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**CONDITIONS AND IMPROVEMENT
OF CROP PRODUCTION, STOCK-
RAISING AND RURAL INDUSTRIES**

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**EUROPEAN CONFERENCE
ON RURAL LIFE**

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CONDITIONS AND IMPROVEMENT
OF CROP PRODUCTION, STOCK-RAISING
AND RURAL INDUSTRIES (*)

(*) This Report has been prepared by the Staff of the Technical Bureau of the I. L. A.

I.

PRESENT CONDITIONS AND IMPROVEMENT OF AGRICULTURAL PRODUCTION

Conditions affecting Agricultural Production.

The purpose of agriculture is to make a profit. According to trade conditions and market requirements, the agriculturist devotes his efforts either to obtaining the highest possible yields, or to raising high quality produce, with a low yield.

In either case agricultural production is largely dependent on environmental conditions, some of which, obviously, are entirely beyond human control, as, for instance, weather conditions (rain, frost, drought, etc.) and the various enemies and parasites which attack plants and domestic animals. Consequently there is always an element of uncertainty about agricultural production until the day the produce is sold.

These special conditions governing agricultural production explain why it is impossible for the agriculturist ever to count definitely upon a profit from his labours, and justify the measures taken, often at great cost, to protect crops against the various enemies and calamities to which they are exposed and domestic animals against the propagation of infectious disease.

For a long time past efforts have been made to render the agriculturist more or less completely independent of such risks by improving methods of cultivation, and encouraging the rational working of land more particularly through the adoption of types of husbandry suited to environmental conditions (soil, climate, etc.). Remarkable results have been obtained, especially during the last fifty years. Nevertheless, unforeseeable calamities such as frost, drought, floods, damage to crops through parasites, the appearance of plant diseases for which no treatment is possible and epizootic diseases are still feared, and justifiably so.

Even assuming that the conditions of agricultural production are satisfactory, it is essential that produce intended for sale should be made to look attractive — which is one of the objects of standardisation — and should be so preserved as to retain its characteristic qualities for a sufficiently long period. The aim, in fact, is to offer the prospective buyer goods answering to various requirements, the first of which is freshness.

Lastly, the business of farming, which, even if attention were concentrated on a single crop, would be highly absorbing, is growing increasingly complicated; production has to be varied to meet the growing variety of the consumer's demands, and must also be adjusted in consideration of the competition of other, and frequently distant, regions or countries.

The practice of agriculture thus calls for a wide range of knowledge. By a brief survey of the more important recent improvements in agricultural methods in certain countries, it will be possible to form a reliable idea of the present position in this matter, which is of vital importance for all countries.

It is proposed to examine in turn present conditions and the improvement of agricultural production, present conditions and the improvement of stock-raising, and, lastly, the highly important question of the industrial transformation of farm produce.

A. — Progress in Crop Production through the Introduction of New Crops and the Improvement of Plants.

(1) INTRODUCTION OF NEW CROPS.

The history of agricultural progress in European countries has been characterised by a series of more or less sudden advances followed by periods of gradual improvement. Periods of unusually rapid progress have often been preceded by the introduction of new crops—new species, varieties or breeds created or selected in the country concerned or imported from abroad.

It is only necessary to go back to the beginning of last century to realise the enormous importance for a large number of European countries of the introduction of sugar-beet, which gave a decisive impetus to all branches of agriculture and also improved, the entire national economy of the beet-growing countries.

More recently the cultivation of plants for green manuring has marked a further stage in agricultural progress. The introduction of lupins and other leguminous plants has made the cultivation of many soils more profitable and has also enabled land which had previously always lain waste to be brought under cultivation.

At one time it seemed as if agriculture had finally passed beyond the stage at which the introduction of new crops is feasible. But the tendency towards self-sufficiency displayed by various countries has again led to attempts to introduce new crops or to revive crops the growing of which had been abandoned. For instance there has been a very marked resumption of flax- and rape-growing in Germany and of cotton-growing in Italy. The cultivation of soya-beans is being generally encouraged not only in countries of autarchic tendencies but also in countries whose foreign trade is still more or less free from restrictions. Certain European countries are also taking a great interest in the cultivation of the rubber-plant, in the hope of producing part of their requirements themselves instead of being obliged to purchase all their rubber from tropical countries, as hitherto. The efforts made in this direction by the Union of Soviet Socialist Republics have led to the production of large quantities of rubber obtained from various species of plants introduced, acclimatised and selected for this purpose.

Whatever may be thought of the advisability of reviving neglected crops and introducing new ones unsuited to European conditions, there is nodoubt

that the agriculturist can confidently expect a profit from them, as, during the experimental period at least, they are usually subsidised by the Government.

As regards the effect of importing new varieties of crops already under cultivation, the most outstanding example is furnished by the English *Square head* wheat the introduction of which in all countries bordering on the North Sea and the Baltic, has greatly increased the abundance of the crops. Similar results have been secured with Petkus rye and Bohemian and German varieties of sugar-beet. Quite recently the Greek wheat crop has been greatly increased through the introduction of *Mentana* wheat from Italy.

Generally speaking, however, the period of large-scale importation of new species and varieties would now appear to be over. Progress in agriculture in recent years has been based much less on importation than on the breeding of new so-called home varieties on the spot. The improvement of plants is a sphere in which each country can really aspire to self sufficiency; for, with the varieties of the entire world to draw on for its parent strains, it can endeavour to evolve varieties of its own which are specially suited to its own particular conditions. Such is the tendency which is clearly revealed by the more recent developments in the fields of plant improvement. Improvement by the mere process of selection had undoubted advantages, and still has, in countries which are agriculturally backward. In all countries moreover, it was by selection that plant improvement began. The effects were often surprising and everywhere resulted in extraordinarily rapid progress. Today, however, in the more advanced countries cross-breeding is preferred. It is the most widely applied method, as well as the most highly developed and most productive of results.

Of all the methods of improving agricultural technique, such as the rational rotation of crops, the use of chemical fertilisers and green manure, the introduction of hoed crops, deep tillage of the soil, perfected mechanical harvesting, etc. none has brought about such progress as the improvement of plants through selection and cross-breeding. Nor should it be forgotten that as a rule, the methods of improvement mentioned above entail considerable expense and constant care, whereas the use of improved varieties only involves the agriculturist in the slight extra expense represented by the surcharge of a few centimes per quintal of seeds, which is his modest contribution to the costs of plant selection work. The introduction of a better variety in an agricultural area means an immediate profit for the agriculturist. It improves the crop either in quantity or in quality, while scarcely increasing the cost of cultivation. The creation of varieties with an improved yield and quality is therefore clearly one of the simplest and most effective means of raising the general level of a country's economy.

If, however, an improved variety is to give the best results, the care shown in its cultivation must correspond to its superior quality; *i. e.* careful methods of cultivation and intensified manuring must accompany the use of improved varieties which repay the care given to them and make it possible to obtain a maximum return from the soil. It would be useless to lay down any rule as to which should come first - the introduction of choice varieties, or the use of perfected and intensified methods of cultivation. The two systems are naturally complementary to each other. This interdependence between the improve-

ment of methods of cultivation and that of the varieties cultivated is one of the best stimuli to agricultural progress. Among the various means of fostering agricultural progress, the improvement of plants is, at the present time, of outstanding importance.

No better proof of this could be found – as far as Europe is concerned – than in the case of sugar-beet. The first result of the introduction of this typical hoed crop in the system of rotation was a marked improvement in the physical condition of the soil. As the beet requires a great deal of nutriment the agriculturist is obliged to manure abundantly, thus considerably improving the chemical qualities of the soil. The increased richness of the soil then leads to the use, for the succeeding cereal crops, of improved varieties, able to turn the good condition of the soil to account and, above all, capable of standing up to the weather. This succession of improvements would, however, have been impossible if the different varieties of sugar-beet had not thereby been able to compete with sugar-cane from overseas. When sugar-beet was first introduced into European agriculture, its sugar content was approximately 8 per cent., of which to begin with only 4 per cent. could be extracted; the amount of sugar produced per hectare was scarcely more than 10 quintals. Now, a century later, the figure of 50 quintals has been reached – which represent a five-fold increase in the crop – partly owing to better methods of cultivation and extraction, but primarily owing to plant selection. The example of sugar-beet is typical, because in its case the increased yield is due to two quite distinct factors: (1) increase in the raw crop, due primarily to improved methods of cultivation; (2) increase in the sugar content of the root, due almost exclusively to the effect of selection. Since 1850, for instance, the sugar-beet crop in Bohemia has only risen from 239 to 278 quintals per hectare, whereas during the same period the sugar content, which has risen from 7.8 per cent. to 17.7 per cent., has more than doubled; a most marked and significant success, due to selection.

Another example is that of Denmark, where, from 1889 to 1929, the average total yield for all crops with the exception of meadow-hay and straw increased by a little over 50 per cent. There is no doubt that the increase was largely due to the use of the superior varieties introduced during that period. The effects of plant-improvement are best revealed by the fact that, if the yield of *square head* wheat (itself a very prolific variety) is taken as 100, the yield of the best varieties of Danish wheat (*Trifolium 14* and *Lawaetz Alshvede*) has, in the course of tests carried out over a long period of years, risen to a comparative figure of 135. Progress is still more marked in the case of barley. In the years 1927 to 1930, the Abed Station's barleys exceeded the yield formerly obtained with ordinary barley by 39 per cent. Excellent results have also been obtained with fodder plants, in regard to which Denmark is among the foremost countries of the world. From 1925 to 1930 the Ostofte early clover, for instance, gave a crop 27 per cent. greater than that of the best variety of non-selected clover.

The above examples, and many other facts which it would take too long to enumerate, afford ample proof of the success of European selectors in producing varieties of plants giving a high yield.

(2) NEW TRENDS IN PLANT IMPROVEMENT.

In recent years two factors have profoundly influenced the improvement of plants: overproduction (and a slump in the market for agricultural produce), and autarchic tendencies. The difficulties experienced in selling agricultural produce led to selection for quality rather than quantity. A striking illustration is offered by the tendency to produce varieties of wheat which are rich in gluten, with a high value for milling and baking purposes, giving perfect bread and suitable, if necessary, for mixing with inferior flour to give it body and improve its quality. That tendency has become more and more marked as home baking has increased, and is to be found in all parts of the world, particularly in the European wheat-producing countries. In this connection we may mention *Tasilo de Lang* (Germany), Biffen's *Yeoman I* and *II* (England), *Vilmorin 27* (France), *Bankuty 1201* (Hungary), etc.

Efforts to produce improved varieties of barley fall into two distinct categories, according to the properties desired: on the one hand there are the brewing barleys, the first methodical attempts to improve which were made in Denmark, with the object of obtaining a high starch content and low nitrates content; on the other hand there are the fodder barleys, in which the highest possible protein content is required.

Here again reference may be made to the example of sugar-beet. An increase in saccharine content, which naturally leads to an increase in the yield, also represents an improvement in quality. Improvement of sugar-beet has long followed two lines: improvement of the sugar-content of varieties from which sugar is to be extracted, and improvement of the nutritive properties of varieties used as fodder. In the case of the latter there appears to be an increasing tendency to attribute chief importance to a high content of dry matter and nutritive substances (especially carbohydrates, and also albuminoid nitrogen) rather than to an increase in the total yield. Altogether, agriculture has derived great benefit from the work of the plant breeders and selectors.

In many plants it is quality which is the main consideration; for instance, tobacco, fruit, market-garden produce and ornamental plants. Here too selection has recently been widely applied with most satisfactory results. Today quality is the decisive factor as regards price and sales in general and consumers have become much more exacting than formerly.

It is now of the utmost importance that plants should be suitable for mechanical methods of agriculture and much is being done to bring about improvement in that respect. In the Union of Soviet Socialist Republics, the primary consideration in regard to any variety of cereal is whether it is suitable for use with a mechanical harvester-thresher.

The chief wish of every agriculturist is always essentially the same: that crops will be certain and regular. In recent years, selection has gone far to making that wish a reality, more particularly through the creation of varieties capable of withstanding various natural disasters (frost, violent rainfall, drought, excessive heat, falling of grain, etc.), and of resisting various diseases (including

a whole series of virus diseases) and insect pests. Here selection and production go hand in hand.

