis.

Each tentative system of records should be considered from the following points of view:

1. Its demands upon the farmers' time and ability.
2. Its ability to answer the most important management questions of the farmer with reference to the internal organization and operation of his farm.

3. Its effectiveness in supplying the information needed for budgeting.

The final interpretation of how closely these objectives are attained, and which particular system of records and accounts most nearly accomplishes the desired end, will be a matter of judgment. The final decision will need to be supported by a constant checking of the number of records actually used, and of how generally the farmers find them helpful in securing increased earnings. Changing conditions, due to progress made by farmers as well as to other causes, will call for frequent revision.

An important problem involved in this study is that of determining whether or not farmers in a particular area or those engaged in a particular type of farming can and will keep the records needed in making an analysis such as has been described. Probably the most feasible method of answering this question is that of testing out various types of records by first allowing farmers to use them and later determining what results have been secured with each type. This plan involves the cooperation of a number of farmers, and obviously will require a considerable amount of time for completion.

PROJECT 29. Economy of Loans on Farming Operations.

OBJECTIVE: To analyze the uses, needs and nature of the credit of the corn, hog and beef-cattle system of farming in Iowa. (Joint with Agricultural Credit.)

(By A. G. Black.)

As a preliminary step in analyzing the credit problem of the corn, hog, and beef-cattle system of farming, the type-of-farming areas need to be carefully defined and located geographically. Procedure for determining the geographic location and boundaries of type-of-farming areas is outlined in Project 1 of this report. This in itself is a research project of considerable proportions.

Given the type-of-farming area, means must be found to study the uses of credit on typical farms. If the farm types in the area have been classified and described according to the procedure outlined in Project 2 of this report, the task of selecting the farms for study should not be a difficult one. Otherwise much care must be exercised in selecting a number of farms which seem typical of the area.

Credit uses and needs may best be studied through rather detailed records of the farming business covering a period of several years. Both financial and production records are needed. The records need to be about as detailed as outlined under the head of "loosely supervised" records in *Research Method and Procedure in Agricultural Economics*; but will need to include more specific details than usual on points relating especially to credit. Data must be secured on the type of credit used, whether mortgage, bank, or store credit,

amounts and purposes of the credit terms as to maturity, interest rates, security given and provisions for payment or renewal; also as to actual experience with making and repaying loans. It may be possible to secure this information by survey, but it may not be as reliable and complete as desired, or as would be if some form of farm records were kept regularly throughout the year. A combination of survey and supervised records may have much to recommend it in some areas.

For purposes of credit studies, the capital structure of the farm business must be examined more in detail than is usually the case with the typical financial projects. Provision must be made for ascertaining the capital need for land, buildings, livestock, equipment, feed and cash. Livestock capital should be subdivided so as to show the amount needed for hogs, feeder cattle and the breeding herds. Careful distinction should be made here between the capital used in the "self-liquidating" livestock where there is a fairly rapid turnover and that used in the breeding herds (both hogs and cattle). Capital used for general farm equipment, crop equipment and special livestock equipment should also be distinguished and analyzed separately; also capital used for farm-grown and purchased feeds and capital used in the form of cash. Out of the foregoing will develop the analysis of the capital structure with particular reference to the classification of fixed, intermediate and working capital, and the proportions between these for various types of farming being studied. The study of the capital should then be extended to include a complete statement of the relative amounts of the various kinds of capital that are owned and the amounts that are borrowed. It will be difficult to determine this exactly, as loans secured by one kind of capital may be used to purchase other kinds. Care will be needed at this point to find out the purposes for which the loans were made, and in the case of renewals, the purposes of the original loans. This point in itself is important, as it may be found that it is customary to supply certain amounts of intermediate or working capital through loans secured by fixed capital, or vice versa. The extent of such relationship should be determined. It will be found, frequently, that so-called "service" loans are secured by livestock or other chattels and used to pay interest on real estate mortgages, or taxes on real estate, or other fixed capital purposes.

The sources of loans used to supply the different capital needs should be determined and the terms of those loans, including such items as length of loan, interest rates, security required, commissions and any special provisions. The extent to which loans of different types are renewed should be determined. All of this information will be helpful in judging the adequacy of the sources of credit.

The data thus far mentioned have been secured from farmers and represent the nature and uses of credit from the farmers' point of view. To give a complete analysis, data from lenders should be collected. These data should deal specifically with the experience

of lending agencies with different types of loans made to farmers following different types of farming. If the sample is large enough, it may be possible by means of tabulation and cross-tabulation to relate those credit factors that can be expressed numerically to profits, size of farm, type of farming, etc. This type of analysis must be handled carefully so as to avoid spurious relationships resulting from climatic and other factors which are not considered in the analysis. Also analysis of this kind may reflect farm management relationships rather than credit elements in the situation, and it will often be difficult or impossible to separate the two in statistical analyses. It will be helpful in such cases to make careful case studies of type farms in the area, using the "budget" method of analysis, as outlined in Project 8 of this bulletin and in Project 15 of Bulletin No. 3 of this series dealing with Research in Agricultural Credit. The indications shown by these may then be tested out statistically with more assurance as to interpretation of results.

Analysis of the credit problem should furnish a basis for passing judgment upon the adequacy of the source of farm credit and for suggesting possible improvements in the use of credit.

Comments. (M. R. Benedict.)

Projects 29, 29A and 29B illustrate the very close relationship between certain types of credit study and the studies in the field of farm management. In many cases the limiting factor in the adoption of what appear to be more profitable practices may lie in the limited credit rating of the farmer or in the limited loaning capacity of the credit agencies available to him. In other cases, however, credit is not used because both farmer and lender are ignorant of ways in which credit might be used to advantage. Farm management studies up to this time have rather generally disregarded the financing problems involved in carrying out the recommendations made. The need is now evident for the development simultaneously of both production and financing programs. The financing program needs to go somewhat farther than merely to make possible the production changes indicated in the farm management study. It should indicate the types of credit best suited to the situation, desirable quantitative relations between these types and a program of debt retirement, including such considerations as those indicated in Project 30 of this bulletin.

A number of projects in Bulletin No. 3 of this series (Research in Agricultural Credit), represent a combination of credit and farm management research so closely interrelated that they might properly be included in either bulletin. Such, for example, are Projects 3, 15, 21, 25A, 25C, 27A, and 27B of that bulletin.

PROJECT 29A. Same as 29, but for Wheat Farming in Kansas.

(By W. E. Grimes and Harold Howe.)

Professors W. E. Grimes and Harold Howe of the Kansas Agricultural College at our request mapped out a project of this nature for a wheat farming region. Perhaps their statement placed more emphasis than the above on need of studying the adequacy of existing credit and upon methods of improving the credit situation in the area. It called for having a typical group of farmers keep account books for a period of two years or more under a certain amount of supervision, and supplementing the data so obtained with survey data; also collecting a certain amount of data from bankers and other credit agencies. In Kansas it is possible to test sampling by matching the averages and frequency distributions against the assessors' rolls, which give rather detailed information for each farm in the state.

PROJECT 29B. Economy of Loans to Buy Fertilizer.

OBJECTIVE: To analyze the related production economy and credit economy of a loan for the purchase of fertilizer for the growing of cotton in a given area. (Joint with Agricultural Credit.)

(By David L. Wickens.)

Stated more specifically, the objectives of this project are:

1. To determine for different prices of cotton, of fertilizer and of credit, the optimum applications of fertilizer.
2. To find what relative proportions of the cost of fertilizer may be equitably supplied by the landlord and by the tenant under each form of tenure prevalent in the area.

Sources of data.

Data indicating the effects on yields of varying the applications of fertilizer may best be obtained from properly planned experiments or statistical determinations as suggested in Projects 17 and 18 of this report. If the experiments are based on a sufficient number of years, the average yield will reflect weather and other risks as well as any influence which heavy applications may have in producing crop damage. Yield figures from experimental plots must be applicable to the conditions of the farm concerned. If local data are not available, caution must be taken in using data developed in other areas. The element of risk in crop growing is analyzed in the report in this series on Agricultural Risk and Insurance. The prevailing tenure arrangements and credit practices will best be secured by survey of farm operators and farm owners and from the credit institutions of the area along the lines indicated for Project 1 in

Bulletin No. 3 of this series dealing with Research in Agricultural Credit. Ascertainment of the various sources of credit, and measurement of the costs of credit from each source, will follow lines already indicated in such Projects as 1, 5 and 7 of that bulletin. If farm management and credit surveys have been made previously in the section being studied, the results may be used without special study to obtain necessary data of this nature. The size of the project should be such as to apply to an area where soil and other conditions which influence farm organization are reasonably uniform. Usually this will require limitation to a type-of-farming area as described in Project 1 of this bulletin.

The principal special unit of measurement requiring attention is the percent per annum cost of credit for fertilizer. All of the many kinds of charges common to the purchase of this commodity should be reduced to the common denominator of per-annum cost in order to permit comparability.

Procedure.

To show the optimum fertilizer application for given price conditions, it will be desirable to construct as accurately as possible a curve showing gross return per acre for each successive unit of the particular type of fertilizer applied. This will involve first building up a curve of diminishing physical outputs for additional units of fertilizer through use of such experimental and other data as are available or can be secured after the manner described in Projects 17 and 18 of this report. The writer has found that the Spillman formula discussed in Project 18 is useful in such analysis. By applying the varying prices of fertilizer to these physical quantities, fertilizer costs may be determined which represent successive applications of fertilizer. The marginal method of analysis, consisting of balancing costs of additional fertilizer inputs against the selling price of additional outputs, will prove most useful in such a problem. The larger yields accompanying larger inputs of fertilizer may involve other additional costs. These should, however, be subject to fairly definite determination. A table showing each of these costs necessary for successive applications of the fertilizer at different prices, especially if used in connection with a three-dimension diagram, is likely to prove useful in aiding one to determine the most economical course under varying price conditions. If the farm acreage is fixed, the production cost for land may be taken as constant and represented on the diagram by a horizontal line. Labor expense likewise may be represented as fixed unless it is hired and if there is no other market for the additional labor supplied by the farmer and his family. Estimates of expected cash returns may be made by applying to the average per-acre yields of cotton resulting from the varying applications of fertilizer and other inputs a three- or five-year average of cotton prices plus any modifications believed warranted by

existing price trends or expected changes. (See Project 16 of this report.)

If the illustrative diagram presents on one side the costs for successive applications of inputs at varying unit rates, the addition of the appropriate expense items gives the total outlay for a given combination of production factors. This expense may be represented graphically by a line extending to the curve of diminishing returns. If on the other side of the diagram, per-acre returns from cotton at varying prices per pound are extended opposite the yield scale, and lines are projected from these points to the curve of diminishing physical returns, the inter-section point of the vertical and horizontal lines representing cost and return should approximate the optimum combination for the particular conditions.

This method should permit a closer approach to actual optimum applications than likely to follow trial and error procedure. It is assumed that there are no limitations to pushing intensity to the full extent. Lack of credit or definite limitations on the amount of labor available may conceivably prevent carrying inputs to the point of optimum return.

The above procedure should indicate for the conditions typical of the area being studied the changes in income to landowner and to tenant with varying applications of fertilizer, and thus should afford a basis for conclusions as to the relative contributions that the two parties should make to fertilizer costs if customary arrangements concerning division of inputs and returns are taken as a basis. The investigator may, however, wish to carry this phase of the project farther, relating it to questions of land tenure and farm family living.

The credit elements of the situation will have mainly to do with the determination of what constitutes carrying fertilizer applications to an uneconomic degree of intensity, and consequently with the determination of the amount of credit necessary to make possible applications which approximate the optimum.