It is no exaggeration to say that if the enemies and diseases of plants were allowed to develop and spread freely, agriculturists in all countries would soon be confronted with very serious — perhaps insuperable — difficulties. Sooner or later people would be obliged to do without many vegetables which are an essential part of their every-day needs. As all crops would be threatened at the start, harvests would become entirely problematical.

A few fairly recent examples will make this clear. During the first few years after the appearance of potato-blight in Europe, the disease aroused little anxiety. Soon, however, it became so prevalent and deadly that potato-growing was seriously endangered, and in parts of northern Europe regular potato-famines occurred.

The first attacks of vine-mildew in Europe also appeared negligible, and it was even said that they would be beneficial, because by causing the leafy shoots to fall off when the grapes were ripening they allowed light to reach the fruit, and thus obviated the need for picking off the leaves by hand. But these alleged advantages were soon found to be very serious dangers, against which vine growers were at first defenceless so that in one country alone the disease resulted in the loss of about 10 million hectolitres of wine in a single year.

In a neighbouring country, during the same period, another pest, phylloxera, destroyed 1,500,000 hectares of vineyards, and the wine harvest, which had been 85 million hectolitres scarcely 15 years before, was reduced to 23 million. As a consequence, the value of viticultural land fell noticeably in certain regions, and part of the population it supported had to emigrate.

Although then still in its infancy, the science which studies plant-diseases and the means of preventing and combating them soon became firmly established, and continued to develop. To-day no one would think of denying how greatly plant pathology and agricultural entomology (a sister science) can contribute to the increasing and improvement of crop production. It cannot be denied that future progress in agriculture largely depends on rationally planned and carefully applied protection of the plants cultivated.

It is, indeed, to his knowledge of these sciences that man owes the remarkable economic results which he frequently obtains from his crops. As an example, it need only be mentioned that, if applied at the right time and in the right way, the treatment at present recommended by phytopathologists as most effective for dealing with potato blight may lead to an average increase in the yield of healthy tubers corresponding to an increase in the crop of from 3,000 to 5,000 kilograms per hectare.

Another classical example, is the selection of varieties of potatoes which are immune from black scab. Completely successful results have already been obtained, and vast tracts in some of the poorest regions have thus been protected from a grave danger.

Another sovereign treatment is that now in current use as a preventive of vine-mildew and in consequence of which, the enormous damage annually caused

by that parasite after its appearance in Europe towards the middle of the last century, has been reduced almost to nothing.

Mention should also be made of the evolution of stock-vines immune from phylloxera, varieties of cereals relatively immune from rust, etc. which achievements have had far-reaching effects on the development of agriculture.

In the sphere of agricultural entomology the success so far achieved by the biological attack on certain pests has been truly astonishing.

The fact that the fight against the diseases and enemies of plants is now being so extensively waged in all countries of the world is sufficient proof of the great practical value attached to phytopathological and entomological studies. At the same time the general use of fungicides and insecticides proves that systematic action against the enemies of crops is now recognised as being of vital importance for agricultural production.

The success of a given variety under the ecological conditions of a particular district depends largely on its ability to withstand the worse kinds of weather. Adaptability to environment is one of the chief properties aimed at by plant selectors at the present time. Hence the great success of the Strampelli varieties of wheat, which mature early and are thus able to withstand, or rather are never exposed to, the effects of drought and excessive heat. Agriculture in Italy, Spain, Greece, and the south of France has greatly benefited from this characteristic of the Strampelli early varieties of wheat, which, being safe from the disastrous effects of periods of extreme heat and drought are particularly well-suited to the conditions prevailing in Mediterranean countries.

Selectors are now trying to combine the abundance of the new with the hardness of the older varieties, so that there is less irregularity in crops — a most important consideration from the point of view of the practical farmer.

Owing to this quality of the new varieties, farmers find that their crops not only increase in size, but acquire a regularity which is practically unaffected by vicissitudes of climate.

Altogether, co-operation with the pathologist, mycologist, entomologist, physiologist and meteorologist is now an important side of the selector's work and would appear to promise most valuable results.

The self-sufficiency movement recently set on foot in a number of countries has considerably stimulated plant breeding, while at the same time causing important changes in the national range of crops. Its first effect was to increase the State's interest in new technical methods; but even more, it has had the effect of directing the attention of selectors to objects of national importance.

In Germany, for example, great efforts are being made to produce plants rich in albumen, and the sweet lupin bred by the Müncheberg Station shows how completely that aim has been achieved. To meet her wheat requirements, Germany has also applied herself to the breeding of varieties which could thrive on sandy soil and be substituted for rye. Several other countries are making efforts to breed varieties of soya bean suited to the climatic conditions of various parts of Europe, as a means of meeting the protein requirements, which in almost all countries are largely unsatisfied. The Union of Soviet Socialist Republics has been very active in selecting rubber plants, the most important being *Par-*

thenium argentatum, in the Asiatic part of the country; several other species, in particular the various composites known as *Saghys*, have been improved and cultivated in the European districts.

In Italy, interest in cotton-growing has received fresh stimulus, and attempts are being made to obtain, through selection, a variety suitable for cultivation under the climatic conditions of southern Italy.

Germany is seeking to satisfy her great need for textile fibre by developing the cultivation of flax, and great efforts are being made by private selectors and the Sorau Station to produce superior varieties.

It is obviously important for countries of autarchic tendencies, which have established fixed prices for agricultural produce, that crops should be as reliable as possible. With that object in view, use is made of varieties capable of withstanding any natural calamities by which the crop might be reduced. An irregular yield would of course mean an irregular price for both producer and consumer. The variations to which crops are usually subject make long-term planning and organisation difficult, and it is therefore of the highest importance to limit their extent.

Mention has already been made of the substitution of wheat-growing for rye-growing in Germany, and a similar change has been taking place in Denmark. This is the result of the appearance of new wheat varieties producing a larger and more certain yield, even when grown on land previously regarded as too poor for wheat.

(3) ORGANISATION OF THE IMPROVEMENT OF PLANTS.

It would be a complete mistake to think that it is only the Governments of autarchic and authoritarian countries which have recently taken an interest in the improvement of plants. In all countries without exception there has been a marked tendency for the State to assume control over this branch of activity, which is of great importance for the welfare of the whole population and the future of the national economy. In several countries the improvement of plants is entirely, or almost entirely, in the hands of the State — in the Union of Soviet Socialist Republics of course, but also in Italy, Greece, etc. In others the work is done partly by the State and partly by private enterprise in varying proportions. In all countries the State first intervened in the scientific sphere and in connection with the control of varieties. Such intervention had very fortunate results. In the scientific sphere — breeding, pure and applied — no confirmation of that statement is needed. With regard to the control of varieties — comparative tests and control of authenticity and purity — the rôle of the public authorities as impartial arbiters is of the greatest importance. There has been considerable progress in that direction in recent years which has greatly benefited agriculturists. The comparison of varieties is a very delicate and important problem, both for honest selectors who wish to submit their creations to an official test, and for growers who wish to know what varieties are best suited to their particular districts. Thanks to the efforts of the authorities in the various countries, the recourse to comparative tests is spreading. The

technique of these tests has incidentally been much improved by the use of statistical methods, which inspire confidence on the part of the growers in the information published. The experience gained as a result of the tests in regard to the characteristics and qualities of new varieties is passed on to the general public by the agricultural organisations or services. The grower is thus provided with valuable practical data as distinct from the purely commercial information contained in catalogues.

But the discovery and selection of improved varieties, the test of their qualities and the distribution of particulars in regard to them to the growers is not enough. The purchaser must be assured that the seeds he buys are those of the desired variety and are pure and free of disease. Control of seeds is therefore very closely connected with the improvement of plants. Official control of seeds has in fact frequently been the precursor of official control of plant-improvement. In France, for example, the establishment of the Station des Essais des semences (seed-testing station) in 1884 was the first step towards the subsequent official control of plant-improvement.

In countries with a satisfactory organisation of plant-improvement the authenticity of varieties put on the market is assured by the use of Registers of selected plants, *i. e.* varieties which have been tested and are proved to be genuinely new varieties. Registration in this connection has been of the greatest service to the practical agriculturist by ridding the market of the chaos of synonymous and superfluous varieties. It is not in the agriculturist's interest to be offered an enormous miscellaneous number of varieties. A selector who places on the market a new variety which is no improvement on existing varieties is really, as M. Schribaux has said, a public offender. A multiplicity of varieties is of no advantage to any one except dishonest dealers. For agriculturists it is a great nuisance. The qualified bodies which have undertaken the work of elimination in several countries are therefore rendering excellent service, not only to agriculturists, but also to honest selectors.

In most countries attempts are being made to protect honest selectors against fraud and unfair competition. The authorities have not hesitated to protect a branch of agriculture which is so important from the point of view of general progress. Methods differ in different countries; but the need for national and international protection of selectors' rights has been generally recognised.

If the present aspects of the problem of plant-improvement are studied, it will be seen that great importance attaches to ecological questions. Today much greater attention is paid than formerly to the relationship between plants and their surroundings. It has been said that the plant is fundamentally the « machine » of agricultural production. The environment may be considered, according to Professor Todaro's definition, as the motor of the plant machine. This interdependence between variety and environment has been carefully studied. It is on the basis of such studies that attempts are made to assign a given vegetable species to a district where it will find the conditions best-suited to growth, and thus be able to make as large a contribution as possible to the improvement of production. It is a question of assigning a zone of cultivation to each species, or *vice versa*, which means that improvement of plants and the distribution of

varieties must be organised on phytogeographical lines. Special attention was paid to these principles in the former Austria and the Union of Soviet Socialist Republics. This "*rayonnement*" (allocation of particular varieties to particular districts) was carried to great lengths — probably to too great lengths — in the Union of Soviet Socialist Republics. The recent improvement of plants in Greece owes its striking success mainly to the attention paid to ecological and phytogeographical principles.

The above is an attempt to describe the present position of plant-improvement in Europe, and to show its immense importance for agriculturists as also for the entire economy of the various countries, by giving a number of examples chosen from the vast amount of available evidence. Before concluding, however, an example may be taken from a country outside Europe, which offers what is perhaps the most striking illustration of the importance of selection, namely, the improvement of the sugar-cane in Java.

Owing primarily to the use of improved varieties of cane, the yield of sugar in Java has increased by more than ten times in barely a century. From approximately 2 tons per hectare, it has risen under the best conditions to over 23 tons — a quite astounding increase. Since 1927, the famous variety known as *POJ 2878*, which has progressed triumphantly till it now covers a large portion of the area under sugar-cane cultivation, has increased the average sugar crop in Java in a manner so striking as to give rise to great anxiety regarding the future of sugar-beet cultivation in Europe. In this case, selection has benefited the overseas cultivator. A very great effort will be required from European selectors if the supremacy of European sugar cultivation is once more to rest on secure foundations.

Every country anxious to improve its agricultural production has always started by realising the practical utility of scientific study and research. For that to be possible, however, a fairly large specialised staff and properly equipped laboratories and test fields are necessary. That is a form of expenditure which no country has ever had cause to regret.

Research and experimental work should be completed by a properly organised inspection service, responsible for supervising the condition of crops, and for testing plants, parts of plants, and other agricultural produce for export or import in order to inspire confidence in importing countries, and at the same time to protect the country itself as far as possible against the introduction of dangerous foes.

Any organisation for the application of scientific research to agriculture will, however, be incomplete and cannot be really useful unless it makes every effort and takes advantage of all available means to carry out intense propaganda and popularise modern technical knowledge. It is essential to keep agriculturists informed of technical progress, if the results of laboratory research work are to be applied in practice. It is necessary to persuade those who work on the land of the supreme importance of such propaganda and popularisation of knowledge. It is the countries which have acted strictly in accordance with these principles which are now at the head of the agricultural movement and pointing the way to further progress.