North Carolina Bulletin No. 270, *Farm Credit in North Carolina, Its Cost, Risk, and Management*, by David L. Wickens and G. W. Forster, includes some consideration of the relation of fertilizer costs to the amount of fertilizer which may profitably be used. A suggestive approach is also to be found in the article by M. J. B. Ezekiel, "Studies on the Effectiveness of Individual Farm Enterprises", *Journal of Farm Economics*, Vol. VIII, p. 86.

PROJECT 30. Financial Program of Farm Families. (Joint with Agricultural Credit and Farm Family Living.)

(By Harold Howe and H. R. Tolley.)

In this project would be studied, *first*, the problem of what to do with the money available for spending or investing after the current farm expenses are paid; and *second*, what to do when the income is

insufficient to support the normal current expenses of the farm business and the farm family.

In years when gross income exceeds current expenses, a farmer has several alternatives. He may use the balance to retire indebtedness. He may reinvest it in the farm business by purchasing additional land, livestock or equipment with the expectation of increasing the farm income in subsequent years. He may invest in some business other than farming. He may keep the balance as a liquid reserve to draw on in lean years. Or it may be used up in a higher plane of living by the family. The home may be remodelled or a new one built, a new automobile may be purchased, or additional help may be employed in the home or on the farm to relieve the farmer, the homemaker, and other members of the family of irksome toil. Whether considered from the standpoint of the farmer and his family, or from the standpoint of farming and other industries, this problem has many ramifications.

The converse of the foregoing occurs in years when because of crop failures or low prices or a combination of the two, the farm income is less than enough to finance the next year's farm operations on the same basis as formerly, and at the same time maintain the family living on its accustomed plane. Situations of this sort are no less in need of analysis, nor beset with fewer implications, than those of the first sort.

Of course these two sorts of situations are closely interwoven. If the surpluses of good years are put to the appropriate use, the lean years will cause much less trouble. But too much preparation for lean years may stand in the way of enlargement of the business and education of the children for greater progress in the more distant future.

The field of such a project as above outlined is very broad indeed. A full analysis of the problem which it comprehends involves a comparison of alternatives that lie in the field of farm family living (even this very broadly conceived), and of credit, as well as of farm management. No project should be undertaken that ignores all these important alternatives. However, if the project is initiated by farm management workers, it may well give major emphasis to the financial program of the farm business as distinguished from the financial program of the family, always recognizing, however, that the two can not really be separated. It is a generally accepted fact that one of the outstanding weaknesses of the farm business is the lack of an adequate financial policy which would build up, in years when farm income is good, a surplus to be used for the dual purpose of financing the necessary extensions on the farm and of a reserve in lean years. Although these two purposes will commonly conflict with one another, they can also be reconciled in a measure. The reserves for lean years can sometimes be used in ways from which they can be recovered when needed. For example, they may be invested in

additional livestock which can be sold if need be. Once the resources reach a certain point, enlargement of the means of obtaining an income may be more important than further reserves. Reconciling these two needs is one of the major objectives of such a project as this.

The first step in such a project would seem to be gathering the facts as to the possibilities which actual farming in an area offers for surplus to arise and to be used in the various alternative ways above indicated, and as to how in actual practice these surpluses are used. This study should note particularly the variations in the foregoing and endeavor to discover what circumstances are associated with these variations. In particular, it should attempt to discover any relationship between different financial policies followed and the results in terms of incomes, rate of progress, and consequence in case of adverse years. Such a project can hardly escape giving some attention to the major factors that seem to be associated with income, wealth and other measures of economic progress.

If the family side of such a project as this were to be emphasized, one would go into considerable detail in trying to determine the consequences of various policies upon the family living and upon the practice with respect to such a major item as education of the children. A farm management worker would obviously be inclined to reserve his detailed treatment to the parallel relationships between financial programs and the success of the farming program. The study might in any case consider carefully the advantages and disadvantages from the foregoing standpoints of various forms of investments for farm surpluses—land, real estate mortgages, various classes of bonds, various classes of stock, insurance, time deposits, etc., and likewise the advantages and disadvantages of various means of obtaining financial aid in distress.

No study of this sort would go very far without encountering the function of the country banker as advisor to farmers in their financial programs, and as source of credit in times of need.

It is obvious that no attempt has been made to outline the methodology for such a project. The field is altogether too new. What is needed at the start is some exploratory research. One can get some help on such a project from the farm family living studies made in Minnesota by Dr. C. C. Zimmerman in which the whole farm and family business was brought under examination and analysis.¹ In these studies, the survey method was used. Other exploratory work ought to employ the case method.²

(1) C. C. Zimmerman and J. D. Black, *How Minnesota Farm Family Incomes are Spent*, Minnesota Bulletin 234, June 1927.

C. C. Zimmerman and J. D. Black, *Factors Affecting Expenditures of Farm Family Incomes in Minnesota*, Minnesota Bulletin 246, July 1928.

(2) See the discussion of Le Play's use of the case method in family studies in the report in this series on Farm Family Living. Also see the projects in the report in this series on Land Tenure which relate to the agricultural ladder and farm family progress.

PROJECT 31. Farm Management and Leasing Systems.

Objective: To determine the most workable leasing system under a given set of farm conditions. (Joint with Land Tenure.)

To be published in the report of this series dealing with research in Land Tenure.

PROJECT 32. Tenure and Quality of Farming.

Objective: To determine the relation between the form of tenure and the type and quality of farming. (Joint with Land Tenure.)

To be published in the number of this series dealing with research in Land Tenure.

PROJECT 33. Part-Time Farming.

Objective: To determine the most advantageous systems of farm organization and management practice on various types of part-time farms and in various situations.

(By J. D. Black and David Rozman.)

Research in farm management is not complete unless it includes analysis of the economics of production on the farms of the United States in which the operators combine a considerable amount of work at fairly regular jobs off the farms with the management of their farms. The census of 1930 in its new type-of-farming analysis chose to define a part-time farm as one which conforms to the usual requirements of a farm—3 acres of land or more upon which farming operations are conducted, or less if the value of products is \$250 or over—and in addition one whose operator worked off the farm 150 days or over. If some other member of the family worked off the farm 150 days or over, even though he worked on the farm the rest of the time, it was not considered a part-time farm. Also, if the value of products from the farm was \$750 or more, even though the operator worked away from home 150 days, the farm was classified as regular. If much family labor was available, a value of products of \$750 could easily have been obtained even though the head of the family worked away from home most of the time.

These rather rigorous limits removed a large number of farms from the part-time class, particularly the requirement of 150 days of outside work. Another considerable group of essentially part-time farms, in which the proprietor and his family engage in non-farming activities at the farm—operating roadside stands and filling stations, custom sawing, grinding, cider-making, etc.—was also omitted. In spite of this rigorous definition, advance estimates indicate that the

1930 census will report several hundred thousand part-time farms. For the six New England States, with an area of about that of Illinois, the census reports 18,299 part-time farms.

The studies made by the Massachusetts Agricultural Experiment Station¹ reported for Holden Town, situated just outside of Worcester, a total of 519 families engaging in some agriculture, with the head of the family working away from the holding for two months or more, and only 66 farmers not working off the farm two months or more. Of the 519, only 169 or 33 percent had produced farm products worth \$250 or more; and 40 percent had products worth \$100 or less. There were at least 50 that had products worth more than \$750.

The 1925 federal census reported 170 farms for this town; the remaining 104 were probably part-time farms for the most part. It is interesting to note that if the definition employed by the census—\$250 value of farm products, or 3 acres of land with some farming on it—had been strictly applied, there would have been 303 farms in Holden Town instead of 170, and no doubt most of these additional 133 would have been part-time farms. The 1930 census was even more incomplete than the 1925 census, reporting only 124,925 farms for New England as compared with 159,489 in 1925. The omissions are mostly the small holdings, as indicated by the following data:

	Number of farms		Percentage of change	
	1925	1930	Increase	Decrease
Under 3 acres	673	2,027	201	
3 — 9	15,068	8,564		43
10 — 19	14,644	9,386		35
20 — 49	29,271	20,284		30
50 — 99	38,368	29,740		22
100 — 259	51,433	44,430		13
260 — 499	8,110	8,329	2	
500 or over	1,922	2,165	12	
TOTAL	159,489	124,925		21

If the rest of Massachusetts averages about like Holden Town in the extent of part-time farming, as there is some evidence to indicate, well over a third of the agricultural production of the state is found on farms classified as part-time according to the definition used in the survey.

In the past, part-time farming has most commonly arisen as a result of efforts of farm families to supplement their incomes from farming activities. At present, it more largely results from having city workers, mostly factory workers, artisans, and clerical workers, move onto small pieces of land near cities. In the latter form, it represents a new development, especially pronounced since 1920. The towns in Massachusetts with less than 5000 population increased 33 percent in population from 1910 to 1930, as compared with 27 percent for towns with over 10,000 population. Developments of the

(1) *Part-time Farming in Massachusetts*, by David Rozman. Bulletin No. 226, 1930.

present decade are giving strong impetus to changes of the same nature.

Research in part-time farming has many aspects—land tenure, land utilization, credit, marketing, income, and farm family living. Early studies will no doubt include all these aspects in single projects, as has been done in the Massachusetts studies. This is needed in order to obtain an understanding of the major aspects of the subject, and to provide a general background for more detailed studies later.

The project here suggested is designed to stress the farm management aspects, and to bring in the others only as essential to the farm management. The methodology for this farm management analysis has probably all been presented in one or another of the projects already discussed.

The particular farm management problems which are significant depend greatly upon the nature of the part-time farming enterprise. There are as many types of part-time farming as there are of farming itself. The Massachusetts studies have indicated some of the more common types. Only 74 of the 519 part-time farms had one or more cows, and of these, all but 18 had one or two cows. Thus few had dairy products for sale. Only 57 had one horse or more, and 43 of these had one horse only. There were 217 which had no chickens, and 186 had less than 25 chickens. Only 203 had any surplus of anything for sale (17 had vegetables only and 4 had livestock and livestock products only). For two other areas studied, near Lowell and Taunton, the marketing outlets are reported ranking in importance as follows: neighbors, stores, dealers and buyers, places of employment, peddling and stands.

It will appear from this that the farm management problems of most significance are as follows:

1. Location—with respect to employment, highways, markets, schools, sanitation, electric lighting, etc. It is obvious from the above that for most types of part-time farms the family living is more important in choosing a location than the agricultural production. The price of land will be an important factor. Unfortunately much of the land near to places of employment is high-priced. Location farther out may easily entail extra cash outlays for travel which represent several hundred dollars when capitalized. To save 10 cents per day in travel, one could well afford to pay \$100 extra per acre for 5 acres of land.
2. Type of land—Land that can be converted into good tillable condition is all that is needed for many small holdings. A good piece of permanent pasture for a cow or two will be desirable; but if the location is near the city, the extra cost of it may not be warranted. Many of the part-time farms have considerable waste or poor land on them for which the owner paid very little. Much of the land near cities in the East is of such a nature that several acres may have to be bought to get a single acre good enough for cropping.
3. Amount of land—depending upon type of land available and the production program and scale of operations.
4. What to produce—determined mostly by family needs, markets available and labor available. Whether or not to keep poultry and a cow or two will be a major problem with many families.
5. What outside work to combine with the farming—This will be the form which the problem of combination will take on the larger part-time farms,

particularly on those in which the farming occupies most of the time during the summer.

6. Source of power—whether to keep the scale of operations on a basis such that all the work can be done by hand except for hiring a little plowing and the like; or to keep a horse or two and enlarge the scale of operations considerably; or instead to use a garden tractor.

Obviously very few of the foregoing problems can be analyzed largely as a farming matter. They require that the incidence of every procedure on the family life be weighed rather than the mere effect on the net income from the farming operations. Attempts to evaluate the income from the farm part of the family enterprise will be largely futile. Placing a valuation on the goods produced by the farm and consumed by the family will answer few if any questions of importance. An estimate of the number of calories of food produced and consumed by the family may be of more consequence than an estimate of value of products consumed. The analysis will in most cases be in terms of alternative procedures, and estimating the various results or effects of the different possible procedures. Some of these can not be estimated. The criteria of choice will be mostly in terms of the economic and social progress of the family, its health, its education, etc., over a period of years.