To sum up, attention is drawn to the following facts. In the present state of knowledge, success will henceforth come, not only to agriculturists who (acting in accordance with the results of modern technical research) succeed in producing large quantities at cheap rates, but also to those who obtain from their land produce which has a fine appearance and good keeping qualities and is free from parasites. Produce with such qualities will always, even at times of depression, fetch a remunerative price and find an easy sale on the home market, with possibilities of export.

Of course, many technical questions have still to be studied or elucidated, and many old problems are still only partially solved. The biological characteristics of certain parasites have to be defined: research work and tests have to be carried out with a view to discovering new hardy varieties: prophylactic and therapeutical methods which are known already, but have not been adequately tested, require to be perfected, etc. New questions and new problems are, however, constantly calling for study by competent technicians. That is one of the interesting things about agricultural problems, which are all fundamentally technical in character.

B. — Improvements in Vegetable Production through the Use of Fertilisers.

Until quite recently, modern agronomy followed in the wake of agricultural chemistry, which, in accordance with the old law of LÆBIG, took into account only the value and quantity of certain mineral elements in the ground and in plants, and disregarded the biological and dynamic processes which are the manifestations of the actual life of the soil and of the plants. LÆBIG's law has now been superseded: it has to be reconsidered in relation to a whole body of modern theories, such as the physiological theory of MITSCHERLICH, the new integral doctrine of fertilisers (TOMMASI), and the humo-mineral theory (DRAGNETTI). These theories, however, are themselves incomplete: they provide no method of accurately gauging variations in the surrounding soil and climate, which in many countries have a predominant effect on soil productivity and hence on the effectiveness of fertilisers.

The use of fertilisers — with the present tendency to use composite and complete chemical fertilisers — requires as exact a knowledge as possible of the supporting medium (the soil) and what happens to it through contact with plants. In this connection, the determination of the pH, and its use as a criterion for the classification of different kinds of land and the establishment of pedological maps, has enabled marked progress to be made in agricultural practice. Such classification, based on the pH and, if necessary, on the rH (oxygen-reducing capacity), should be accompanied not only by data relating to the composition and structure of the soil, but by indications as to the two most important factors in fertility, namely, the amounts of water and of sunshine available.

The enrichment and improvement of land by means of fertilisers which modify its structure and its micro-biological content have considerably improved conditions of agricultural production.

Areas recently brought into cultivation generally include land which is rich in humus. The latter, particularly in the case of intensive cultivation, is exhausted in a comparatively short time; moreover, the soil nearly always lacks some main mineral fertilising substance which plants need.

A sound combination of manure with chemical fertilisers is the classical system which has given the best results, as regards both quantity and quality, at the lowest cost.

The future of agriculture therefore largely depends on research and progress in the fertiliser industry. Only 16 per cent. of the world's population gains a livelihood from non-agricultural work; hence it is natural that attempts should have been made, by a process of long and careful experiment, to acquire an exact knowledge of the best technical methods of obtaining and using various forms of fertiliser. A recent result has been a tendency to the use of synthetic fertilisers, owing to the special conditions obtaining in certain post-war industries.

In view of the fluctuating extent to which agriculturists were able to buy fertilisers, and in view of the improved technical methods of production resulting from the most recent study and research on the subject of the stabilisation of the relationship between fertility and maximum yield, the fertiliser industry had to try to adapt itself to existing conditions. New methods of manufacturing nitrogen were invented, which were a great improvement on the old processes of HABER; the large establishments in Norway, Italy, England, France and elsewhere, set up on different principles and for production by different processes (CASALE, CLAUDE and FAUSER) exemplify the great progress which has been made in the commercial manufacture of synthetic nitrate products.

With regard to potash fertilisers, not only has the exploitation of the famous deposits of Stassfurt, Alsace, and the mines of Russia, Spain, America and elsewhere been intensified, but the greatest possible use has been made of insoluble potash substances such as polialites, leucites, micas, glauconites, etc., and of methods of recovering potash salts from the sea (the salt beds of the Dead Sea and of the Mediterranean and African Basin).

With regard to phosphate fertilisers, the main objective of the industry is to produce concentrated superphosphates and nitrated superphosphates, and in particular neutral bicalcic phosphates with a high phosphoric anhydride content (38-42).

The present tendency, particularly in America, is to use complex, and complete, mineral fertilisers. The old ideas have not been completely discarded however. At one time there was an undue tendency to disregard the humo-mineral factor and its effects on the bio-energetic processes of the soil and the plant. Humus which has accumulated in the soil is rapidly destroyed through intensive cultivation. It must therefore be reconstituted with sufficiently large rational doses of organic fertilisers and mineral fertilisers. Although chemical fertilisers used alone may to a certain extent and for a certain time take the place of manure, the use of organic fertilisers in conjunction with chemical fertilisers is the most advantageous method from the point of view both of productivity and of the maintenance of soil fertility. In addition to the series of concentrated artificial fertilisers, plain and composite natural or artificial guanos

(meat, fish, blood, etc) and the various forms of vegetable waste (such as oil-cake), lignite and peat are capable of fixing ammonia, and provide organic fertilisers which are fairly rich in fixed nitrate products (amide, urea, etc.); such fertilisers constitute a new group, the "super-organic nitrates", and are easily absorbed by plants.

As the outcome of research and practical tests, there is a general increase in the manufacture of super-organic nitrophosphates out of many forms of vegetable waste from the main crops and derived industries (grape-marc; olive-oil cakes; town refuse; waste from the treatment of coffee, cocoa, maize, cellulose, etc.).

The fertiliser industry has also turned its attention to "oligodynamic-catalytic" fertilisers, which complete the action of the plastic substances in the vegetable tissues and thus facilitate the processes of the plant's growth. Certain crops (crucifers, etc.) require, in addition to ordinary fertilisation, extra quantities of sulphur, magnesia and catalytic substances (boron, copper, manganese, zinc, etc.); such substances afford specific protection against certain diseases and promote sturdy growth, especially in the case of plants grown from seeds containing — both in the embryo and in the seed — a greater concentration of catalytic elements. Fertilisers can be used rationally and economically by choosing those which are most suitable for the various types of crop and climate. The use of complete or composite fertilisers, specially prepared for particular kinds of soil and climate according to the best methods available in the fertiliser industry is therefore to be recommended. Biammoniacal phosphate is the most widely used fertiliser of that type.

A more complete study of conditions, and of the relationship between chemical fertilisers, manure, and organic and super-organic fertilisers, now appears to be necessary to explain a series of phenomena and practical results connected with the combined use of organic and mineral fertilisers. In this field new technical knowledge should be set out in a clear and simple form, so as to be of real assistance to the practical farmer.

C. — Progress made in Crop Production through Mechanisation.

The mechanisation of agriculture undeniably reduces to a great extent the need for human labour and also for draught animals. Yet mechanisation is not so much the cause as a result of the reduction in the numbers of agricultural labourers. In countries where labour is very cheap and where the use of draught animals is economical, mechanisation has not advanced very far even now, as may be seen in the greater part of Asia and Africa; on the other hand, it has made very great progress in countries where labour is scarce and costly and the use of draught animals attended by difficulties, but where, at the same time, the land can easily be worked in large units, *e. g.* in the United States, Canada and Australia. The progress achieved in these countries is due chiefly to the use of mechanical traction, together with the appropriate machinery, as a substitute for draught animals.

To judge of the advantages and effects of the use of mechanical traction, it must be borne in mind that while, in the case of tractors, variable costs are

high and fixed costs low, in that of draught animals the variable costs are trifling and fixed costs considerable. In other words, the tractor, though expensive when in actual operation, costs little when idle, while the cost of keeping draught animals, although scarcely higher when they are at work than when they are resting, is continuous, since they have to be fed and cared for whether working or not.

Hence the use of tractors is most profitable when a great deal of work has to be done in a short time. Animals, on the other hand, are more economical when the work is divided fairly evenly over the entire year. Owing to its high running costs, the tractor must be turned to the best possible account, and the best results are thus obtained in the most highly specialised forms of agriculture—in which comparatively short periods of work at high pressure alternate with long periods of inactivity. It is also admirably fitted for use during rush periods on farms where the regular work is done with draught animals.

Mechanisation has developed most freely in overseas countries, where it has not been hindered by local conditions of land tenure; in Europe, on the other hand, where the average area of undertakings fluctuates around 5 hectares and where the population is dense, mechanisation is less valuable as a means of working large areas of land with a minimum of labour as a means of improving the quality of output, while at the same time facilitating the work of the individual agriculturist. The general tendency among European manufacturers of agricultural machinery is to turn out machines suitable for use on small holdings, while possessing the advantages of large machines. The mechanisation of farm work is making particularly rapid progress in densely populated areas where electrification is providing agriculture with an increasingly powerful auxiliary. The progress of electrification in rural areas is usually in close relationship to the density of population. In densely-peopled areas such as the surroundings of large towns, electrification has made great strides, whereas in sparsely populated areas it has encountered great difficulties, because the consumers are widely scattered and find it hard to meet the high costs of installation. In such circumstances the systematic electrification of rural districts has nevertheless been possible in many countries, with the help of State subsidies. Through the many uses to which electricity can be put in the farm-house and farm-yard, and its simplicity, convenience and cleanliness in working, together with the facilities afforded by wireless for the cultivation of the mind, life in the country now holds prospects of development whereby the flight from the land may well be checked.

Mechanisation has not followed the same lines in Europe and overseas. In overseas countries it is more or less epitomised by the use of the tractor and the harvester-thresher. According to a survey published by the United States Department of Agriculture, the production of twenty bushels of wheat per acre (8.74 quintals per hectare) required some 57.7 hours of human labour in 1830, with the primitive methods then in use, some 8.8 hours in 1896, using the binder and threshing-machine, and in 1930, using the harvester-thresher, only 3.3 hours.

In Europe, on the other hand, mechanisation seems increasingly likely to take the form of the electrification of the countryside and the use of labour-saving machinery, leaving the social structure of the small-holding unaffected.

II.

PRESENT CONDITIONS AND IMPROVEMENT OF STOCK-RAISING

General Conditions.

The development of agricultural production within the limits laid down by economic and natural laws largely depends upon how far the agriculturist is able to turn the results of scientific and technical research to practical account. This is as obviously true of stock-raising as of crop production. Scientific and technical progress, as applied to methods of production, have resulted either in an improvement in the quantity and quality of the yield or in a decrease in costs of production.

In the particular case of stock-raising, such progress has been effected through the selection, proper care and rational feeding of domestic animals, and though it has been far from uniform in the various parts of Europe, it has nevertheless profoundly affected both the technique and the economic situation of this branch of agriculture.

SELECTION.

Zootechnical science has caused a far-reaching revolution in theory and in practical working methods. In recent years the purely empirical method based entirely on the stock-breeder's experience and ability to judge animals has given way to a method of selection at once scientifically exact and purely objective. This last method is rapidly gaining favour and is being applied more and more to economic ends, *i. e.* first and foremost, to obtaining a profit. Until recently, the method commonly followed was based upon external characteristics and breed.

Remarkable, if slow, progress was undeniably achieved in the course of centuries by this empirical method, based on the breeder's personal judgment. By this slow process, live-stock has been raised to a level of productivity much above that of the primitive domestic animals, and the majority of the breeds still found in Europe at the present day and used as the basis for modern selective methods represent the combined result of natural selection due to conditions of existence and the artificial selection practised by man. In the long run, however, the empirical method of selection was bound to prove inadequate. For one thing, the further selection progressed, the harder it became to obtain good results; moreover, the steady growth of the commercial exploitation of male breeding-animals and the development of breeders' co-operative associations (keeping male animals to which females are brought by many different owners) led to the development of methods affording some guarantee as to the genetic value of the animals concerned. For this purpose, breeders' stud-books were instituted, in which were entered the animals possessing the

qualities required in each area. At first these qualities were based only upon external features, until standards were established by which a more exact form of selection could be practised. The first studbooks were instituted in England in 1882, but they soon made their appearance in other European countries, partly through private initiative but chiefly under the influence of the co-operative associations.