Any program or research relating to the foregoing questions should be pointed at supplying present or prospective farmers with the facts as to the different procedures now being followed, as to what circumstances seem to have determined the procedure adopted, and as to the apparent results of the different procedures under different circumstances. The method of research will involve collecting most of the information by single visits to the farms; but conditions will vary so much from farm to farm that statistical analysis will suffice only for the more obvious questions. What are most needed are case analyses, after the manner outlined in Project 37, of carefully selected part-time farm and family enterprises considered as wholes; and case studies of particular questions, such as the power question above indicated.

PROJECT 34. The Economy of Large-Scale Farming.

(By D. Curtis Mumford and H. R. Tolley.)

Objectives.

A study of the economy of large-scale farming should have three main objectives as follows:

1. To determine the prevalence, general characteristics, and significance of large-scale farming in the United States, or within any smaller geographical subdivision.
2. To compare the present relative economy of utilization of resources on large-scale farms and small-scale farms as they exist today.

3. To compare the relative economy of the most effective utilization of resources on large-scale farms and small-scale farms as they may exist in the future.

In order to carry out these comparisons it will be necessary to build up examples of large-scale and small-scale farms in different areas which will represent the highest possible degree of effectiveness obtainable in the utilization of resources such as land, labor, capital and managerial ability.

Value and uses of project.

The information secured in a project such as here outlined should aid in clarifying the thinking and help to coordinate teaching, research, and extension work on the subject of large-scale farming by providing a body of facts upon which to base conclusions.

Conclusions founded upon an analysis of the facts should be more valuable than conclusions based upon highly opinionated, biased, and oftentimes ill-advised popular discussion on the subject.

The dissemination of information on the most advantageous systems of organization and management for large-scale farms under various conditions should benefit individual large-scale farming concerns in organizing their business along more profitable lines. Among other essential requirements for success, this investigation should indicate the optimum amount or degree of the delegation of the management function from the central management to the subordinate units under various types of large-scale farming organizations. If this optimum degree of management delegation were known, it should tend to reduce the time spent in the trial-and-error stages of development of many concerns.

From a national point of view, a knowledge of those instances in which large-scale farming organizations can utilize land, labor, capital, and managerial ability to better advantage than small-scale organizations should make for a superior national economy by helping to guide legislative action dealing with certain phases of the large-scale farming development. By a wise dissemination of the conclusions to be secured from this study, it may be possible to hasten certain more or less economically inevitable readjustments in particular phases of the agricultural industry, thereby reducing the time lag that otherwise might occur.

An analysis of the facts to be secured in such a project should aid materially in determining the present and possible future importance of large-scale farming in the United States and thus furnish an intelligent basis upon which to apportion work in the research, teaching, and extension fields—giving to large-scale farming the attention that its importance may deserve.

Scope of project.

It is suggested that the present study should be limited in scope only to the extent of confining it to the economic aspects of the

subject. Thus it may include the entire country, or a state or group of states comprising a region; and it should include all forms of large-scale farming. It is proposed to exclude such considerations as the history of large-scale farming in the United States, and whether large-scale farming tends to bring about a rural situation which is socially desirable. These considerations are indeed important, and the results of studies of them should temper our economic conclusions to a certain degree, but their investigation does not properly fall within the scope of this project.

Basic qualitative analysis.

There appears to be considerable confusion, and naturally so, as to what constitutes a large-scale farm. Any number of terms, such as industrialized farming, chain farming, group management, supervised farming and corporation farming, have been used interchangeably in this connection and have been considered frequently, especially by the reading public, as connoting the same general system of agricultural operation. Strictly speaking, some of these terms have little or nothing in common save that usually, but not always, a large number of acres is involved.

It appears, therefore, that the term large-scale farming must involve a rather all-inclusive concept, especially if it is to be applied under varying conditions to distinctly different types of farming throughout the United States. For the purposes of this study, a large-scale farming organization may be defined as follows: *A single farm or a group of farms under one closely controlled and supervised management if the size of its total farm business is at least five to eight times as large as the typical farm business in the same locality producing the same kinds of products.* To measure the size of business properly, some sort of an index is needed. The following scheme has been used and found reasonably satisfactory in determining the size of a particular farm business almost regardless of the section of the country or the type of farming. It might be called a "combination size index." Its essential feature lies in combining into one figure an index of size constructed by an arbitrary

CODE FOR OBTAINING COMBINATION SIZE INDEX

Group value	Acres	Group value	No. of men	Group value	Capital
0	Under 100	0	Under 2	0	Under \$10,000
1	100 - 174	1	2 - 4.9	1	10,000 - 24,999
2	175 - 499	2	5 - 9.9	2	25,000 - 49,999
3	500 - 999	3	10 - 14.9	3	50,000 - 99,999
4	1000 - 2499	4	15 - 19.9	4	100,000 - 249,999
5	2500 - 4999	5	20 - 24.9	5	250,000 - 499,999
6	5000 - 9999	6	25 - 49.9	6	500,000 - 749,999
7	10,000 - 24,999	7	50 - 74.9	7	750,000 - 999,999
8	25,000 - 49,999	8	75 - 99.9	8	1,000,000 - 2,499,999
9	50,000 - and over	9	100 and over	9	2,500,000 and over

and approximately equal weighting of three significant measures of size of business, namely, acres, men, and capital. The "acre" figure in the above table represents the total number of acres under the direct or close supervision of the owner or manager. The "number

of men" refers to the average number of men employed during the year, and includes operators, managers, and supervisors as well as share or wage hands. The "capital" figure refers to the average annual total capital invested in the entire business including land.

The combination size index may be calculated as follows: Suppose we take a Middle-western diversified farm consisting of 160 acres, employing a total of 2.5 men on the average for the year, and having a total capital investment of \$20,000. The respective group values according to the table are 1, 1 and 1. Adding the individual digits we obtain the sum of 3, which is its combination size index. It is not to be expected that an index of "one" for acres will be associated always with indexes of "one" for men and "one" for capital. In fact, it is this very feature which enables the combination index to be used for different types of farming. For example, in a ranching country, one might obtain a series of values such as 6, 1 and 3, giving a combination index of 10.

Depending upon the section of the country and upon the type of farming in question, a certain value of the combination index may be selected above which value all farms will be called "large-scale," and below which all farms will be called either "small" or "medium." It should be clearly recognized that there is, of course, no hard and fast line of demarcation between a small- or medium-sized farm and a large-scale farm. They shade into each other by imperceptible degrees. The important thing in selecting large-scale farms is to see to it that the farms selected as such are not just "overgrown" family farms, but are clearly over the border line and representative of a distinctly different type of farm organization.

It has been found that ordinarily a classification about as follows gives fairly satisfactory results:

Small = A combination index of 0 to 3.

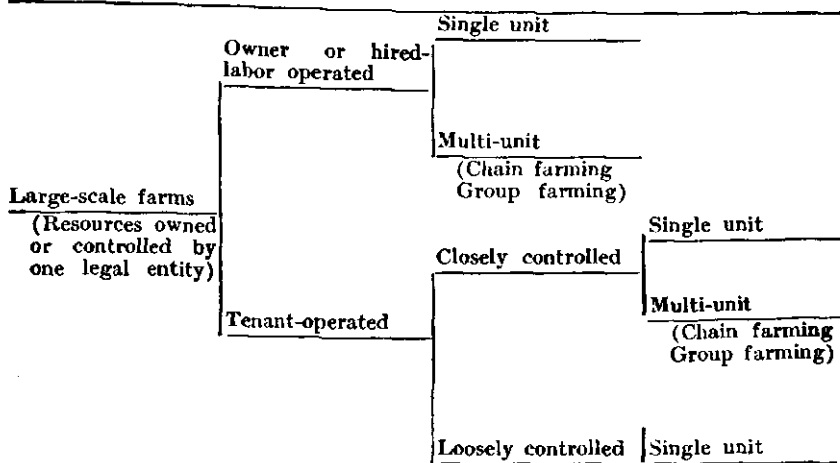
Medium = A combination index of 4 to 9.

Large scale = A combination index of 10 and over.

In dealing with specialized types of agriculture such as wheat farming, the number of acres in wheat is perhaps one of the best single measures of the size of the business; in a specialized dairy region, the number of cows in milk; in a specialized cotton country, the acres in cotton, and so on; but even here a combination index is perhaps the safest guide in determining what shall be included in "large-scale" and what shall not.

At this point it may be well to clear up a certain amount of confusion with reference to the differences in meaning between chain farming, group farming or group management, corporation farming, and so on—terms that have already been mentioned. This may be done probably to best advantage by drawing up a chart such as the one following and discussing its contents.

LARGE-SCALE FARMS CLASSIFIED ACCORDING TO TYPE OF ORGANIZATION AND OPERATION.



Under the owner-operated classification fall all large-scale farms which are operated on the wage basis. This classification may be subdivided into "single-unit" and "multi-unit" farms. The single-unit farm is composed of one compact body of land, usually possessing but one headquarters. A multi-unit farm is composed of several tracts of land or separate farming units or even several individual farms, each multi-unit farm possessing more than one headquarters. The ownership or control of resources on single-unit and multi-unit hired-labor-operated farms is ordinarily vested in one legal entity such as an individual, a partnership, a corporation, a trust, or an estate. The term "chain farming" may be applied correctly to the operation of a single-ownership multi-unit farm and may be defined as a group of farms either in one or several localities, the resources of which are owned or controlled by one legal entity which exercises a virtually direct and complete authority and control over the operations on each farm through an overhead management service usually set up by the parent organization itself. It is possible also to speak of such an organization as an example of "group farming," although as will be pointed out a little later, there is a significant difference between a certain type of group farming and chain farming.

In the main it is correct to include only the "closely controlled" tenant-operated farms under the term large-scale farming. A tenant farm may be said to be "closely controlled" when the owner or central management exercises a large amount of supervision and control over the tenant. Ordinarily this involves a control over the conditions under which purchases and sales of livestock, seed, crops, fertilizer, and supplies are effected, a specification of the crops to be grown, and the determination of what rations are to be fed to livestock.

Under this system the landlord or central ownership usually owns all or a share of the livestock.

There are, of course, all gradations of management supervision to be found, and considerable judgment must be exercised in deciding where to draw the line between "closely controlled" and "loosely controlled" tenant-operated farms. A loosely controlled tenant farm is one in which most of the decisions are left to the discretion of the tenant. Thus the loosely controlled tenant-operated farms are excluded from a large-scale farming classification with this exception, that if a single-unit loosely controlled tenant-operated farm is large enough in and of itself, it may be classed as a large-scale farm. The closely controlled tenant farms may be classified again into single-unit farms and multi-unit farms. The latter, namely a multi-unit closely controlled tenant-operated large-scale farm is another good example of chain farming. It may also be cited as an example of group farming.

The distinction between chain farming and group farming may be explained as follows: The term group farming may be applied to a group of farms either in one or several localities owned by one or more legal entities and operated by either its own management organization or by a farm management service which may have complete or only partial authority and control over the operations on each farm. Hence it appears from our definitions that all chain-farming organizations may be considered as examples of group farming, but that only certain phases of group farming may be called chain farming. To be the latter, there must be one ownership or control of resources, and complete supervision and control. It might also be mentioned that practically all chain-farming organizations can be considered as examples of large-scale farming, whereas only such group-farming enterprises as can exhibit sufficient size, complete control, and one ownership or control of resources can be considered as examples of large-scale farming. Every large landholder does not practice large-scale farming.

Corporation farming is frequently thought of as being almost synonymous with large-scale farming. This is very far from the truth, as there are a great many incorporated farms which are small in every sense of the term. Also there are perhaps more large-scale farms which are not incorporated than there are those which are.