At the same time as stud and hed books were coming into general use in countries where stock-breeding is of outstanding importance, breeders were also beginning to take up the idea of improving *productivity* by systematic selection. They continued, however, to lay stress on certain points regarded as essential to the maintenance of the standard types and for pedigree purposes, although without any direct bearing on productivity, and disregarded others which, from that point of view, were of greater importance. The discoveries of MENDEL, de VRIES, TSCHERMAK and other authorities on heredity have served as the scientific basis for a radical change in this matter. It was realised that the factors determining productivity are transmitted in accordance with fixed laws and that, by breeding from animals with a high productivity, progeny was obtained distinguished by similar characteristics. Subsequently, animals of outstanding quality were systematically crossed with high productivity as the object in view. This new tendency may be regarded as one of the most important signs of progress, and as being typical of modern stock-breeding methods.

The basis of systematic breeding for productivity consists in an exact understanding of such productivity, which has been obtained by means of various tests.

Such tests have rapidly become indispensable in zootechnics and have spread throughout the Continent. Apart from horse races — the earliest of such tests — there are now milk productivity tests, productivity tests for pigs (fattening and reproductive capacity), egg-laying tests for hens and work performance and wool productivity tests.

The most widely practised tests are those for milk productivity: in 1934 there were 3 ½ million cows in Europe whose milk yield was under constant observation. Such methods have been most highly developed in Denmark, the Netherlands, Germany, Danzig, Southern Sweden, Finland and the Baltic countries, but are less advanced in Central, Western and Southern Europe. These matters are dealt with at length in a monograph entitled *Le contrôle des vaches laitières dans le monde*, published in 1935 by the International Institute of Agriculture, Rome.

In some countries, such as Germany, where milk-yield records have been made compulsory, and where, even as early as 1937, 70 per cent. of the cows were included in the system, there is a tendency to bring the greatest possible number of milch cows under observation so as to carry the process of selection right through the national herd. In other countries, such as Hungary, records are kept only in regard to certain cows, with a view to the selection of high-grade animals through which the general level may be raised.

Productivity tests for pigs are also widely practised, although as a rule they are applied to relatively few animals.

Laying tests for hens are also current. They generally take the form of competitions and are commonest in Great Britain and Northern and Central Europe, although they are now known almost everywhere.

Wool productivity and work performance tests are still uncommon, as also are fattening tests for cattle, at least in Europe. A few tests have been carried out at experimental stations, but that is all.

The main purpose of such tests is to provide breeders with data for selection and a guide to the proper care and feeding of stock. The results have also been used, however, in connection with co-operative selection, and they clearly afford a valuable criterion as to the value of animals whose services are on hire for breeding purposes.

The principal factor in selection is not the productivity of a given animal, but rather its genetic value as seen in the productivity of its progeny. Hence it was soon realised that the result of productivity tests must be incorporated in the studbooks so that the transmission of such qualities might be readily ascertainable. For this purpose special registers of high-grade animals and productivity records have been instituted, in addition to the general studbooks registers in Great Britain, the Netherlands, Denmark, Sweden, Germany, Hungary and other countries. In general, a very high standard of productivity is required as the qualification for entry in these registers, and that of each animal included is shown in comparison with that of its ancestors and progeny. In this way it is possible to ascertain the breeding value of an animal for productivity purposes, a point which may be of the greatest importance when attempting, for example, to assess the genetic value of a bull in the matter of milk production, since this cannot be determined directly.

There can be no doubt that productivity tests have done much to improve the productivity of domestic animals, this being true more especially of milk tests and those with regard to the fattening of pigs and the laying capacity of hens. Their greatest value consists in the fact that they have provided breeders with a sounder basis on which to work, and have consequently lessened the hazards of selection.

The importance of such tests is now recognised in all countries. Their results are not only entered in the studbooks, where they serve as a valuable guide, but they are also given increasing weight at shows and in the award of prizes. This new system of judging has largely replaced the old methods based on external characteristics, but it has not entirely supplanted them and there is general agreement that it should not be allowed to do so. External characteristics are indeed an index to the health and constitution of an animal, such as it would be difficult to obtain by the objective method; certain external characteristics are a guide to the animal's potential productivity, whereas the effective productivity can only be judged when the animal reaches a certain age or even in some cases after its death. Effective productivity moreover, depends not only on the animal itself, but also on external circumstances.

At all events, the method of judging on the basis of effective productivity has to a great extent replaced that based on external characteristics, especially when the latter are unconnected with the animals productivity, physical consti-

tution and state of health. But this tendency has not yet been carried to its logical conclusion, particularly as regards the characteristics thoughts indicative of "breed".

Less importance is now attached to high individual productivity over short periods of time than to good average productivity throughout a flock, herd, etc. over a long period. Thus the German cattle productivity register has now been superseded by a new compilation in which are entered only such animals as can show a good productivity record over a period of several years, whereas all that was previously required was a certain minimum productivity over a period of one year.

The method of judging by external appearance is losing ground chiefly in Denmark, Finland, the Baltic countries and the Union of Soviet Socialist Republics (ENGELER). On the other hand, it is still practised in the Alpine regions and in the south and south-west of Europe. In this respect the Netherlands, Germany and Sweden occupy an intermediate position.

The productivity method has been carried furthest in pig-breeding. Here much less attention is paid to an animal's outward conformity to the accepted type than to its probable productivity. ENGELER thinks that the Danish export type of pig has been evolved not through selection based on appearance but on the results of fattening tests.

Side by side with the keeping of studbooks and selection for productivity, a third tendency is to be noted, namely co-operative selection of male animals for breeding. In some countries, such co-operative associations have been formed voluntarily, whereas in others they have been made compulsory and the State has concerned itself with their organisation. In some countries it is illegal to breed from male animals other than those "certified" by the State authorities. The granting of such certificates is very strictly regulated by the State. On the other hand, in countries where the official certification of male animals is not compulsory the State confines itself to subsidising their breeding and maintenance.

CARE OF LIVESTOCK.

The more artificial the selection and the greater the emphasis on productivity, the more liable do animals become to disease and the more sensitive to unfavourable surroundings.

It has thus come to be realised that the greater delicacy resulting from intensive selection with a view to productivity must be counterbalanced by better conditions, so as to increase the animals' powers of resistance and to keep them as far as possible out of the way of infection. With this object, the period of pasturage is extended, especially in the case of young stock and valuable male animals. The propaganda in favour of such methods is meeting with growing success, and the practice of keeping animals at grass for longer periods and sometimes even into the winter months is steadily gaining ground. Progress has also been made in regard to the indoor accommodation of animals, and the sheds now built are designed to ensure them the most hygienic condi-

tions possible. The improvement of existing buildings is an expensive matter, however, and progress is therefore slow. In many parts of Europe, the peasants still use unhygienic premises, in which the health and condition of the stock are liable to suffer.

Feeding.

Stock-raising has been greatly influenced by the progress made in feeding methods during the second half of last century. This progress was based upon the results of scientific research regarding, in the first place, the nutritional requirements of animals in relation to productivity, and, in the second place, the nutritive value of the various kinds of feed.

The knowledge thus obtained has made it possible to establish the most suitable diets, and to supplement the fodder available on the farm by other feeding-stuffs guaranteeing optimum productivity. It has further led to the introduction of new feeding-stuffs on the farm, and in many countries to the importation of feeding-stuffs from abroad, thus greatly stimulating stock-raising and bringing about what might well be called the veritable industrialisation of agriculture.

This process is very marked in the countries of north-western Europe, since their proximity to densely peopled countries offering a valuable market has made the change very profitable. On the other hand, some districts of western Europe, which are far from industrial centres, have done little to develop their own stock-breeding and export to the centres of population a considerable proportion of the fodder which the latter require. Between these two extremes there are of course intermediate forms of economy, as will be found on reference to the monograph, entitled *La Production mondiale de la Viande* published in 1938 by the International Institute of Agriculture, Rome.

Great changes have taken place in this respect during the last twenty years. Europe is going through a period of economic separation as between the different countries, accompanied by a decline in international trade, that has profoundly influenced stock-breeding and has caused it to be viewed in an entirely new light.

Certain countries, and especially Germany, which profess autarchic principles, are endeavouring to combine the exclusive use of national feeding-stuffs with the greatest possible development of animal husbandry. This tendency has raised entirely new problems in regard to the feeding of domestic animals.

At first an attempt was made to increase stock-raising and to provide the necessary feeding-stuffs by increased cultivation of fodder crops. This process could not, however, be carried far, since all the land in Western and Northern Europe was already under intensive cultivation. It thus became necessary to resort to other measures such as the extension of catch-crops, the improvement of meadows by botanical methods, the growing of certain fodder plants of particular value, such as winter barley, lucern and maize, the introduction of new fodder plants and the improvement of the existing plants by selection (an example of this being the production of sweet lupin), etc.

Great importance is also attached in this connection to a better use of the fodder already available. Steps have been taken to ensure the more efficient use of meadow-land by the subdivision of big fields, methods of storing fodder have been improved and new ones devised, thus increasing the possibilities of storage; new methods of drying have been introduced and new silos constructed. Above all, stress is laid upon the need for turning all the available food to the best possible account by making use of scraps and waste. This is done by the careful sorting and, if necessary, conversion of waste. In general it may therefore be said that the tendency is to make a rational use of every possible scrap of food and to avoid any kind of waste.

This movement has been assisted in recent years by extensive research and experiment, some of which has led to valuable results, enabling methods of feeding to be changed without serious inconvenience. Some of these new methods have even been adopted in other than autarchic countries. In consequence, many countries until recently dependent upon foreign supplies of fodder, have been able to increase their national production and reduce imports. The United Kingdom is an exception in this respect. Some of the countries concerned have increased their production and reduced their imports for extremely varied economic reasons. The difficulties encountered in selling their animal products on the ordinary markets have induced them to reorganise and balance their economy by reducing stock-raising and increasing their crop production. In countries which have never depended upon foreign supplies of fodder the situation was different; their fodder production and stock-raising depend upon economic conditions such as the natural fertility of the soil and the economic organisation of agriculture, which differ not only from country to country, but from one district to another in the same country. In these countries too, great importance is attached to the application of modern ideas on feeding, to the rational use of the fodder available and to the purchase of foreign fodder to enable greater advantage to be drawn from that produced within the country.

Stock-raising in the countries of southern and south-western Europe is affected by the big fluctuations in the production of fodder. This also affects the total amount of stock in such countries, since fodder becomes so scarce in years of drought that the peasants are obliged to get rid of a proportion of their animals. The resultant uncertainty seriously hampers the work of selection and causes the stock-breeder grave difficulties. In these countries livestock should generally be kept within the limits set by a poor fodder crop, so as not to expose the owners to the risk of an inadequate supply; in a good year, such countries are obliged to export their surplus fodder, even if they are normally importers of animal products.

In these circumstances, the problem of fodder supplies for stock-raising is naturally very different from what it is in the countries of northern and north-western Europe. The production of fodder must be maintained even in the event of drought, and this is done by means of irrigation. The accumulation of reserves and the storage of fodder are also of great importance. Large numbers of fodder silos have been constructed in these countries, despite their cost. In some countries, such as Italy, the construction of silos and of irriga-

tion works is encouraged and subsidised by the State. The situation is very different in the countries of eastern Europe, which produce fodder in great abundance and export it; these countries are generally exporters of animal products as well, and it is only to be expected that the problems of stock-raising should be very different there from those arising in the rest of Europe.

When considering how an abundant fodder production may best be turned to account, that which is saleable must be distinguished from that which is not.

As far as the first category is concerned, the question whether it is preferable to sell it abroad or to use it to feed animals for export is determined by the economic situation and export possibilities. This question is of special importance to countries producing maize on a large scale, since they can sell either the maize itself or pork, beef or fats.

As regards fodder which cannot be sold, such as hay, straw, waste, pasture grass and even potatoes, in districts remote from means of communication, the quantity of fodder produced directly determines the amount of stock raised, since such fodder must necessarily be converted into animal products if it is to be used at all, and the cost of production then becomes a secondary matter. As a result, an abundant fodder crop in these countries introduces a disturbing element into the markets of stock-raising countries, if still open to international trade.