Cooperative farming is a term usually applied to a situation in which two or more individual farmers cooperate with each other in the use of machinery, pure-bred sires, exchange work, and so on, or employ a farm management specialist to act in an advisory capacity to each farmer in the group. In no way can this be called large-scale farming; and yet cooperative farming obtains some of the advantages of large-scale operation.

Management farming, often spoken of also as group management, is a phase of group farming. Three examples may be given:

1. A landlord or his agent exercising only partial or loose control over tenant farms.
2. A group of farms belonging to more than one owner under the supervision of a commercial farm management service.
3. A group of farms belonging to more than one owner under the advisory supervision of a farm manager employed by the co-operating farmers who pay his entire salary or a portion of his salary, the remainder being paid by the state agricultural college or some other public agency. This is a phase of co-operative farming mentioned previously.

Management farming should not be confused with large-scale farming.

The criteria, therefore, of a large-scale farm are, first, a large farm business, determined either by the "combination size index" or by some other perhaps better measure; second, a close or tight control and supervision over the entire property; and third, an ownership or control of resources by a single legal entity.

Large-scale farms, in addition to being classified into owner- or hired-labor-operated and tenant-operated farms, may be further classified as to the financial objective of operation and as to the anticipated period of ownership. There are some large-scale farms which are operated largely for pleasure or for "show." The problems involved in such operations are radically different from the problems arising on large-scale farms operated for profit. With regard to the period of ownership, there are many farms which are being managed on a "liquidation" basis. Ordinarily, foreclosed farms and other distressed land in the hands of banks and insurance companies are handled on a liquidation basis which generally carries with it a policy of putting as little money into improvements as possible and almost always a policy to sell as soon as a satisfactory sale can be made. Obviously the management in these cases is confronted with an entirely different set of problems from those faced by the management under conditions of a more permanent ownership.

The foregoing remarks upon the classification of large-scale farms and upon the differentiation in the meaning between several rather commonly used terms have been made in the belief that a study of large-scale farming, to be of the greatest usefulness, should take them into account.

In analyzing large farming organizations of the chain or multi-unit variety it may be found that, along with other fairly well recognized factors, a considerable portion of the success or failure of these organizations may have been due to the amount or degree of management delegation which the owner or central management has seen fit to grant to the individual units in the chain. In a project, therefore, such as the one here outlined, it would be essential to make a careful study of the delegation of the management function and

also of the degree to which certain organizations are departmentalized.

Since one of the chief aims of this project is to determine the relative efficiency with which large-scale and small-scale farms are able to utilize land, labor, capital, and managerial ability, comparisons between large and small farming organizations must be made. If the required detailed information on small farms is not already available for these comparisons, then it will be necessary to obtain such data by a procedure similar to that outlined under Projects 8 and following in this report. A discussion of some of the problems involved in these comparisons appears under methods of analysis.

Sources of information.

In the execution of this project the greater portion of the information used will need to come from primary sources, that is, from actual farms or farming organizations. About the only secondary data which can be used will be a certain amount of detailed information concerning small- and medium-sized farms which has been secured by farm management workers in various parts of the country, and such information as can be obtained from the tabulations of the Census of Agriculture.

Sampling and collection of data.

In practically every phase of this project, the question of sampling is involved in one way or another. At the outset the problem is one of trying to secure the names of the large-scale farmers in the United States, or within a state or group of states comprising a region. This may be done by circularizing a list of farmers such as the Bureau of Agricultural Economics' Crop-Reporter List, the "Key Bankers," the County Agents, and state farm management workers with a very brief questionnaire asking them to fill in the names and addresses of the owners or managers of any large-scale farms, ranches, or plantations that they may know of in their locality. It is probably not feasible to attempt to define large-scale farming precisely in this questionnaire. At the same time these men could be asked to estimate the number of acres in these large-scale farms and the principal products produced.

The next step in endeavoring to ascertain the prevalence, characteristics, and significance of this development in farming would be to circularize the men on the mailing list just secured by sending each of them a questionnaire designed to obtain answers to the set of questions suggested in the next section of this project statement. When the returns have been received and the usable schedules selected, the question will then arise as to how good the sample is. The chances for empirical tests of this are rather poor. The census figures, although offering perhaps the best check available, are limited in their usefulness for this purpose because they array farms ordinarily by

one measure of size at a time, such as acres, number of head of livestock, and so on, no one of which is a sufficient measure of size; and because, especially in the South, it is impossible to tell from the published reports how many large plantations there are in certain areas, many plantations having been reported as a number of separate farms. Still more limited in its usefulness for this purpose is the report entitled "Statistics of Income From Returns of Net Income," published annually by the Division of Internal Revenue, United States Treasury Department, Washington, D. C., which contains a classification of corporations engaged in "agriculture and related industries." As previously explained, all corporation farms are not large-scale, and all large-scale farms are not corporations, and still further, "related industries" are not farms. Hence the empirical checks available on the representativeness of our sample or the proportion of the entire universe which is represented, are decidedly few and limited in their value.

Looking ahead now into the more intricate phases of this project, it appears that the analysis of the large-scale farming questionnaire should bring to light a number of significant individual organizations that might very well be selected for more intensive study. These may be further sorted out by sending out a second and more detailed questionnaire, in the nature of a follow-up. The farms finally selected for intensive study will need to be observed in action, and the data needed for real analysis will need to be collected by the person in charge of the study. This will be no easy task if the farm is unusual in size and the business complex. It may take one man as much as three weeks. The smaller and simpler organization can be handled in from three days to a week.

Looking toward an ultimate solution of some of the problems involved in this project, one will undoubtedly want to enter into cooperative relationships with certain outstanding large-scale farming organizations, arranging for them to keep detailed records of the type which will be most useful in analyzing their present effectiveness of utilization of resources and in indicating future possibilities.

Schedules and forms.

A questionnaire to be sent to the operators of large-scale farms for the purpose of ascertaining their prevalence, characteristics, and significance might include questions relating to the following points:

1. Type of ownership—whether a corporation, partnership, or individual.
2. Complete information on acreage of land owned, rented from others, managed for others, rented out to others, and the type of lease or agreement involved.
3. A total figure representing the entire acreage under the direct operation of the management plus all the acreage rented out to tenants or croppers under close supervision; and the amount of this acreage which is in crops.

4. Of the total acreage owned, how much acquired by inheritance, marriage, mortgage foreclosure, bargain counter or forced sale, normal sale, or homesteaded.
5. Whether or not the present operation is conducted principally upon a liquidation basis or primarily with the idea of holding and operating for profit.
6. Full information on the number of separate tracts of land, number of separate farming units from the standpoint of operation, and the degree of "scatteredness" of the units.
7. Length of time the farm or farming organization has been operated in the present fashion.
8. The number of managers, supervisors or foremen, and wage or share hands employed during each month of the year.
9. Information on the total capitalization of the entire farm business.
10. The number of head of livestock by kinds on hand at a given date and the number and kinds of livestock usually fed out during the year.
11. Information on the principal sources of income in the order of their importance.
12. Whether the total income of the legal entity is derived chiefly from the farm, or does it come chiefly from some other source, and if so, what?
13. Whether the farm ordinarily pays its way, or requires support from some other source in order to operate under present system.

If time and funds do not permit a plan of research involving the second and third objectives outlined above for this project, then it may be desirable to add the following subjects to the above in order to obtain an advance estimate on the investment in machinery and equipment on various sized farms, the amount of power used, and a general estimate of the financial success of large-scale farms.

1. Information as to the total value of farm machinery, equipment and tools.
2. Complete information as to the amount of motive power on the farm, the number of horses or mules, and the make, size and age of tractors.
3. Whether in the judgment of the owner or management the farm or farming company has been a financial success.

The second phase of this project, dealing with comparisons of the present economy of utilization of resources on large-scale and small-scale farms, involves the collection of a large amount of detailed information from certain farms selected from those included in phase number one of this project. The schedule should include, among other things, the following:

1. Full and detailed information on physical input-output relationships for crops, livestock, and farm power, both animal and mechanical.
2. Detailed data on accomplishment per man per day with different outfits and under varying conditions.
3. Market values or purchase price for the physical data mentioned.
4. A complete financial statement, constructed upon a comparable basis, for each farm.
5. Detailed information dealing with the whole question of management.

Because of the probable importance of the management function in the success or failure of large-scale farming organizations, the information to be secured concerning it in such a study as the present one deserves some discussion. First of all, the management should be asked for information which would enable one to trace the chain of responsibility from the highest authority down to the individual men doing the actual physical work on the farm. In other words, data should be procured indicating the extent to which departmentalization and the delegation of authority from the owner or central management to the subordinate units entered into the various systems of management found in connection with various types of farming organizations. A number of questions should be asked in an effort to discover how really "close" is the supervision and control exercised by the central management over the actual operations on the farms. For example, these might inquire into the average number of "contacts," meaning telephone calls or personal visits, that the manager has during the course of a year with his various unit managers or foremen. Information should be secured indicating what types of questions or problems are left to the decision of unit managers and foremen, and what types of questions must be passed upon by the central management. It should be determined whether or not the units of operation, farm buildings, work stock, mechanical power, buying and selling, and so on, are centralized or decentralized. If the operation is decentralized, what arrangements are made for the transfer of labor, power, and equipment between various units at rush or peak-load intervals?

It would also be well to secure information on the wage scale of employees all the way from the manager down to the farm laborer, and to discover what, if any, perquisites are allowed. A careful study should be made also of any bonus or profit-sharing arrangements which are in vogue.

When it comes to the type of forms or schedules to be used on farms which have agreed to keep records for the investigating parties or institutions, it will be necessary to adapt such forms or schedules to the needs of the particular situations involved.

With reference to the third phase of this project, namely, that of comparing the possible future effectiveness of utilization of resources on small-scale and large-scale farms, no new forms or schedules will be needed, as these conclusions will be reached from an analysis similar to that followed in phase two of this project, except that now the question will be, "What is possible?" instead of, "What is today?"

Methods of analysis.

In analyzing the data to be obtained in the first phase of this project, namely, the determination of the prevalence, characteristics, and significance of large-scale farming within a particular area, a combination of the statistical, informal statistical, and case methods of analysis should be used, the predominating method depending largely upon the size, complexity, and variability of the data secured. The analysis should be conducted in such fashion that information may be summarized on the following points: (The list is not intended to be complete.)

1. The location and density of large-scale farms by type of farming, and state or region.
2. The type of ownership, such as a corporation, partnership, individual, estate, etc., by types of farming, and states or regions.
3. Average size of farms in acres, men employed, capital invested, by types of farming, and states or regions.
4. The type of operation—that is, whether by hired laborers, closely supervised tenants, etc., by type of farming, state or region.
5. The number of years in business by type of ownership, and type of farming.

In analyzing the detailed data to be secured in the second phase of this project, namely that of comparing the effectiveness of utilization of resources on large-scale farms and small-scale farms, the statistical method of analysis will be very much in evidence, although in many instances recourse will be had to the informal statistical and the case methods. In analyzing the data and formulating conclusions with reference to the relative effectiveness of large-scale and small-scale farms in utilizing agricultural land, labor, capital and managerial ability, there are two important aspects of the problem which must be kept in mind. First, if the purpose of the comparison is to secure a true picture of what actually is being accomplished today on large-scale farms compared with actual accomplishments on small-scale farms of the same type, then the correct procedure is undoubtedly to select large-scale and small-scale farms with the "representative firm" idea in mind. In other words, the aim would be to compare the efficiency in the utilization of the factors of production on typical large-scale farms and on typical small-scale

farms of the same type. If there is a wide range in types of either, attention will need to be given to the proportional emphasis given each type. If records from a sufficient number of these farms of both sizes can be secured, the statistical method may be used; otherwise the case method will need to be employed.