The pig-producing countries are those most affected by fluctuations in the fodder harvest, and it is this fact which is the chief cause of speculation in that trade. The raising of cattle and sheep is more stable, and consequently less affected. The fattening of cattle however, depends, on the amount of fodder produced and on the relation obtaining between the price of fodder and that of meat.

In consequence of these fluctuations in fodder crops, certain countries still keep animals of primitive and slow-developing breeds since these require less care and are better able to survive periods of dearth than those of the improved breeds. It is obvious that countries where such economic conditions obtain must be less suited to the more advanced methods of stock-raising than those where animals can be well fed, either on home-grown or imported fodder.

In recent years, various difficulties in the way of exporting fodder and animal products have exerted a very unfavourable influence on stock-raising in exporting countries, and have prevented progress in the production and use of fodder. The essential problem is to protect the fodder crops against unfavourable climatic influences and to form reserves of fodder by appropriate methods of storage with a view to preventing sudden fluctuations in stock-raising.

To sum up, it may be said that the improvement of livestock by the new methods of selection, care and feeding introduced in recent years, tends to increase the amount of stock raised, to improve the quality of the animals and to reduce costs of production. The results of scientific research in the field of zootechnics have been differently applied in different countries, according to the extent to which their respective peoples are accessible to new ideas, and also to their economic situation.

Great importance is to be attached, in this connection, to the development of international trade in animal products and fodder and to the policy followed by the various Governments. The influence of these factors has been felt in all European countries, though in varying degrees, according as to whether they are importer or exporter of animal products, and whether their supplies of fodder, which is the raw material of the stock-raising industry are abundant or inadequate.

During the past few years, certain countries have tended to reduce their fodder imports. This tendency has had a marked effect on stock-raising in all countries, but it is to be differently explained in those which are endeavouring to perfect the industrial transformation of animal products and are faced with marketing difficulties, and in certain other importing countries which have adopted a policy of extreme economic self-sufficiency.

The situation has become particularly difficult in countries which have hitherto been exporters both of fodder and of animal products, and still more so in districts possessing abundant supplies of fodder which prove unsaleable and must therefore be used, whether the market is favourable or not.

These difficulties are still further accentuated, owing to the lack of elasticity in the market, by fluctuations in fodder production and stock-raising due to climatic conditions.

Poultry Keeping.

A characteristic aspect of European agriculture since the War is the development of poultry breeding.

Poultry keeping, which used to be treated as a sideline of farming, has now become a satisfactory profit-making business. The economic importance of poultry keeping has increased in such measure that in certain countries it has now become one of the greatest sources of income; the consumption of eggs and of poultry meat has increased to such an extent that these products now play an outstanding part in the nutrition of the population. A special study of recent progress in this industry would therefore seem to be justified and in fact an exhaustive paper on the subject was published some years ago by the Institute (*).

The dearth of statistics on this subject before the War in almost every country is a proof of the slight consideration then given to poultry breeding. Only during recent years have statistics been made of the numbers of fowls and their productivity, while even those available at the present time are not sufficient to give a complete view of the industry throughout the world.

In spite of this, however, the available figures give an idea of recent progress, which is all the more interesting since farm production was going through a critical period and was still suffering from losses resulting from the War.

(* International Institute of Agriculture. *L'Aviculture dans le Monde*, 3 vols. Rome 1933.

The greatest stimulus came undoubtedly from the steadily increasing demand. Changes in public taste during the past few decades have led ultra-civilized and industrialized town-dwellers to prefer lighter and more varied fare, consuming a large quantity of easily digested meat without fats and showing a particular liking for eggs.

Eggs supply dense animal albumen which is almost tasteless and they are easy to use as a complement to many modern foods with a poor albumen content. They are easily transported and keep fresh for long periods without requiring any special preservation; even when preservation is necessary, the process presents no great difficulty since methods have now been perfected.

The great advantage of poultry meat is that small quantities are always available. Improvements in production technique and in quality have also contributed to an increase in consumption. This trend of demand is highly satisfactory for the specialized poultry breeder and the poultry keeping farmer. Only a small amount of capital is required, the turnover is fairly rapid, running expenses are not very high and the waste products form the farm and the home, useles for other purposes; can be utilized on the poultry farm.

The comparatively favourable situation of poultry farming is proved by the fact that prices have maintained a more satisfactory level than is the case for most other farm products. As a result of the various measures taken to maintain their level, the movement of prices varies from one country to another, but, generally speaking, it may be said that the trend is relatively more favourable for poultry products than for any other farm produce. This has, of course, stimulated poultry breeding, but the main impetus was given by the heavy fall in cereal prices on world markets. In those countries where cereal prices were not maintained artificially, in those which exported cereals and in those where only a small customs duty or none at all was imposed, poultry farmers were able to profit by the situation. This was the principal cause of the considerable development of the poultry industry in north-west Europe (Belgium, the Netherlands and Denmark). Countries with a high customs tariff on cereals tried to compensate this by distributing denatured wheat, but this system was not always successful. Producers were therefore unable to compete with foreign countries offering cheaper products, except by asking for an increase in import duty on poultry produce; this increase was eventually granted in almost all the countries importing poultry products on a large scale. It should, however, be observed that the tendency towards self-sufficiency became manifest in this branch of farming much later than in other sectors of production, thus contributing to the spread of poultry farming in exporting countries.

Nearly all exporting countries suffer from the tendency toward economic self-sufficiency in importing countries, while in the latter, which generally have a high customs tariff on cereals, the ratio of the price of eggs and slaughtered poultry to that of poultry feed is often to the disadvantage of the producer. Other general causes of the crisis are the decrease in purchasing power, the growing use of products derived from eggs, etc.

While, according to VON DER DECKEN, egg consumption in the United States, Canada, etc., is very high and cannot be increased for the present, Euro-

pean consumption is susceptible of considerable increase. Higher consumption in the United States could only be induced by an improvement in quality and this appears highly improbable since the standardization of eggs is already generalized throughout the country. In Europe, on the other hand, the only means of increasing consumption is to improve the relation between purchasing power and egg prices.

TRENDS IN POULTRY PRODUCTION.

The differences between the various forms of poultry farming are due to the changing relationship between the prices of the two principal products: eggs and slaughtered birds on the one hand and the cost of feed on the other. The price relation between killed poultry and eggs determines the trend of production, according to whether the production of eggs or the sale of poultry meat is more profitable, while the relationship between the price of products and that of feed determines the extent of production.

In addition to these material factors, the character and general inclinations of the inhabitants, their degree of culture and their traditions all play a very important part.

The relations between the prices of poultry meat and eggs differ according to the country and the period. The distance between the producing country and the market is another very important factor, as eggs stand shipment much better than poultry meat. It has often been observed that eggs had come to be appreciated much more in relation to slaughtered fowl, but that this advantageous position is now being lost as a result of progress made in farming methods and the increased demand for poultry meat.

In this connection it is interesting to compare egg prices with those for poultry meat in the various countries. According to WOERMANN⁽¹⁾ the ratio between egg prices and poultry meat prices was 1:0.7 in Western Poland and 1:1.2 in Berlin; it is obvious that where eggs are dear in comparison with killed fowl, there is a tendency to raise poultry for egg production and vice versa.

Several attempts have been made, by means of calculations based on price ratios (eggs: feed), to compare the competitive value of eggs produced in various countries. These comparisons have only a relative value, however, since this ratio between prices only plays an important part in the case of intensive poultry rearing, when the greater part of the feed has to be purchased; the same cannot be said for the areas where extensive farming is the rule and where the so-called "absolute" feeds are utilized almost exclusively, *i. e.*, feeds which can only be given to poultry (stubble, waste products from the farm and the home, etc.).

(1) E. WOERMANN, *Die Veredelungswirtschaft*, Berlin, 1933. — F. AERBOE, *Allgemeine landwirtschaftliche Betriebslehre I. Band*, Berlin, 1923.

ORGANIZATION OF A POULTRY FARM.

The considerable increase in poultry production described above is due in part to a notable rise in the numbers of poultry but also, and to a considerable extent, to the improvement in production itself, expressed in yield per head.

Before discussing the purely technical factors which have led to this development during the past few years, something should be said concerning the organization of a poultry farm, this being the foundation of every improvement in poultry rearing methods.

During the last few decades the poultry breeder has shown a marked tendency towards specialization. Although it is true that, even today, in almost every country the great majority of fowl are to be found on ordinary farms, it is equally true that the number of specialized poultry farms was increasing rapidly up to the beginning of the world depression.

While the tendency towards specialization was at first encouraged by technical and economic conditions, the later development of world economy seems instead to be unfavourable to this tendency.

During the period favourable to specialization and industrialization of poultry keeping, the general trend of this industry was towards separation from the rest of agriculture, specialization going so far as even to divide the industry into separate branches. Hence special enterprises were created for egg incubation, others for producing eggs for the market, others for fattening birds, while other concerns specialized in rearing fowls for breeding purposes.

One of the chief disadvantages of the specialized poultry farm in the resultant need to purchase a great part of the *feed*, while an ordinary farm can utilize its own waste products and allow the birds to seek their own food in the fields and meadows.

Another disadvantage in the specialized farms lies in the quite considerable losses often suffered by a certain number of farms from disease, which tends to spread more easily among large flocks on an extensive poultry farm. Poultry kept on ordinary farms are generally composed of less productive but more hardy birds.

Again, in specialized poultry farms, the interest and amortization of invested capital often constitute too heavy a burden on the undertaking and affect its income capacity and its possibility of facing the competition of the more extensive rural poultry industry. It should also be mentioned that in some cases the failure of specialized poultry farm was due to incompetence on the part of the operators or to poor management.

Even admitting, however, that specialized poultry farms have often shown slight resistance to economic and natural adversity, it must nevertheless be recognized that the great progress realized in the industry during the past few years is due to these same specialized concerns. Such undertakings have always been the pioneers in introducing modern methods and scientific processes into

the practice of poultry keeping. Specialization has contributed in large measure to the improvement of the birds themselves and has succeeded in introducing the results of special breeding and selection into a great majority of poultry farms attached to farms of mixed type.

The production of newly hatched chickens and pullets, founded as a general rule on an extremely careful selection from the genetic and productive standpoints, has led farmers in many countries to use highly bred and very productive birds, at the same time eliminating their difficulties and worries in connection with incubation and rearing.

The question of specialization should therefore be considered from this aspect also, and not only from that of income and resistance to periods of crisis.

QUESTIONS CONCERNING POULTRY BREEDING.

For many decades poultry breeding tended to be based on external features with the result that breeding for fine points played an important part in poultry raising. Breeding with a view to production now tends to dominate and racial characteristics are taking second place. This tendency has been especially marked in those countries where improved breeds with well defined features have been widely distributed and where it has been possible to practise selection with a view to laying qualities or meat production.

One reason why the practice of selection from the productive standpoint was so long delayed was the difficulty of checking up individual production without incurring excessive expenditure. These difficulties have been overcome by the introduction of the trap-nest an appliance whose importance in poultry breeding has led to its being widely distributed throughout the world. At first the trap-nest was only used by poultry breeders to check the production of their finest birds and as a basis for selection with a view to productivity. Later, however, with the introduction of collective checking of production, the appliance became increasingly useful. Collective checking is carried out differently in each country. Laying competitions are organized and, like the checking of traits of other domestic animals, this method not only offers the advantage of being a means of selection, but serves also in the sale and purchase of birds for breeding purposes and in the selection of birds from the stock of a large group of breeders.

Laying competitions are now very common in every country where poultry breeding is practised according to rational methods. It may even be said that in the field of animal husbandry, few measures have developed to such an extent and in so brief a space of time.

The establishment of centres for rearing selected breeds has also contributed in large measure to progress. This system is practised in a number of countries according to more or less varied methods. These centres are really private breeding farms which have put themselves under the control of local or government authorities, submitting to regular inspection and fulfilling certain minimum requirements in connection with cleanliness, breeding and feeding of

birds, hygiene, absence of contagious diseases, and production. These centres, which supply the product of their genetic selection to poultry breeders and other farmers interested in the industry, have made an extensive contribution to the diffusion of selected breeds and of highly productive birds.