If, however, in contrast to the above, the purpose of the comparison is to secure an idea of what is possible in the way of effective utilization of the factors of production on large-scale farms and small-scale farms, then the correct procedure is to select the best example of small-scale farm efficiency and pit it against the best example of large-scale farm efficiency in the same type of farming and determine which size of farm, all things considered, is capable of the most effective utilization of the factors of production. As a matter of fact, the investigator need not be limited in this latter comparison to the actual farms in existence, but may very properly construct a farming organization synthetically on the basis of his investigations and upon the basis of experimental conclusions reached in other projects.

With the above considerations in mind, this project has been designed in such fashion that the problem of comparing the existing effectiveness of utilization of resources on large-scale and small-scale farms comprises Phase "Two" of the project, while the problem involving like comparisons of what may be possible in the future is dealt with under the third phase.

Continuing now the discussion of the methods of analysis of the second phase of the project, it appears that much of the basic material on small farms needed for the comparisons with large-scale farms will be found available in the results of studies already conducted. The chief problem involved in the analysis of this second phase will be the construction and use of various measures, let us call them ratios, to be used in an endeavor to represent accurately the effectiveness of utilization of resources on both large-scale and small-scale farms. This task of comparison is beset with innumerable difficulties, some of which will be mentioned shortly and some a little later. Obviously, this problem must be faced squarely.

At the outset, we must recognize that in the comparison of large-scale farms with small-scale farms, two essentially different universes are involved. Hence it is expedient to try to make as many outward conditions alike as possible. For example, it would be desirable to pick out large-scale and small-scale farms practicing the same type of farming and located in the same general territory as nearly as this can be done. There will be some chance, then, for such conditions as soil type, distance to market, regional competition, etc., to be about the same. It should be remarked, also, that many of the coefficients, measurements, and ratios which have been developed for the analysis of small farms automatically break down when applied to large-scale farms.

There are a number of commonly used measures of efficiency and effectiveness, however, which may be used very properly in comparisons between large-scale and small-scale farms. Without intending to give a complete list of these, one may mention a few. For example, in a recent study it was found that on a certain group of large-scale farms in the corn belt the horses and mules worked 1382 hours per head during the year in question, whereas other studies have shown that the horses on the "small" farms in the same area work an average of about 870 hours per head. One of the large-scale farms had over one hundred tractors and they were used, on the average, 604 hours during the year studied, as against an average of 236 hours per tractor per year on "small" farms. In a complete study of the use of power, it is of course necessary to obtain a great many physical measures of input per unit of output, such as the quantity of feed per head of workstock, and quantity of fuel and oil per tractor. These measures and many others, such as crop-acres per head of "productive" livestock, cash cost of hired labor per hour, crop-acres per man and per horse, value of machinery and equipment per crop-acre, and cost of repairs on machinery and equipment per crop-acre, may be used to compare efficiency, accomplishments and effective utilization of various classes or resources on both large-scale and small-scale farms.

There are other measurements, however, which are indeed difficult to compute for small-scale farms, and which after being computed, are not exactly comparable with similar measures computed for large-scale farms. For example, the labor inputs on family-sized farms are likely to be larger than on large-scale farms; but this largely means that more family labor relatively is available on such farms, and being available is utilized as best may be. Attempts to compare returns between large and small farms run into questions of psychic income and family living from the farm. These questions will be discussed and dealt with in the report entitled "Research Relating to Agricultural Income."

It would be desirable in such comparisons if one could use a measure of the quality and types of management on large-scale farms and on small-scale farms. Is it the differentiation of management into managerial tasks of various kinds that is possible in a large unit, or simply the selection of persons of high managerial ability to run the large units, that furnishes whatever advantage there may be in agricultural management on a large scale? On small-scale farms, is management of high potential productivity as such submerged by actual physical labor? Research relating to such questions as these is just beginning to be undertaken. The reader will find some discussion of them by C. L. Holmes in Project 36 of this report, dealing with the relation of the human factor and entrepreneurship to success in farming.

The conclusion will be reached from the foregoing discussion that many new measures, coefficients and ratios are needed in order to compare the effectiveness of utilization of resources on large-scale and small-scale farms to best advantage. Some of the more common measures, long in use for the purpose of comparing the utilization of individual resources one at a time work fairly well in and of themselves. However, if one wants a figure representing the combined or united effectiveness of the utilization of all the resources put together, then certain combined ratios must be developed. A few of these will be suggested in what follows. Three general types of ratios will be discussed.

First of all, it would be too much to expect that any one ratio would measure perfectly and in a summary manner the effectiveness of the utilization of the combined resources of a farm. However, if it were possible to calculate for small-scale farms as well as for large-scale farms a value ratio, the numerator of which represented the money value of the total output of the farm and the denominator of which represented the money value of the total input of the farm, then this particular value ratio would come about as close to measuring the comparative effectiveness of utilization of resources on various farms as it is possible for any single index to come.

But to compute a figure to represent the total value input on a small farm, the problem of how to value family labor would be at once encountered; also the similar question of placing a money value upon the proprietor's labor, and the closely allied problem of trying to separate the management of the owner or operator from his activity as a laborer. Similarly to compute a figure to represent the total value of output on a small farm, one would need to put a value on farm products used in the home, and other psychic elements in income.

Another precaution necessary in the construction of this first general type of ratio is to take account of the period of use of each of the input factors. Machinery is tied up in the farm business all year; feeder cattle, only part of the year; dairy feed, perhaps only a few weeks. The result will take the form of total dollars of input of all production factors combined. Total dollars of output divided by total dollars of input is the ratio desired. The principal difficulty with this ratio is that it requires valuation to be placed on all inputs and all outputs.

Although perhaps more difficulties arise in connection with small farms, large-scale farms also present their troubles. For example, many large-scale farms are operated in connection with, or are an integral part of, a larger organization; and in many cases no method is possible for really separating the salaried management of the farm business from that of the other departments of the larger organizations; and likewise of some other expenses of the business. Hence any calculation of the money value of all inputs on large-scale farms may require such a proration of costs as to leave the re-

sults merely in the form of judgments of the investigator. Also in securing the money value of the total farm output on some of these large-scale farms, the problem is made more difficult because of the many complementary and supplementary relationships existing between the farm business proper and the marketing organization, or the canning department, or the manufacturing department.

Two other ratios of this same general type are the profit ratio,¹ and the earning ratio.¹ The former is a ratio of the net income to the gross income, and indicates the return on gross business. The latter is a ratio of the net income to the total assets, and indicates the return on total assets. Both of these ratios might be used, bearing in mind the above-mentioned difficulties and also the additional problem of securing a comparable value figure for the total assets on large-scale and small-scale farms.

A secondary general type of ratio would be so constructed as to indicate the above total "physical" volume of combined outputs per physical input unit of each of the several resources, one at a time. A ratio of this type automatically disposes of the difficulties arising from valuation of input factors. Following are some ratios of this type:

1. Total "physical" volume of output per unit of land.
2. Total "physical" volume of output per unit of labor and management. Labor and management would be thrown together here due to the difficulty of separating them on the small farms. This combination of management and labor may be justified if the assumption is made that management represents the same percentage of the total human input on large-scale farms as it does on small-scale farms.
3. Total "physical" volume of output per unit of capital.

The problem of how to combine physical output units of one commodity with physical output units of another may be solved by applying a fixed or "blanket" scale of prices to units of the same commodity. For example, every bushel of wheat of a given quality, regardless of whether it was produced on a large-scale farm or a small farm might be multiplied by a given money value. This same procedure should be applied to other commodities, and the results combined into total dollars of output of all commodities per acre of land, per man, per \$100 of capital, etc.

Obviously, however, the total physical output of a farm cannot be ascribed to the land. The total output is the resultant of the combined cooperation of all the resources—not of just one. The proportions in which the various input factors are combined will influence the magnitude of the resultant output. Another weakness of these particular ratios is the fact that they ignore differences in the quality of the input factors. Without further discussion at this

point, it may be suggested that, despite all of the above limitations, these ratios will be found very useful in making comparisons between large-scale and small-scale farms.

The third type of ratio suggested is that of total physical output to total physical input, both being summated in money terms. This ratio is similar to the first general type suggested, but differs from it in that in the construction of the numerator and the denominator of the first type, the actual prices obtaining in each individual instance were used. In the present case uniform or "blanket" prices are to be used in order that the ratio of output to input which is procured will represent essentially "physical" amounts even though the necessity of the case makes it expedient to sum these physical quantities in money terms. This illustrates an attempt to measure the combined physical resultant of the resources employed in production—the result and resources both being summated by expressing them in money terms. The same method of combining physical units of unlike commodities and resources as was used in constructing the numerators of the ratios of the second type will be used here—that is, all physical units of the same resource and of equal quality will be given a definite money value weight. In this way we obtain the nearest approach to a ratio of physical volume of output per physical input of combined resources.

It should be recognized that all of the three types of ratios here suggested have their limitations. Any one ratio is not complete in itself, nor is it the final test of effective utilization of resources. Nevertheless, it is not unreasonable to suppose that the use of the ratios here proposed or the use of certain variations of them will tend to throw considerable light upon this difficult problem, even though perhaps the final conclusions may be largely of an approximate rather than of a definite quantitative character.

Discussing now briefly the method of analysis to be employed in connection with the third phase of this project, it may be said that the method will be largely synthetic. The analysis will draw heavily upon the second phase, in which information supposedly has been secured with reference to what the present status of large-scale farming is. The procedure will be to take the records of the large-scale farms now in existence which seem to indicate the highest degree of utilization of resources, and with the aid also of experimental conclusions reached in other projects, build up large-scale farming organizations synthetically along the lines suggested in Projects 8 and following in this report. By this process the investigator should have constructed finally an "ideal" large-scale farming organization for each of the major types of farming in the area studied. The same procedure should be followed in building up small-scale farming organizations. Then by the method of case analysis, each "ideal" large-scale farming set-up should be compared with an "ideal" small-scale farming set-up representing the same type of farming and the

same locality in so far as possible, for the purpose of determining whether a large-scale farming organization or a small-scale farming organization, each under its own "ideal" conditions, could obtain the more effective utilization of resources.

Other considerations which should be taken into account in the third phase of this project are such questions as the relative "staying power" of small or family-sized farms and of large-scale farms in periods of adversity. Among other things, the questions of shifting price levels and means of perpetuating "going concerns" are here involved. The argument on these scores will not be one-sided.

Summary of research with similar or related objectives.

Definite research in this field has been limited up to the present time, although much descriptive material has appeared in print. One of the best ways to become familiar with the literature on large-scale farming is to consult "Agricultural Economics Bibliography No. 30, Large-Scale and Corporation Farming" published in November 1929 by the Bureau of Agricultural Economics Library, United States Department of Agriculture, Washington, D. C.

Specific mention should be made of the following publications:

1. *Large-scale Farming*, published in July, 1929, by the Agricultural Service Department of the United States Chamber of Commerce, Washington, D. C. This report contains data summarized from income tax returns; but chiefly it summarizes a study made by questionnaire of seventy-four large farms throughout the United States. Certain tentative conclusions are reached with regard to large-scale and small-scale farms.
2. *Large Landholdings and Their Operation in Twelve Ohio Counties*, published in June, 1929 by Ohio State University and Experiment Station, Columbus, Ohio, as Mimeograph Bulletin No. 17. This investigation was directed toward a study of large landholdings and their operation rather than toward an analysis of large-scale farming. However, it throws considerable light upon the organization and management of large-scale farms in certain sections of Ohio. The data pertain to 123 holdings, which comprise 127,262 acres of land, and the information was secured by personal interviews of the investigator.
3. *A Survey of Large Farms in New Jersey*, published in June, 1931, by the Bureau of Statistics and Inspection of the State of New Jersey Department of Agriculture, Trenton, New Jersey, as Circular No. 194. This publication reports a survey made in the summer of 1930 of 88 large farms in New Jersey. Special attention was given to the earnings of these organizations, and comparisons were made between large farms and small farms representing the same general type of farming.
4. An unpublished manuscript on *Economic Aspects of Large-scale Farming in the Corn Belt*, by D. Curtis Mumford of the Division of Farm Management and Costs, Bureau of Agricultural Economics. This manuscript, bearing the date of January, 1930, reports a study of large-scale farming in the Corn Belt States conducted by extended personal interviews with ten large-scale farming organizations in Indiana, Illinois, Iowa, Missouri and Minnesota in years 1928 and 1929. The manuscript attempts to compare these large-scale farming organizations with small-scale or family-sized farms in the Corn Belt. Certain tentative conclusions are reached.