The improvement of poultry breeding was greatly facilitated by progress in *incubation on an industrial scale and by commercial production of newly hatched chickens.*

In those countries where this development has been considerable, a very high percentage of chickens to be reared for egg production are produced by these means. It is therefore obvious that the quality of the chickens supplied by these establishments have a considerable influence on the progress and improvement of the birds in the countries in question.

In spite of the tremendous progress realized by modern poultry breeding in several countries, and although associations and training centres have made the use of modern breeding methods familiar even in the most out-of-the-way areas, primitive and traditional methods still predominate.

A similar situation may be noted as a general rule in the treatment of the fowls. Research and experiments have led to considerable progress in this field, proving that hygienic and rational care of the birds is essential. In practice, however, it is often found that the conditions under which the birds are kept leave a great deal to be desired.

Hygienic and economic improvements in hen-houses consist mostly in: cleanliness, good ventilation and lighting of the coops, the building of small and if possible transportable hen-houses, which are the best protection against the danger of disease, separate coops for raising chickens apart from the fully-grown birds, etc.

Lastly, it should be stated that the results obtained in certain experimental poultry farms in connection with the effect of artificial light on egg production have encouraged a number of poultry farmers in various countries to introduce this method.

Technical relation of European to World Livestock Production.

It is extremely difficult to determine the quantitative relation between animal production in Europe and the rest of the world. There are so many gaps in available statistics that it is impossible to make even an approximate estimate.

In the first place, statistics of livestock numbers, which must be considered as the basis of every study of this description, are not comparable in various ways. The systems according to which the various countries collect their data are quite different, the periods when surveys are carried out also vary from one country to another and finally the results are so incomplete in such large areas, that the necessary summarized comparative data are inevitably only approximate.

Bearing the above considerations in mind, the following numerical estimates may be made (*):

Europe (not including the U. S. S. R.) owns :

approximately 16.8 per cent, of the numbers of cattle in the world;
approximately 18.3 per cent. of the numbers of sheep and goats in the world;

approximately 29.0 per cent. of the numbers of pigs in the world.

The population of Europe (not including th U. S. S. R.), represents about 18.9 per cent. of the total world population.

The density of livestock in Europe, as compared with that of the whole world, may be expressed by the following averages:

	Cattle per 1000 hectares	Sheep per 1000 hectares	Pigs per 1000 hectares
Europe (not including the U. S. S. R.)	197	230	147
World	48	49	20

A rapid glance at the above shows that the numbers of livestock in Europe are comparatively dense, although they do not suffice to meet the demand for animal products, both because of the density of the population and because the standard of living is relatively high. A study of foreign trade statistics of almost all animal products brings this fact to light.

But these figures afford only a slight idea of the quantitative relation between the numbers of livestock in Europe and in the whole world. It would be much more difficult to compare the respective productions, since not even approximate figures are available for production of meat, milk, eggs, etc. without mentioning utilitarian production, which cannot be even approximately appraised: the provision of work, for instance, which is one of the most important. The same may, be said of many other animal products, such as hides, bristle, bone, etc.

Although it is hardly possible to establish satisfactorily the quantitative relation between livestock production in Europe and in the whole world, it may nevertheless be said that, generally speaking, European livestock production occupies a very special position, both quantity and quality being much superior to what might appear from the ratios between numbers of livestock. The relatively high productivity of livestock in Europe is a result of very intensive utilization of the animals (manifested by: rapid growth, generalized intensive stabling, more intensive methods of exploitation, higher degrees of fattening, greater utilization of milk, etc.) and the superior quality of the animals. It should not be forgotten, however, that outside Europe there are other regions which can boast of high quality production competing seriously with European

(* Cf. *World Production in Meat*, International Institute of Agriculture, Rome 1938.

stock, so that the above comparison refers only to average European livestock production and to the average type of animal bred in the rest of the world.

Apart from economic considerations and the trade policy required to meet the European demand (either with European products or by imports from other countries), and looking only at the technical aspects of stockbreeding, mention should be made of two points which play an essential part in relations between stockbreeding as practised in Europe and elsewhere: (1) the question of animals used for breeding and (2) the problem of fodder supplies.

Improved breeds as used in stockbreeding in extra-European countries are mostly descended from breeds imported some time ago or even recently from Europe, or else from special breeds created with a high percentage of improved European stock. At the present time stockbreeding areas which maintain European or pure-bred stock often own even more of these animals than are to be found in their country of origin. In the majority of cases, however, practice has shown that it is advisable to continue to import fresh breeding stock from their native country. This is a tie between stockbreeding in Europe and in other parts of the world that it is advisable to maintain in the future.

Another link between European stockbreeding and extra-European agriculture consists of the above-mentioned fodder supplies for Europe. In spite of efforts made by several European countries to increase production of fodder crops, imports of these products are still absolutely necessary if animal production is to be maintained at its present level.

When considering European animal production in relation to world production, special mention should also be made of the particular characteristics of the former in relation to the general economy of the farm; except in extremely rare cases, livestock usually forms one branch of the activities of a farm of mixed type. Not only does this give livestock production a fundamentally different character from that of extra-European farms, but at the same time stockbreeding assumes an economic and politico-social character of a general nature which must not be overlooked when studying the situation.

III.

RURAL INDUSTRIES

Tendencies discernible in the Development of Agricultural Industries.

In every period, consideration has been given to the problem of the industrial transformation of the products of agricultural activity. The problem first arose in connection with bread-making cereals, which required milling before they could yield flour from which bread could be prepared. Further problems which arose were how to use on the spot milk for the manufacture of butter and cheese, oil-seeds and oil-fruits for the extraction of oils, fruits containing sugar for the production of alcoholic beverages, beetroot for the manufacture of alcohol, potatoes for the extraction of potato flour, wheat, maize and rice for the preparation of starch, etc.

Whereas some of those processes have traditionally remained linked with the cultivation of the soil, others have broken away from agricultural undertakings because they had become so much perfected as to have developed into vast independent industries; this is, for example, the position of the beet-sugar, distilling, tinned foods, potato-flour, malting, and brewing industries.

Today that tendency stands out sharply owing to the inability in which the agriculturist finds himself to set up, within his farming undertaking, a modern industrial plant, with the considerable equipment and capital and the specialised workers such a plant involves. Only the simplest forms of industry are still found on the farm, together with those consisting in the preparation of high-quality products in which a dominant part is played by labour-power and tradition resting upon long experience.

Except in the last-mentioned cases, agriculturists are more and more becoming suppliers of raw materials to the so-called agricultural industries. Those industries, in return, frequently send back to the farm industrial by-products or waste which can be used either for feeding to farm animals (*e.g.* pulp, slop, feed-cake, etc.), or as fertilisers (inedible oil-cake, waste of animal origin, etc.), or again sometimes as fuel or building material.

A close link is thus created between farm and factory. The most typical example is that supplied by the beet-sugar industry.

As processes for the preservation of agricultural produce improve, the need for placing processing factories near to the production centre becomes less marked. We thus find centres of industrial activity being created to supply a whole district and sometimes an even wider market.

To summarise the position, the majority of agricultural industries tend to become separated from the farm, although separation is never complete, in the sense that the interests of the agriculturist and the industrial producer will always partly coincide, thus making it necessary for the two types of activity to become organised and to develop on parallel lines following a pre-established plan. Governments anxious to assist or organise the essential industrial process-

ing of agricultural products must therefore concentrate their efforts upon the realisation of that co-operation.

As regards the transport to the consumer's door of products which do not require industrial processing in the strict sense, such as fruit, fresh meat and milk, the only satisfactory method is to have recourse to the latest processes for the preservation of foodstuffs, and particularly to artificial cold. Here again it is a case of typically industrial processes. According to each particular case, it is possible to envisage the supply of agricultural produce in the very form in which it is harvested or — and this is much to be preferred — only after a process of stabilisation, usually in the form of a preparatory refrigeration, than which there is no better means of preparing commodities for efficient conveyance to the markets or centres of consumption.

Problems arising between Harvesting and Delivery to the Processing Factory.

If the processing factory is situated within the farm undertaking itself, there is no difficulty in supplying it with raw materials gathered on the spot in good conditions of freshness. But where the factory is some distance away, produce must be efficiently preserved and conveyed and special precautions become necessary.

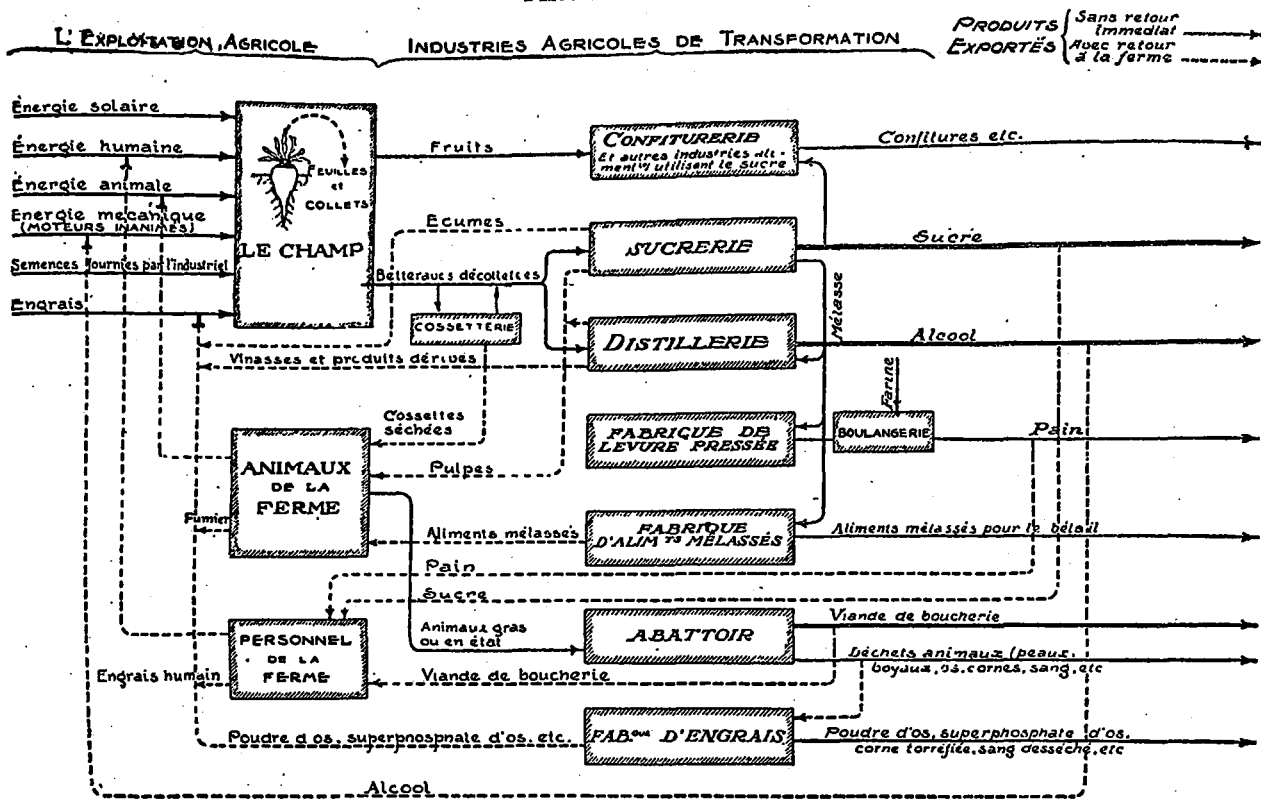
Products such as cereal seeds, roots and tubers do not require special precautions in storage and handling. The problem is therefore relatively easily solved. The position is different, however, in the case of other substances liable to ready damage, such as fruit and milk; this is particularly the case during the summer in temperate climates, and at any time of the year in hot countries.

The problem of preserving products liable to damage thus arises as soon as the attempt is made to establish contact between the agricultural undertaking and the processing factory by such means of transport as are available (railways, roads, sea or river transport, etc.). It is found that the various agricultural products must be handled, packed and protected against damage by means which vary considerably in detail, according both to the nature of the product and to its destination.