Of the above four studies reported, the last mentioned comes the nearest to corresponding with the objectives, procedure and analysis suggested in the present project, although it by no means covers the entire scope here suggested.

In addition to the four studies just mentioned, there are several research projects under way at the present time as follows:

1. A study of large-scale farming in the United States, being conducted by the Division of Farm Management and Costs, Bureau of Agricultural Economics, Washington, D. C.
2. A study of large-scale farming in Kentucky being conducted by the University of Kentucky in cooperation with the Bureau of Agricultural Economics, Washington, D. C.
3. A study of large-scale farms in South Dakota, by the South Dakota State College of Agriculture.
4. A study of systems of management on large farms and groups of farms in Minnesota, by the University of Minnesota.
5. A census monograph on large-scale farming is to be published, based upon the 1930 Federal Census.

PROJECT 35. Human Aspects of Entrepreneurship in Farming.

OBJECTIVE: To measure the influence of human factors on financial success in farming. (Joint with Rural Social Psychology.)¹

(By Walter W. Wilcox and George A. Pond.)

This project is purposely stated in very broad terms. Human factors are understood to include personal characteristics of the *farm operator and his family* and those factors which affect the success of the farm business through their influence on these personal characteristics.

In order to show how this project fits into a farm management research program, and at the same time to indicate the specific field of this project, the following outline of factors affecting the success of farming is presented.

- I. Factors largely uncontrollable by the farm family
 - A. Natural productive capacity of the farm
 1. Quality of soil
 2. Natural advantages of layout, location, etc.
 - B. Acts of God
 1. Weather
 2. Other fortuitous events (some accidents)
 - C. General price and market conditions
 1. General level of prices
 - a. Changes in long-time trends
 - b. Changes in seasonal trends
 2. Availability of markets and market facilities
 - a. Changes in transportation facilities
 - (1) Bringing in more competition
 - (2) Making available other markets
 - b. Changes in market demands
 - (1) In quality of products
 - (2) In kinds of products.

(1) A discussion of many of the points mentioned in this project statement will be found in the article, "The Human Factor from the Viewpoint of Farm Management," by W. W. Wilcox in *Journal of Farm Economics*, January 1932.

- II. Factors largely controllable by the farm family**
- A. Productivity of capital goods used**
 - 1. Quality of livestock and seed grains used
 - a. Influenced by breeding
 - b. Influenced by purchases made
 - 2. Quality of implements, farm power and hired labor used
 - a. Influenced by purchase of selection of the unit
 - b. In the case of implements and power influenced by subsequent care and reconditioning
 - B. Adjustment to productive capacity of the farm**
 - 1. Determined by farm organization
 - 2. Determined by farm practices
 - C. Adjustment to general price and market conditions**
 - 1. Adjustment of production to general market demands
 - 2. Adjustment of production and marketing to seasonal variation in demand
 - D. Availability of credit and size of operating unit. After the first few years this depends on—**
 - 1. Credit connections established
 - 2. Managerial ability exhibited
 - 3. Intensiveness and extensiveness of the farm business
 - E. Timeliness, efficiency and technique of performance of farm tasks**
 - 1. Timeliness in performing operations such as planting cotton or corn
 - 2. Choosing the methods of performing each task
 - 3. Selection of the person to perform each task or supervision of the performance
 - F. Quality and quantity of labor furnished by the farm family including the operator**
 - 1. Influencing the efficiency and technique of the performance of farm tasks
 - 2. Influencing the amount of hired labor necessary

This outline is not presented as a final classification of factors affecting the financial success of the farm. Other groupings are possible. Its usefulness is in setting down the various factors which influence farm earnings in such a way that their interrelation is quickly recognized. Some obvious limitations of such an outline may be pointed out, such as classifying quantity of family labor as a factor largely controlled by the operator and his family. Parents do, however, to a large extent determine whether children stay at home, continue in school or leave home after they are old enough to do a man's work, and the quality of the work they perform is largely a result of their training. Size of business, too, is often quite definitely limited by factors beyond the control of the farm operator and his family.

With the exception of the quantity and quality of family labor, all the factors mentioned under II, "Factors largely controlled by the farm family," are directly the result of the management of the farm business. The capacity and efficiency of management in turn depends on the personal characteristics of the farmer and his family. The quality and quantity of family labor are influenced by the personal characteristics of the farm family through the capacity and efficiency of management and also through the number of children, their health and physique, and other factors.

Psychological measurement has not advanced far enough to make possible an accurate description and measurement of the various elements of personality. For this reason only a few will be mentioned, and not all of these can be measured at the present time. These are: interests, likes and dislikes, ambition or will power, general intelligence, possession of technical knowledge, ability to make decisions, and ability to execute decisions.

No attempt will be made to classify the hereditary influences. Environmental influences may be classified under the following heads and subheads:

- I. Childhood experiences of the farm operator and his wife such as:
 - A. Type of farm on which they were raised
 - B. Number of children in the family and amount of responsibility given them as they were growing up
- II. School training of the operator and his wife
 - A. Amount of school training
 - B. Kind of school training
- III. Occupational experiences of the operator and his wife such as:
 - A. Different occupations pursued
 - B. Financial progress
 1. Inheritance of property
 2. Accumulated net worth at different periods
 - C. Experience with different sized units of farm business
 1. As the manager and farm operator
 2. As a hired man or son at home
- IV. Community experiences of the farm family
 - A. Community affiliations
 1. Member of farmers' educational and business organizations such as the farm bureau and grange
 2. Other local organizations
 - B. Community activities
 1. Attendance at educational meetings such as extension meetings
 2. Community leadership
 - C. Other community influences such as:
 1. News and farm papers read
 2. Contact with other members of the community
- V. School training and other experiences of their children
 - A. Technical information furnished the parents by their children
 1. From school training
 2. From 4H club work
 - B. Parents' point of view as influenced by the children's performance of certain tasks or jobs, such as developing a high-producing dairy heifer.

Many projects in farm management research have been concerned with determining the factors affecting net farm income. The factors considered have been for the most part factors of technical efficiency, and as such fall under the headings in the outline listed as those largely controlled by the farm operator and his family. The influence of uncontrollable factors has been held constant in so far as possible.

This project is an attempt to analyze the influences responsible for these differences in technical efficiency. Some of their differences may be associated with measurable differences in the personal characteristics of the farmer and his family. Some specific objectives might be:

1. To determine the relative importance in the financial success of the farm of certain factors which may affect management such as education, native intelligence, earlier experiences, habit of using market information, outlook reports, and the like.
2. To determine the relative importance of various human traits, such as industry, interests in various farm processes, family life, etc., as they affect success or failure in the proprietary function.
3. To determine the importance of variations in family help and cooperation as they affect the financial success of the farm business.

Value and uses of the project.

The value and uses of this project are twofold in character. Information gained from this project would make it possible for the professional men in farm management to get a better perspective of their problems. The availability of such facts would direct their attention somewhat to the ways and means of influencing that one factor, the human element, which, after all, is responsible for carrying into practice the results of research. In fact, the findings of this project would be extremely valuable to any extension man no matter what type of information he carries back to the farmer. Extension work is fundamentally adult education, the ultimate aim of which is to help the farmers realize more from their efforts in the way of monetary income and enjoyment of life. A careful analysis of the factors affecting the functioning of the human element would make it possible for extension specialists to carry on their work much more effectively in many cases.

Secondly, the findings of this project would be used in the training of our future farmers. Those teaching agricultural education under the provisions of the Smith-Hughes act are especially anxious for data of this nature to supplement their fields of study in technical production. Efficient agricultural production is a result not only of technical knowledge, but of its use through the medium of a capable farm operator. Young boys have a greater opportunity to benefit from the findings of such a study than do adult farmers. With some factual knowledge relating to the effect of various influences on managerial ability they can set out to avoid certain situations and participate in others.

Scope of project.

As indicated in the title, certain aspects of this project require the cooperation of psychologists and sociologists. This is a broad project which, if desired, might be broken up into several more specific ones after some preliminary investigations. The discussion of research in entrepreneurship elsewhere in this bulletin is an indication of the possible developments in this field. In this pioneering stage,

however, the project would investigate all measurable factors affecting the economic performance of the farm family. Success in farming in this project would be measured by the various farm business efficiency and accomplishment factors.

Net worth, operator's labor income, family labor income, net farm income, rate earned on the investment, and combinations or modifications of these five financial measures may be used as the dependent variable. These standard farm business indexes are not measures of financial success in farming *per se*, but are indications of success. These measures obtained for any farm business increase in reliability as a measure of success as the length of the period of time covered increases. The effect of other than human factors affecting these measures must be determined and eliminated along lines indicated in other projects which examine statistically the factors affecting farm income, to get a better measure of the effects of variations in human factors.

Managerial ability is a result of a complex of human attributes, the source and extent of which have thus far eluded determination. Certain progress will be made in the measurement of these human attributes, their source, and their individual accomplishments. However, after allowing for these advancements in the technique of psychological measurement, there will yet be some basic human attributes which cannot be fully measured in this project.

Sources of information.

Two types of data are necessary in this project, one, farm financial data as an indication of the success of the farm business; the other, data on the factors outlined in the preceding paragraphs. Data regarding the farm business must of course originate with the individual farmer. It is almost impossible to get both types of information at one interview because of the time required. For this reason it is suggested that this project be limited to those farmers in any state or locality for which farm business analyses have been made. For the most part, the data on factors affecting the farm family must be obtained from the farm operator in an interview. To a certain limited extent, other parties acquainted with the farmers in question would be called on to furnish information, make relative ratings and check certain facts obtained from the farmer.

Units and coefficients.

The presence, absence, or influence of many factors can be expressed in terms of common usage. The environmental influences such as school training and occupational experience are expressed in familiar terms.

Cooperation of wife may be measured by actual hours of physical labor expended in farm work, but that is only one of the ways in which the wife may help her husband. The inspiration, direct

management advice, and energy with which she stimulates and supplements her husband's efforts is often a large factor making for the size of the balance on the correct side of the ledger. This contribution of the wife can probably best be arrived at by asking certain well selected questions of her husband and scoring the answers. The following list of questions is illustrative of such possibilities:

Wife's Interest and Help

Work done by wife: care of poultry..... help with chores..... help with field work
 keep farm records..... Does your wife know your rotation plans?
 your livestock production plans?..... Do you always consult her before making changes
 from your usual plans?..... If you were ill, would she be able to direct the work?
 During the past five years, has she wished repeatedly that you were following some other occupation?
 When the work gets behind schedule, because of rainy weather or otherwise, does she
 become concerned about it?..... Does she become discouraged easily about the future of
 farming?..... Does she want the children to be farmers?.....