As will readily be understood, the agriculturist's desire to supply produce in a perfect state of preservation lays a heavy burden on him, which he is compelled to shoulder. The preparation of goods for sale can be rendered less onerous either through the close collaboration of the industrial producer (*e. g.* by collecting the produce at the farm), or by combining the efforts of agricultural producers, thus making them both more effective and less costly, by applying the principles of co-operation. In either case the greater facility secured for the producer enables him to devote more care to the crops themselves and to the process of classification which must precede any delivery even in the case of products supplied in bulk.

Under the stimulus of necessity, a whole series of methods have been evolved and perfected. Although they are so varied as to make it impossible to describe them in a few pages, a few outstanding examples may be given in order

THE BEET CYCLE



to present a clear picture of the stage now reached in the handling of a problem of fundamental importance to agriculture — the problem, namely, of the liaison between the farm undertaking and the processing factory. Such liaison must rest on a foundation of genuine equality of rights and lead to exchanges profitable to both parties. Take as a typical example the organisation of the beet industry, now brought to a pitch which justifies Prof. Georges Ray's phrase — the "beet cycle".

In order fully to understand the significant aspects of this remarkable cycle, reference may be made to the attached chart, which clearly reveals the close links existing between beet producers, industrialists and consumers. In this way, in spite of the relative complexity of the whole, all the separate features of a form of agricultural production, the importance of which is too often overlooked, spring to light.

The most striking feature of the beet-production industry is the fact that it can only operate and prosper in close contact with the processing industries, by far the most important of which are sugar manufacture and distilling.

Whereas many agricultural industries despatch their processed commodities to an anonymous mass of consumers, the sugar and distilling industries, with their related agricultural industries, return to the agricultural producers who supply the beet practically the whole of their industrial residues, together with an appreciable proportion of their production proper. This re-despatch to the farm provides cheap sustenance for the workers and for farm animals, and also enables cultivation to proceed more efficiently and remuneratively.

It is now necessary to examine in detail the links between the agricultural undertaking and the processing industries.

The position of course is that the demand for a type of beet with a high sugar content creates a situation in which sugar manufacturers not only pay for the raw material according to its sugar content, but also supply the grower with seed selected in accordance with strict scientific methods. After the beet has been gathered, the tops are removed. The tops, with leaves still attached, are generally left on the field, thus providing an immediate supply of fertiliser of considerable value for the soil.

The roots, with their tops removed, are then sent to the sugar-mill or distillery. Part of the crop can, however, be dried in the beet-drying plant, either to provide a concentrated fodder of high value for cattle, or to supply raw material to the latest types of sugar refineries working on the Vecchis, Oxford and other principles, under which dried, sliced roots, which can be stored for a considerable period, are used.

Normally of course sugar-mills and distilleries employ fresh beet. After the sugar has been extracted from the sliced roots by mixing, the residue in the form of pulp is sent back to the farm. This pulp provides very economical fodder for the livestock required to work the soil and to produce manure. The supply of pulp to farms is at present the strongest link between factories using beet and agricultural undertakings. It is advantageous to both parties, and ensures the maintenance of a large livestock population, which in turn guarantees the production of a considerable quantity of butcher's meat.

Another important by-product of sugar-mills is the molasses group, for which many uses have been found. In particular, it provides pressed-yeast factories with a cheap sugar-containing raw material. These factories in turn provide bakeries with the yeast they require for the fermentation of bread-dough. The part played by molasses in the manufacture of various types of forage, in which it is blended with various fodders of low value such as straw, residues of apple-pressing and other by-products, is becoming more and more important in connection with the feeding of farm animals.

Agricultural industries dependent upon beet growers also supply the latter with a number of less important by-products which play their part in enriching the soil, e. g. the froth (carbonation cakes), residuary molasses and other fertilisers containing molasses.

A jam factory is frequently attached to the sugar-mill, and itself becomes a direct client of the beet-supplying agricultural undertaking.

Finally, a part of the production proper of the beet industries finds its way back to the farm after sale. In many cases contracts are entered into between sugar-producers and beet-growers for the supply to the latter of considerable quantities of sugar; this practice is current in Belgium. In other cases part of the alcohol produced is also returned, especially where the agricultural undertaking has adopted the commendable course of using the fuel-alcohol for power and heating.

It is unnecessary to dwell further on the other links which are clearly shown in the accompanying chart, first published in the *International Review of Agriculture* (*). It shows the part played by slaughter-houses and factories for fertilisers of animal origin, both in the production of butcher's meat - of which part returns to the farm in the form of food for the workers - and in the manufacture of various fertilisers which also contribute to raise agricultural productivity.

The conclusion which emerges from this survey is that it would be dangerous to place restrictions upon beet cultivation, especially in European countries: indeed, serious dislocation of agricultural production might result. It is in the manifest interests of European countries to increase agricultural production as a whole, even though the disposal of sugar surpluses may involve producers in temporary difficulties. Yet it would not prove as difficult as is currently believed to secure a rapid increase in world sugar consumption, and to discover new uses for sugar, apart from its consumption by humans.

The Alcohol Industry.

Of the two primary forms of exploitation of the sugar beet, the alcohol industry is the only one which still in many cases conserves its character as an agricultural process with factories on the spot where the raw material is grown and use of the material and personnel engaged on its cultivation.

(*) *Monthly Bulletin of Agricultural Science and Practice*, year XX, no. 4, April 1929, pages 164-166.

The importance of alcohol has come to bulk larger and larger with the development of the fuel-supply problem; and a brief review of the position as it presents itself in a number of European countries may not be without interest. The following is a summary of the results of an enquiry published in 1938 by the International Commission on Agriculture under the title *Documentation et renseignements concernant l'alcool dans le monde*, in so far as it relates to European countries.

BULGARIA.

Production of alcohol. — The principal product used in Bulgaria for the manufacture of alcohol is molasses, though damaged maize is occasionally used. Latterly, in order to defend the interests of the vine-growers, the Government has authorised the distillation of wine and spirit for the manufacture of alcohol at 95°, known as "fruit alcohol".

The annual production by distilleries has varied considerably, at any rate during the period 1920-1932. Thus, in 1921 the output amounted to 3,212,774 litres, whereas the following year it fell to 1,661,090; in 1929 it rose to 2,370,248, but in 1932 declined again to a much lower level — 973,086 litres.

The quantity of alcohol used for the preparation of various beverages has been steadily declining since 1920, whereas the amount of power alcohol has increased (35,272 litres in 1929; 482,803 litres in 1932). If the use of home-produced power alcohol became general, the total annual production of molasses (about 800,000,000 kg.) and a large quantity of maize could be turned to account. At present a considerable proportion of the available molasses is not utilised.

DENMARK.

Production of alcohol. — The amount produced rose from 9,432,791 litres in 1936 to 10,378,045 in 1937. The raw materials used by the distilleries are potatoes, barley, wheat, maize, molasses, malt combs and sugar-beet, the chief ones being potatoes and molasses; thus, in 1936 and 1937 respectively, the distilleries used 28,235,556 kg. and 30,726,750 kg. of potatoes, and 19,272,098 and 20,925,492 kg. of molasses.

The alcohol produced is used for the manufacture of spirituous liquors, vinegar, denatured alcohol, and also for technical purposes. The sale of spirits showed an increase of 4 per cent. in 1937 as compared with 1936, though the heavy tax on them reduces their sale. The use of alcohol for technical purposes and of denatured alcohol increased considerably in 1937; sales are now four times as large as in 1913 (8,000,000 litres at 100 per cent. in 1937).

There is also a demand in Denmark for alcohol for the perfumery industry (121,920 litres at 100 per cent. in 1937).

FRANCE.

Production of alcohol. — The principal raw materials used in the distilling industry are beetroots, molasses, apples, pears, perry, lees and grape-marc. The amount of alcohol produced from beetroots in the 1935-36 season was 2,397,516

litres. The quantities produced from apples and pears during the same period were: quantity reserved for the State — 403,861 litres; free quantity — 88,442 litres. The production of cognacs and armagnacs increased from 13,806 litres in 1935-36 to 41,109 litres in 1936-37.

The principal uses to which alcohol is put in France are: manufacture of spirituous liquors (474,525 hl. in 1936-37); manufacture of vinegar (47,426 hl.); perfumes and pharmaceutical products (119,785 hl.); exports in any form (65,327 hl.); chemical products (229,520 hl.); denaturation, heating and lighting (369,104 hl.); power alcohol (2,555,625 hl.).

UNITED KINGDOM.

Production of alcohol. — During the year 1936-37 the stocks of alcohol in the United Kingdom amounted to 208,036,273 proof gallons. Of these 137,374,733 p. g. were in bond on March 31st, 1936, 79,567 p. g. had been replaced in bond after being exported and re-imported, and 70,581,973 p. g. were distilled during 1936-37. The amount of alcohol used in 1936-37 was 61,170,937 p. g. From 1934 to 1937 the output of home-manufactured alcohol steadily increased rising from 51,838,535 p. g. in 1934 to 70,581,973 p. g. in 1937.

HUNGARY.

Production of alcohol. — The production of alcohol for the year ending on August 31st, 1937, amounted to 430,576 hl. Of this quantity 248,232 hl. were manufactured by agricultural distilleries and 124,995 hl. by industrial distilleries (both classes of distilleries being liable to the tax on consumption). In addition, 57,349 hl. were produced by distilleries liable to the tax on production.

The alcohol produced during the past year was used for the following purposes: power alcohol (128,059 hl.), spirituous liquors (22,108 hl.), denaturation, heating and lighting (44,503 hl.), industrial purposes (31,370 hl.), manufacture of vinegar (15,142 hl.); a considerable quantity was also exported (132,766 hl.).

NORWAY.

Production of alcohol. — The production of alcohol for the years 1935 and 1936 was as follows:

Alcohol derived from the manufacture of yeast: 8,341 hl. at 100 per cent. in 1935, 7,142 hl. at 100 per cent. in 1936.

Alcohol derived from potatoes, 23,372 hl. during 1935-36, and 25,540 hl. during 1936-37.

An important Norwegian firm which utilises wood products has begun to manufacture alcohol from wood pulp treated with bisulphite.

During the year 1936 the consumption of home-produced spirituous liquors amounted to 59,184 hl. and that of fruit drinks to 3,365 hl.

CZECHOSLOVAKIA.

Production of alcohol. — The production of alcohol by agricultural distilleries amounted to 723,373 hl. (at 100 per cent.) during the year 1936-37 and by industrial distilleries to 276,918 hl. The amount produced by agricultural distilleries is therefore far larger than that produced by industrial distilleries. The number of distilleries in operation in 1936-37 was 934, of which 899 were agricultural and 35 industrial.

The production of fruit spirits for the year 1936-37 was 11,243 hl. as compared with 5,671 hl. for the preceding year. The raw materials used in agricultural distilleries are potatoes, beetroots, maize, malt grain, molasses, etc., the most used being potatoes and beetroots.

The alcohol produced is utilised for the manufacture of vinegar, for industrial purposes, in the form of denatured alcohol for heating and lighting, and as power alcohol. Since 1935 the amounts used for heating and lighting have steadily increased (172,006 hl. in 1936, 177,504 hl. in 1937). The same is true of the vinegar industry (17,848 hl. in 1935 and 18,392 in 1937). Home-produced alcohol is also used in the perfumery and pharmaceutical industries and for the manufacture of soap and varnishes.

Milk Industries.

The milk industry has one very interesting feature. It is often carried on in the farm itself, particularly as regards the production of butter and cheese. The farmer, however, also supplies milk to urban centres and to special industries, to be used as the raw material for the manufacture of condensed milk, milk powder, etc.

The problem of milk production is complicated by the necessity, now generally recognised, of supplying a hygienic product, that is, clean and wholesome milk, so that dairy herds must not only be kept under the best possible hygienic conditions (clean sheds, good feeding, etc.), but the milk must keep fresh, all causes of contamination being guarded against.

Valuable residuary products are left over from the milk industries; these are often sent back to the farms as a food for animals, e. g. skim-milk and whey, which are very important foods for calves and pigs.

It should also be noted that the industrial uses of milk are developing in a direction which would have seemed paradoxical fifty years ago, namely, the use of milk for non-nutritive purposes. Thus, casein is used as a plastic substance and as raw material for the manufacture of artificial wool.

The Milk Industry in Europe.

The milk industry in Europe has as its source of supply more than 50 million head of cattle, yielding 105,800 million kg. of milk per annum. Part of the milk is made into butter (1,610,000 tons) and part into cheese (about 1 million tons).

The countries with the largest number of cattle are Germany, the Danubian countries, France, Poland, the Scandinavian countries, Italy, the United Kingdom, Denmark, the Netherlands, etc.

The production of milk is governed by the number of cows and their yield, which depends on the level of progress reached in cattle-raising. The use to which the milk is put varies widely according to the country. In some countries most of the milk is consumed in its natural state, in others it is made into butter and cheese. The total production of milk in Europe exceeds 100,000 million kg.; that of butter is nearly double that of cheese and amounts to 1,600,000 tons, as compared with 850,000 tons of cheese.

In the following table, we have reproduced the principal statistics for milch animals and the production of milk, butter and cheese in the chief European countries. The Scandinavian, Danubian and Baltic countries have been arranged in groups, instead of separately.

Number of milch animals, production of milk, butter and cheese.

(Compiled from the latest statistics)

Country	Number of cattle (in 000's of heads)	Milk output (in 000,000's of kg.)	Production of butter (in tons)	Production of cheese (in tons)
Germany	9,950	24,000	460,000	135,000
United Kingdom	2,500	7,000	30,000	30,000
France	8,450	14,000	190,000	200,000
Netherlands	1,450	5,000	95,000	125,000
Denmark	1,750	5,500	180,000	25,000
Scandinavian countries	4,100	8,000	95,000	35,000
Baltic countries	2,000	4,000	60,000	—
Poland	6,500	12,000	180,000	—
Danubian countries	8,250	15,000	190,000	45,000
Switzerland	900	2,800	25,000	60,000
Italy	3,500	6,000	60,000	200,000
Ireland	1,250	2,500	45,000	—
Total	50,600	105,800	1,610,000	855,000

In studying the development of the milk industry during the past few years account should be taken not only of natural conditions, which were formerly the only determining factors, but also of economic and political conditions, which at the present time are just as important as the other factors.

An examination of natural conditions in the various countries reveals the fact that soil and climate are of fundamental importance, as they directly determine the nature of the feeding stuffs available for milch animals, their state of health and the quality of the milk. Natural conditions also directly influence the keeping and breeding of the various kinds of milch animals. In Europe the milch animals are the bovines (cows and buffalos) sheep, goats and reindeer. Of these the bovines are the most important and require better grazing conditions and

care. A glance at the geographical distribution of milch animals in Europe will show that where bovines predominate the milk industry has nearly always reached a very high level of development, whereas in other regions, where it is dependent on sheep and goats and, less frequently, on buffalos, it has remained at a more primitive stage. The countries in which the milk industry has reached a high degree of perfection are those of Northern and Central Europe.

In other agricultural industries there are not so many factors directly connected with natural conditions and affecting their progress as in the milk industry. The tendency to emigrate shown by other milk derivative industries, such as the manufacture of butter and cheese, is in no case a reason for failing to produce good milk. To ensure such production, bovines must be examined from a health point of view and officially inspected; they must also receive a diet based on the principles of modern science. More and more care is being taken to ensure hygienic conditions in cattle-sheds as well as in milking, the tendency being to take the greatest precautions to obtain milk which is hygienically pure. In certain countries hand-milking has been replaced almost entirely by mechanical milking, while in others the pasteurisation of milk is becoming general.

Governments have adopted various measures to improve the quality of milk. The training of breeders and milkers, an increase in the selling price of milk of better quality from the nutritional and health points of view, and the study of the effect of cold and heat, have all helped to ensure to the consumer a supply of pure and wholesome milk. Furthermore, the legislation governing the production and inspection of milk is being constantly improved in nearly all European countries. The main objective is the improvement of hygienic conditions, and it is in this connection that the legislator makes the most exacting demands on the producer and the tradesman. Whereas formerly only flagrant cases of fraud could be discovered and punished, to-day the legislator not only provides for the exercise of supervision to prevent the fraudulent treatment of milk, but is also concerned with the health of the animals and of persons who, directly or indirectly, come into contact with the milk. Great importance is also attached to the containers in which the milk is kept for a longer or shorter period of time, and special rules have been laid down for this purpose also.

The hygienic production of milk has made considerable progress during the last few years. In several countries it is possible to obtain a special kind of milk which can be consumed raw without any danger to health. This milk, produced in model sheds by healthy animals fed on rational lines, will soon cease to be an exceptional kind of milk and become the milk generally consumed in the most advanced countries.

Milk, together with its derivatives, constitutes, after bread and meat, the most important foodstuff of the white races. Conditions for the consumption of milk *in its natural state* are most favourable among the Germanic and Slav nations of Europe. On the contrary, the Latin peoples of the warm temperate zones, with a large wine production, consume far less milk. *Butter* is the chief fat consumed by the Germanic and Slav populations but is of less importance in regions with a moderate or warm climate where large quantities of oil are produced. In the case of *cheese*, the position is just the reverse, since for many,

white nations in the warmest regions, it often almost entirely replaces meat, and is then an essential foodstuff. Such climatic and ethnographic conditions lead to considerable differences in the consumption of butter and cheese.

With regard to the consumption of butter per head of population, the United Kingdom heads the list with 11.5 kg. of butter, as compared with 7.9 kg. in Germany, 6.0 kg. in the Netherlands, 4.6 kg. in France and 1.5 kg. in Italy.

The consumption of cheese, on the other hand, is largest in the Netherlands 7.5 kg., as compared with 5.2 kg. in France, 4.5 kg. in Italy, 3.7 kg. in the United Kingdom and 2.4 kg. in Germany.

Milk differs from other agricultural products, in that it is produced daily and must be consumed or used without delay.

The internal provisioning of a country with milk and dairy produce and the more or less satisfactory organisation of such provisioning depend on the distances to be covered and the means of transport. When the milk producer's farm is situated near a town or an important centre, the milk can be entirely disposed of as soon as milking has taken place. The position is very different in isolated mountainous regions remote from urban centres. In such regions numerous special local cheeses are often manufactured, which would be difficult to produce industrially without the loss of their special aroma and characteristics.

At the present time, the chief features of the milk industry are: (1) the combination of producers to meet the growing economic difficulties; (2) the desire to improve products, which the perfecting of technique has made possible, in order to satisfy the more and more exacting demands of a critical public. There is also a tendency to present the products in a more attractive form, with a guarantee of their quality, by regulating the market, by establishing, with Government assistance, a strong organisation of the producers themselves, or by setting up a special association comprising a certain number of producers. In nearly every European country we find that this tendency to combine usually originates among the producers themselves.

Though the natural conditions prevailing in a country play a leading part in the development of its milk industry, economic and political conditions are equally important. Certain countries have endeavoured to achieve self-sufficiency as regards milk by increasing production for export purposes. In such cases their intention was not to export milk in the natural state but in the form of butter, cheese, condensed milk and other non-perishable products.

Butter and cheese can, of course, no longer be manufactured to any extent on the farm, as the buyers' requirements must be met and the products have to compete with others in foreign markets. In order to improve the means at their disposal—*i. e.* to obtain plant, more skilful technical personnel, etc.—milk producers, both large and small, instinctively formed associations, which became more and more powerful, so as to guarantee the sale of their produce abroad at a high price. This competition was mainly responsible for the improvement in the quality of exported products. Gradually a part of these products, which were originally intended exclusively for export, was also sold on the home market; the difference between the products manufactured industrially and those produced on the farm was noticed by the home consumers

and did not fail to exert a favourable influence. A clear distinction must, however, be made between the butter and cheese industries. While butter manufactured industrially, in accordance with all the requirements of modern science, is and always will be superior to that produced on a farm, the same is not true of cheese, or at least of all kinds of cheese, as local conditions play an important part in cheese-making, *e. g.* in the case of Roquefort. Other cheeses, on the contrary, can be profitably prepared industrially, particularly since pasteurisation has been introduced. There is, however, one cheese industry, that of melted cheese, which can in no circumstances be carried on in rural districts.

The most important dairy product on the international market is butter. During the past five years the world trade in butter has shown a steady and continuous development. The biggest buyer of butter is Great Britain, followed by Germany.

The production of butter by oversea nations, particularly New Zealand, is a serious menace to the further development of the European industry. The largest butter exporter is Denmark. The Netherlands, in view of the decline in cheese exports, have considerably increased their exports of butter in the course of a few years.

Up till 1931, the Netherlands were the most important cheese exporters. They have now been outstripped by New Zealand, which has proved to be a serious competitor of Europe in the matter of cheese exports also. The next countries are Canada and Switzerland.

In countries where the production of cheese predominates, and in those where it is almost as large as that of butter, there will be no excess of casein (skim-milk), as is the case in countries producing butter almost exclusively.

Skim-milk is sent back to the farm to be used there, when it cannot be utilised for human consumption.

Casein was at first used solely as a food, but nowadays it would appear to be mainly employed for industrial purposes (*Lanital*).

Lactose, too, can certainly not be recovered on the farm, as this operation necessitates a somewhat complicated and expensive plant if the extraction is to be worth while from a commercial standpoint. Whey left over after the manufacture of cheese is partly used for the feeding of pigs and calves.

Generally speaking, it may be said that the amount of milk preserves has increased considerably during the last few years.

The subsequent development of the milk industry will therefore depend on various factors. It will be assisted if the purchasing power of money improves, if scientific research brings out even more strongly the nutritive value of milk and its derivatives, and if new discoveries such as the recent discovery of "*Lanital*" lead to the introduction of new and as yet unknown industrial processes.

Butter is already involved in a more or less open conflict with another edible fat namely, margarine, and also indirectly with vegetable oils and lard.

In the cheese industry the new manufacture of melted cheeses, which ensures a higher degree of preservation, is encouraging the utilisation of surplus quantities of milk. The production of milk is slowly but steadily increasing, and

there is no reason for predicting a decline in its importance, unless unforeseen circumstances were to reduce the number of cattle. This industry, which produces man's most essential food-stuffs, has already reached a high degree of perfection. But it is difficult to foresee its evolution in European countries, and for the time being nothing can be added to what has been said above.

Other Processing Industries for Agricultural Products.

Attention has been drawn to the alcohol industry and the milk industries, because they provide typical examples of agricultural industries. There are, however, a very large number of other processing industries, the study of which would be too involved and which need only be enumerated.

The following may be noticed for purposes of information: the processing industries for starchy products (flour-milling, bread-making, alimentary pastes industry, potato and other starch and glucose manufacture); food preserving industries (fruit, vegetable, and meat-preserving); the so-called "hygienic beverages" (wine- and cider-making, brewing); industries for the extraction and utilisation of fatty substances (oil-works, melting works, refineries, margarine factories, etc.); the essential oils industry; the wood industry (charcoal-burning, distilling, paper-pulp manufacture, extraction of resinous products, etc.); the textile industry (flax, hemp, grass-cloth, wool, silk), as well as operations which must still be carried out on the farm such as retting; the animal offal industry (hides and skins, horns, bones, carcasses); the tobacco industry (drying and conditioning).

This list might be made still longer. What should be borne in mind, however, is that the agriculturist is necessarily interested in the development and perfecting of these complex industries, even if the plant used belongs to independent factories.

Handicraft Industries.

Certain traditional industries, carried on chiefly during the dead season, to utilise the skill of agricultural workers of both sexes, deserve special mention. The textile and woodwork industries are particularly suited to occupy the leisure hours of farm hands, who make rustic furniture, toys and household articles of wood and basket-work, or set up small spinning or weaving looms. The articles produced — especially the embroidery work, lace and clothing — often artistic or original, and it is on this account that they are appreciated.

These handicraft industries should be encouraged because they tend to occupy farm hands and at the same time increase the total receipts of the undertaking. They also make it possible to valorise certain local products by finding ready markets for them now that the extension of the tourist traffic brings urban populations into more frequent contact with those of the country-side.

In such cases the peasant's ingenuity should be relied upon and his traditional handicrafts encouraged as much as possible.