The following scoring system might be adopted: if the wife helps with work under all four headings, she would get a score of 20, that is, 5 percent for each type of work done. There are 8 other questions. The husband's answer to each question may be recorded in one of three different categories—"yes", "sometimes", or "no". The questions, "Has she wished repeatedly that you were following some other occupation?" and "Does she become discouraged easily about the future of farming?", are stated in such a way that an answer of "yes" indicates lack of interest in the farm business and a score of zero. These two questions would be scored 10 if they were answered "no". All other questions answered "yes" would be scored 10, answered "sometimes", 5 and "no", zero. This gives a possible distribution from 0 to 100.² In a study of this problem in Indiana in which the Bureau of Agricultural Economics cooperated with the Indiana Experiment Station, a list of questions almost identical to these was asked of 166 married farmers. The following frequency table shows the resulting variations in scores:

Score	Number of cases
85 — 100	47
70 — 84	52
55 — 69	29
54 and less	38

Indications of likes, dislikes, ambition, aptitudes and other personal traits may be differentiated by the individual's answers to carefully selected questions.

In the study just mentioned, it was attempted to measure variations in the operator's interest in farming by asking the following questions:

What occupation did you wish to enter as a boy?
 Are you sorry that your wish was not fulfilled?
 Do you think that you would have had greater financial success in some other occupation?
 Do you have any major interest in addition to your family and farming at the present time?
 During the past five years, have you wished repeatedly that you were in some other occupation?
 Do you want your children to be farmers?.....

The answer to each one of the questions was graded from 0 to 15,

(2) These scores and the others following merely represent the judgment of those working on the project. See the report in this series on Rural Social Psychology for discussion of other methods of determining scores.

making a total possible score of 90. The distribution of the scores made by 183 Indiana farmers on this group of questions is as follows:

Score	Number of cases
85 — 90	85
75 — 80	54
65 — 70	15
55 — 60	10
Under 60	19

Measurement of the possession of technical knowledge may be accomplished by having the farmer answer a number of technical agricultural questions of the multiple-choice type. Psychologists point out that the results of trade tests such as this correlate highly with the results of formal psychological tests. On this basis, the resulting scores would also be an indication of variations in general intelligence. The questions for such a test should sample all of the various fields of agricultural information with which the farmer must be more or less familiar to conduct his farming business. The following is a sample of the various types of multiple-choice questions which might be included:

A dairy herd improvement association's chief purpose is to help you:

- 1.....find out how your herd compared with the average
- 2.....determine the profit you are making on your dairy herd
- 3.....find out how much butterfat each cow is producing
- 4.....advertise your dairy herd.

Oat smut is carried over from one year to another:

- 1.....in the ground
- 2.....on the straw
- 3.....on the oat kernel
- 4.....in the seeder

The 1929 potato crop brought a good price because:

- 1.....people ate more potatoes
- 2.....potato growers put on a strong advertising campaign
- 3.....there was a small crop
- 4.....the Farm Board stabilized the market

A ration that is too low in protein will cause the hens to:

- 1.....lay fewer eggs
- 2.....lay soft-shelled eggs
- 3.....lose flesh
- 4.....lay infertile eggs

To avoid losses from goitre in pigs, lambs and calves:

- 1.....feed grain
- 2.....exercise the brood animal
- 3.....feed potassium iodide
- 4.....feed succulent feed

Hog cycle is a term referring to:

- 1.....stages from birth of the pig to its slaughter
- 2.....long-time swings in pork production and prices
- 3.....swings in the demand for pork products
- 4.....variations in the amount of pork products exported

W. A. McCall in his book *How to Measure in Education* sets down the following requirements of a good question:³

1. It must be in the language of the trade.
2. It must be a unit complete in itself, requiring no explanation.
3. It must not be a good chance question that could be answered by guess.
4. It must be short, not ambiguous, and the meaning must be unmistakable.

If they are to have the answers suggested as indicated, it must also be possible to answer them quite definitely and without qualifications.⁴

(3.) Page 213.

(4.) See Paterson, Donald, *Preparation and Use of New-Type Examinations; a Manual for Teachers.*

The exact number of such questions necessary to get a reliable indication of variations in the possession of technical knowledge or general intelligence has not been determined. Feasibility is one of the considerations in applying such a test, and the number of questions would probably be governed by the time it would take to get them answered. A test of 50 questions has been used in two such studies with good results.⁵

The relative possession of certain other characteristics on the part of the farm operator might be arrived at by having the field man give each farmer interviewed a score based on his observance of this characteristic. This was done for the factor "ability to do physical work" along with a number of others in the Minnesota study.

The frequency distribution of the rating on physical ability is as follows:

Score	Number of cases
86 — 95	9
76 — 85	6
66 — 75	11
56 — 65	24
46 — 55	73
36 — 45	13
26 — 35	9
16 — 25	9
0 — 15	12

Collection of data.

Data of this nature cannot be collected by mail. They can best be collected by one individual. If a group of field workers, even under careful direction, collects the data, they are almost certain to lack comparability. The field man must first gain the confidence of the farm operator and then by means of tests and questions obtain the desired information. It may be necessary to make more than one visit to a limited number of the men to evaluate more adequately the influence of certain factors.

Errors in records.

Data of this nature are not subject to the same precise measurement and interpretation accorded physical data. Personal bias, a potential source of error in any data gathered by an investigator, must be especially guarded against in an investigation of this type. In order to make the answers to numerous questions fit into a scale that can be tabulated, the investigator may have to ask the question in a number of ways. He must be extremely careful or he will get what he thinks the man's answer should be rather than what it really is.

(5.) The Bureau of Agricultural Economics cooperated with the Minnesota Agricultural Experiment Station in *A Study of Certain Human Factors in Farm Management* in 1930, and with the Indiana Agricultural Experiment Station on a similar study in 1931, in the course of which such tests were used.

Methods of analysis.

Most of these data collected relate to attributes that cannot be measured numerically. Since a farmer or his family either has good or poor health, at best only a limited number of classifications can be made on the basis of health. The same is true of a great many other items. The discussion of "Association Analysis" by Dorothea Kittredge in *Research Method and Procedure in Agricultural Economics* is especially applicable at this point. Yule gives a similar discussion of the theory and method involved in the analysis of data of this type in Part I of his book, *An Introduction to the Theory of Statistics*, under the heading "The Theory of Attributes". The usual cross-classification scatter diagram and simple correlation analysis will be found useful. Multiple and partial correlation will probably have only a limited field of usefulness.

One of the first things to investigate will be the accuracy and adequacy of the various measures of business and technical efficiency and accomplishment. Unless the investigator wishes to take upon himself the task of working out new measures of accomplishment in the farm business, he must be extremely careful to analyze and interpret his data in the light of the measures as they are, and not as he would like them to be.

Probably a case method of analysis,⁶ applied to a limited number of the group after a rather general analysis of the entire group has been made, will yield more information than an involved correlation procedure. Care must be taken in either case to distinguish between cause and effect, associated but not related reactions, and associations random in character. Because of the large variations found in data of this nature, it will be unwise to base conclusions on small samples.

There are no final results of a project of this nature published. The Division of Farm Management of the Bureau of Agricultural Economics, in cooperation with the Minnesota Agricultural Experiment Station inaugurated a project in this field in 1930. Some preliminary findings are published in Mimeographed Report No. 42 issued by the Division of Agricultural Economics of the Minnesota Agricultural Experiment Station in cooperation with the Bureau of Agricultural Economics. Field work on this project was continued in 1931 in Minnesota, and also begun on a similar project in which the Bureau of Agricultural Economics and the Indiana Agricultural Experiment Station are cooperating in Indiana.

PROJECT 36. Agricultural Entrepreneurship.

(By C. L. Holmes.)

Throughout the presentation of all of the farm management research projects outlined in this handbook there is the underlying

(6.) See *Research Method and Procedure in Agricultural Economics*, section on "Case Method".

although usually tacit assumption of responsibility on the part of the farmer for the organization and operation of the farm. However, in practically all of these projects, as in most of the actual farm management research of the past and now in progress, the study has been with reference to the objective types of farm organization and farm practice in their relation to the desirable result of profit making; and almost not at all with reference to the creative and directive force itself which is responsible for the organization and the operation.

Entrepreneurship, as has been pointed out by F. M. Taylor, is essentially this responsibility for the organization and operation of production. In popular speech it means business proprietorship. It is essentially personal and human. It implies the exercise of man's judgment in the conception and shaping of plans for production and requires the directive force of the human will in the realization of these plans. It is not passive nor mechanical but positive and purposive.

There are, of course, excellent reasons why farm management research has not concerned itself, up to the present, with farm business proprietorship itself, but only with the objective results of such proprietorship. The fruits of proprietorship, embodied in types of farming, in farm practices, and in the financial results of organization and management are objective and may be expressed in quantitative measures. Proprietorship itself, however, since it is concerned so much with psychological and subjective phenomena, is a difficult field to cultivate and involves the forming of judgment upon many factors which cannot be definitely measured or for the measuring of which we have not as yet found satisfactory means. It is, nevertheless, one of great importance, particularly in this time in which education, both formal and informal, in the field of the economics of agriculture is receiving so much attention. The fact that the art of organizing and managing farms, although based very largely upon the facts and principles of physical science, and dealing very largely with objective considerations, is itself a matter of the exercise of human judgment and will, makes it a thing which itself cannot be mechanized but which must find its perfecting through the processes of education and experience.

The fields of action for entrepreneurial judgment and will are the two important phases of farm proprietorship. The first is organization, in which the important psychological process is that of judgment forming. The second is management, which depends primarily upon what may be termed the executive will of the proprietor. We need not at this point go into a detailed discussion of the specific elements in the function of organization of a farm business, which primarily involves decision making; nor into management, which calls for the driving force of the human will. Neither do we need to dwell on the fact that these two functions of farm proprietorship are not

in actuality entirely distinct each from the other in the nature of the mental effort they require. While organization requires chiefly judgment, it also requires will; and management though primarily a function of the will, also rests upon judgment.

The factual material which has been and is being treated in farm management research, is, of course, related to research in this special field of farm proprietorship in a very intimate way. The phenomena of farm organization and operation are the external manifestations of the exercise of the functions of proprietorship. Much of the basis of inquiry in proprietorship research must be found in the field already being worked—that of farm organization and management.

So far as can be discerned at present, the new lines of inquiry centering around the function of farm proprietorship will have to do with (1) the determination of intellectual, emotional, and physical characteristics associated with varying degrees of excellence in entrepreneurial talent; (2) with the determination of the type of education and experience best suited to develop entrepreneurial talent; and (3) studies of actual and potential farm proprietorship in given areas, regions and countries.

In the first of these objectives—the determination of intellectual, emotional and physical characteristics of importance in farm proprietorship—the farm management research man finds himself occupying common ground with the psychologist. In the project described by Mr. Wilcox and Dr. Pond (Project 35), a beginning has already been made in exploring the field of psychological analysis for help in studying the human element in agriculture and in the utilization of the mental test for determining the relation between innate and acquired abilities and success in farming. Only a beginning in that direction has been made, however, and there would seem to be adequate reasons for further exploration and the testing out of such technique as the psychologist has already developed, modified in the light of the specific problem in hand.

It is true that the dependability and efficacy of mental tests have strict limitations and that these limitations are more clearly recognized now than a decade ago. It is also true that with the realization of these limitations more dependence may be placed upon such results as psychologists are willing to stand back of. Further, it would seem possible that with the background of such experience as has already been accumulated from the use of this technique in other fields, series of tests may be developed looking toward the determination of qualities contributing to effective farm proprietorship which may prove to be of importance in the development of research methods in this field. Undoubtedly a considerable amount of qualitative evaluation and the formation of judgment based upon non-quantitative evidence will have to be resorted to in this difficult field of research.

The results of this sort of study should be of unquestionable value to those who are working in the field of agricultural education. Not only in the matter of vocational guidance, which, it would seem, should be of some service in directing young people as well as older people into or out of agriculture somewhat on the basis of their personal fitness, but in the determination of subject matter and curricula, are the facts and generalizations concerning farm proprietorship needed. It would seem that we tend to overlook, in our current consideration of the problems of agriculture, the probability of a significant change in the quality of our farm proprietorship, and the education of this proprietorship. The work of county agents, club specialists, and agricultural teachers, must certainly have an important effect upon the point of view with which the young people of this generation will enter upon agriculture. They are getting acquainted with the scientific and educational background of their occupation and will seek further formal education in fitting themselves for it. It is altogether likely that a very much higher percentage of our enrolment in agricultural colleges in the future will be made up of young people who have had, at entrance, a considerable agricultural educational background and who can more intelligently select their fields of study than the students in these colleges in the past have been able to do. It therefore behoves the makers of agricultural college curricula to enlighten themselves as to what is most fundamental and important in agricultural education as to subject matter and objectives of training. It is no less important that they revise their methods of teaching to bring them into line with sound psychological principles. It would seem that the results of such inquiries as are here suggested will be of utmost value in shaping courses of study, particularly in the field of the economics of agriculture.

Research projects aimed at the determination of the type of formal training and the sorts of experience best suited to develop effective farm proprietorship would seem to be practical. Here again the farm management worker finds himself occupying joint territory not only with the psychologists but with the education specialists. It is possible that a species of job analysis studies, based on results from the other phases of farm management research, determining not only the specific functions of proprietorship but the human traits which make for the most successful functioning, can be worked out. If this sort of effort is successful the results will be of first importance in the placement of students in agricultural positions and in the designing of the agricultural ladder by which young men may climb to successful farm proprietorship. The results of such studies, combined with those previously discussed, should be of practical value in the teaching of farm management in high schools and colleges and in the work of extension specialists.

Another field of study involving farm proprietorship, which may have a somewhat broader and possibly more immediate objective than those already suggested, is that which has to do with the responsible human element now in command of agriculture in given areas and regions. It would be of considerable value if we knew more definitely the personal limitations and possibilities, from a proprietorship point of view, of the farmers now operating farms, and of their sons who will presently be operating them. We need, first of all, a more definite and detailed characterization of the task involved in farm proprietorship, the judgments that have to be formed, the available background of information and understanding upon which such judgments can be based, the prevailing mental qualities, in terms both of native ability and acquired training, of the farmers who must make these decisions.

Such an understanding would go far in the successful conditioning of campaigns of education and program shaping looking toward needed readjustments in agriculture. For example, much discussion has taken place of late with reference to the need of sweeping readjustments in the farming of the South. The specific nature of the changes which are desirable and feasible cannot be determined without an adequate understanding of the people, through whose understanding and participation the proposed changes must come, if they do come. Suppose it is determined, as a result of farm management research coupled with the findings of research into future demand and supply of agricultural commodities, that a given area of the South should be encouraged to increase the size of farms and to go over to a considerable higher degree of mechanization than is now prevalent. The success of farming thus reorganized will largely depend upon the availability of farm proprietors capable of functioning successfully under the new system involving, as it does, greatly increased responsibility in financial organization and management and in the successful carrying out of a very much more complicated farm technique.¹ It would seem that here is a need and an opportunity for effective proprietorship research with fairly immediately practical results. Wherever thoroughgoing readjustment in the prevailing agriculture seems desirable there is need of this type of study.

PROJECT 37. Case Studies of the Entire Farm Business.

(By J. D. Black.)

Several projects above outlined have suggested the use of the case method of analysis either alone or in combination with the statistical method. (See particularly Project 21.) It is a method well adapted to answering many questions arising in farm manage-

(1) That this factor is of primary importance is recognized in discussions in Projects 8, 10, 11, 12, 13, 14 and others following.

ment research; yet farm management workers have been slow to adopt it. In the early days of farm management study in this country, a procedure was followed that had something in common with the case method, namely, selected farms were studied and reported upon individually. But the farms selected were commonly only the most successful, and were supposed to serve as models for other farmers. There was no analysis; nothing but description. The case method as a method of research includes a complete and careful individual analysis of each unit studied, and attempts to arrive at scientifically determined conclusions.

In these early days also an excellent foundation was laid for the use of the case method in the so-called statistical route method, later usually called the cost-accounting route method. A small group of farms was carefully selected, and detailed data were collected on the operations on these farms, on their receipts and expenses, and opening and closing inventories, etc. All that was needed to complete the process was a *case analysis* of the data and information collected. What ensued instead was a combination of the data into a series of unit costs for the different products on each of the farms, and then a statistical analysis of the unit costs in the form of simple tables and averages. There usually was some explanation of the differences in cost between the farms, and other comparison of the farms, that had a generic resemblance to case analysis; but this part of the process was not well developed.

Subsequently, critics of this type of approach to farm management analysis stressed the inadequacy of the samples upon which such averages were based, and those using the "route" procedure attempted to meet this criticism by including more farms—15 to 35 in place of the 5 or 10 formerly included—and by giving more thought to representativeness in selecting these farms. In later years, such projects have included over a hundred farms in some cases, at the same time reducing the amount of detail and the frequency of visits so as to keep the projects within their budgets.

As has been made clear in several projects—see No. 8 particularly—there is a definite need for fairly detailed projects which meet the requirements of sampling, either random or purposive, and the foregoing evolution has led to useful procedures. But the logical way to have met the criticisms of the statisticians would have been to quit trying to make the small group of farms selected into a statistical sample, and to quit trying to summarize the data into a few figures such as unit costs of production and averages of these, and instead to treat the farms as individuals to be compared with others one at a time, after the manner of case analysis. So handled, the information from these route farms could have been made to point to significant conclusions; and could have been put to excellent use in the classroom, as in fact it often was even though it had also been

put through the cost accounting and statistical mill; and no doubt it could have been put to simple direct uses in extension work.

But the case method was not a topic of discussion in those days, at least in agricultural colleges. LePlay's name was sometimes mentioned in graduate courses in economics; but few persons took the trouble to read him. What we now need is a careful testing out and development of the possibilities of the case method as applied to small numbers of farms. Farm management workers need to acquaint themselves fully with its essential principles and processes, and see what these mean when interpreted in terms of farms.

Some references on the subject are as follows:

"The Case Method" in *Research Method and Procedure in Agricultural Economics*.

The discussion of LePlay's methods in the report in this series on Farm Family Living.

Project 19 in the report in this series on research in Rural Population.

Analyses 9 and 39 in *Methods in Social Science*, compiled under the direction of the Social Science Research Council.

These references will reveal that there is still a wide latitude of thinking as to the nature of the case method. Probably there are several forms of the case method. The one principle included in all of them is that the case method arrives at the truth by a careful examination of all the details of a small number of units of observation, perhaps only one, whereas the statistical method abstracts a few of the more important attributes of a sample of units of observation. The protection against error in using the case method is that all the aspects of the subject are considered; the protection against error in using the statistical method is that the unmeasured factors affecting the result tend to be distributed on both sides of the line of regression, and hence to cancel out.

The nearest approach to the use of the case method in farm management research is in R. L. Mighell's study reported in part in Massachusetts Bulletin No. 275, *Planning the Farm Business on Three Dairy-Fruit Farms in Massachusetts* (1931). Mr. Mighell does not state in this report that the three farms described and analyzed were selected from twelve for which data were obtained in detail, and that the work done on the other nine not only assisted in selecting these three as best representing three sets of conditions found in the area, but also helped to explain what was found on these three; and also is being used constantly as a basis for interpreting conditions found on still other farms in the territory. The actual published report is of course only a farmers' bulletin and includes no statements on these points or as to the analytical methods used.

It is doubtful, moreover, whether this study made really adequate use of the data collected; or went as far as could be in developing general conclusions as to dairy-fruit farming in the area. Further attempts will be needed to develop the possibilities of the method with farms as the units. Mr. Arthur Jones of the Midland Agricultural College in England has also been experimenting with the method in farm management research. Some of the recent reports of closely supervised or route studies contain analysis that suggests the case method. (See Project 8A above.)

No attempt will be made to outline a definite project here. The discussion in *Research Method and Procedure in Agricultural Economics* contains the writer's ideas as to the nature of such a project. One would first need to decide which of the plans and objectives there outlined was to be followed. Then would come an exploration of the area as a basis for selecting the cases to be included; then deciding what information would particularly be needed; then collecting this and any other information that could in any possible way be pertinent; then studying one farm as a unit and endeavoring to understand thoroughly *why it is as it is, and works as it does, and gets the results that it does, and what influence each particular element in it has on all these*; then doing the same with the second farm studied and comparing every part and relationship in it with the parallel facts and relationships for the first farm; and similarly for other farms. The procedure at this second and the later stages will depend upon the general plan of the study, the types of farms chosen, etc.

The case method will no doubt be used fully as often in studies of parts or phases of farm business as in studies of it in its entirety; but the background of the special phase will need to be filled in rather completely.

The units in a case study can be areas as well as single farms.

PROJECT 38. Description of Agriculture in an Area.

(By J. D. Black.)

Hundreds of studies of farm organization and management have been made in the United States and abroad whose principal value is in the description of the agriculture of the area which they provide. Teachers and students of farm management in the early years very much needed these descriptions; and they still need them. Similar studies now being made in all parts of the earth are contributing greatly to the development of the economics of agriculture. They are providing us with the store of facts and data that we need in order to see our own agriculture in its proper perspective; and to set over against each other for comparison the systems of farming in the densely populated regions of the Orient, of the pasture lands

of southwestern England, of the far northern farms of Norway and Finland, and the grain farms of the western frontier of Canada. Such studies may not classify as the highest order of research in themselves, but they are furnishing the materials for research by others.

To be as useful as possible in the foregoing ways, such studies should include a description of the general social background—population factors, occupations, rural organization, tenure, land values, etc., and of the natural factors of climate, topography, soil, etc. Sizes of farms should be presented in terms of total area, arable area, labor force, capital invested, output, etc. Expenses and receipts should be itemized in considerable detail. Incomes should be stated as returns to the farm family, as returns to capital, as spendable income and in all other significant ways. Cultural and feeding practices should be itemized in considerable detail. The variations between farms will be as important as the summary figures.

The term “analytical description” is commonly used in the literature of research. Applied to the present problem, analytical description will include the summarizing of the data for all the farms, defining the variations between them, classifying the farms into groups or types, and discovering associations between the different variations, and between these variations and such factors as soil, tenure, type of operator or family, etc. It is apparent that such an analytical description of the farms in any one area will make the report of it much more useful in subsequent analyses, and give to such projects a more definite research value. Each area thus studied may be looked upon as a case study of the sort indicated in Project 37.

A certain amount of uniformity in the procedure for collecting data, in units of measurement, in coefficients and the like, makes the reports of such descriptive studies more useful in combination with those of other similar studies; but standardization can easily be carried to the point of deleting from the reports of any one area the details peculiar to it that are of most significance. *The major parts of the values in such studies will not lend themselves to tabular or graphic presentation.*

The descriptive studies now being made are too nearly cast in one mold. The principal reason for this, of course, is an effort to combine with them the further testing of a certain conventional set of generalizations that have come to be accepted by many workers in the field of farm management—generalizations such as with respect to size of business and yields in relation to income—using the statistical procedures outlined in the first part of Project 8. If the subject of farm management is to be enriched as should be by

these studies, particularly the studies in other countries, we must let the special conditions and the facts in each area speak more nearly for themselves and suggest their own hypotheses.

With this much general discussion of the research problem involved in such a project, one should be able to lay out for oneself the task of preparing a description of the agriculture of an area.

ANNOUNCEMENT

This series of reports is part of a program of assistance to research in agricultural economics and rural sociology in the United States undertaken under the auspices of the Social Science Research Council. The following other numbers in the series on "Scope and Method" are in process of preparation: Agricultural Income, Marketing of Farm Products, Transportation and Agriculture, Prices of Farm Products, Index Numbers for Agriculture, Farm Family Living, Rural Organization, Agricultural Insurance. Other numbers contemplated will deal with such fields as Agricultural

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The next stage in the program is this present series of reports in which the various sub-fields of agricultural economics and rural sociology are made the units of study.