

POST-WAR BUILDINGS

NO. 17

FARM BUILDINGS

BY

A COMMITTEE APPOINTED BY THE
MINISTER OF AGRICULTURE AND FISHERIES



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FOREWORD BY THE
MINISTER OF AGRICULTURE AND FISHERIES

Old country such as ours, many industries have been handicapped because we have inherited fixed plant that does not suit modern practice. Agriculture is no exception, and our farms daily demonstrate the difficulty of maintaining high standards of milk production, animal health and of the storage of produce in buildings which may be anything between 100 and 500 years old, and often in a poor state of repair.

A good set of buildings cannot change a poor farm into a rich farm, but a good set of buildings properly laid out and properly equipped will enable the best use to be made of land, labour and stock. I believe firmly that British agriculture can make a most important contribution to the maintenance of a high standard of living in this country, and to this end we should re-equip our farms with modern date structures as soon as we can.

We have got to achieve this work of re-equipment as soon as possible, largely during a period when there will be many other calls upon building labour and materials. We must, therefore, make the fullest possible use of all the existing buildings that can be adapted, and make sure that we do not make mistakes in the buildings we put up. These new buildings, whether they are needed for housing stock, for storage or for processing, must be well laid out, designed to ease work on the farm, capable of adaptation to meet the varying needs of agriculture, simple, cheap and in harmony with the countryside. All these problems of adaptation and new construction are difficult.

For the reasons that I appointed, in November 1942, a Committee on Buildings, after two years' hard work they have completed a most valuable report. Their recommendations are now being carefully studied. One of the members of the Commission will visit Canada and the United States this year to study conditions there. The Report of the Committee, with illustrations and designs, should be of great help to architects, and to all others interested in the subject. I hope, therefore, that it will be

R. S. Hudson

COMMITTEE ON FARM BUILDINGS

TO THE RIGHT HON. R. S. HUDSON,
MINISTER OF AGRICULTURE AND FISHERIES

SIR, We were appointed by you in November 1942, "to consider and make recommendations regarding the layout, design, and construction of farm buildings after the war," and we now submit our Report.

We have suffered two pieces of great ill-fortune in the course of our work. Mr. George Gee, whom you had appointed to the Committee, died in February 1943. We were thus deprived of help in which an authoritative knowledge of building was coupled with first-hand farming experience and solid common sense; and we lost a colleague for whom we felt sincere affection. His place was taken by Mr. H. T. Holloway. Then our Chairman, Mr. Tristram Haward, was taken so seriously ill in March 1944, that he was unable to take any further part in our work, and he died in the following December. While he presided over us he was a wise counsellor, a gentle but firm mentor, and a friend.

Mr. J. C. Turner, who left on a mission abroad shortly before the Committee finished its work, has not been able to sign the Report. His comments on the final drafts of nearly all the Chapters had, however, been received before he left, and he was in agreement with our recommendations.

Your Committee was linked with a series of Study Groups set up by Departments or by members of technical organizations under the general supervision of the Ministry of Works. This relationship with bodies investigating analogous subjects has been valuable.

Mention should be made of the way in which our work was organized. We set up a Technical Sub-Committee with the duty of designing and reducing to drawings, buildings satisfying those requirements which our studies had led us to specify. The Sub-Committee had no enviable task; their meetings have been frequent and long. The Committee are greatly indebted to them and in particular to Major J. B. F. Cowper, F.R.I.B.A., who was their Chairman. We must also record the services given to the Committee by Mr. A. Thorpe, F.R.I.B.A., Architect to the Ministry of Agriculture and Fisheries, and his staff who carried out an immense amount of highly proficient work in the preparation of drawings.

The hardest part in the work has inevitably been that of our Secretary, Mr. P. J. Moss. To all the difficulties under which we as a Committee have laboured have been added for him other hindrances to the discharge of an exacting task. We highly appreciate his services and heartily thank him.

The preparation of Chapter 9, "Accommodation for Milking Cows, their Followers, and the Dairy"—one of the most important Chapters in our Report—requires particular mention. The Ministry's Bulletin No. 40, *The Construction of Cowhouses*, has, we understand, always been the most popular of the Ministry's Bulletins, in greatest and most constant demand. Your predecessor of the time had appointed a Committee in 1938 to revise the Bulletin with a view to reprinting. That Committee had made a revised draft but the outbreak of war led to the postponement of its presentation. Realizing that our Chapter 9 must cover substantially the same ground as Bulletin 40 we approached the Chairman of the

FARM BUILDINGS

Bulletin 40 Committee, Professor H. D. Kay of Reading University, and the following joint Sub-Committee was set up:

<i>Chairman:</i>	J. Mackintosh.
<i>Farm Buildings Committee:</i>	W. Alexander. J. Turner, B.Sc. R. W. Trumper. A. Thorpe, F.R.I.B.A.
<i>Bulletin 40 Committee:</i>	H. T. Tate, F.S.I., F.L.A.S. E. Whone, M.B.E. J. Holmes, B.Sc.(Agric.), N.D.D.(Hons.).
<i>Secretary:</i>	L. J. Gray.

Their work resulted in a revised form of Bulletin 40 which appears as Chapter 9 of our Report.

In normal circumstances we would have been able to reap great advantage from extensive visits to farm holdings in various parts of the country, and from the study of modern farm building development in certain other countries. The difficulties of war travelling have confined us to this country and have limited our inspection of buildings to a relatively small number of specially selected examples.

We naturally desired to draw as fully as possible on the knowledge and experience of landowners and agents, of farmers, of farm workers and of agricultural scientists. To this end we invited the bodies named in an Appendix to our Report to assist us by sending statements of their views. We are greatly indebted to the bodies and the individuals who have assisted us by statements and by designs, and for all their help we make grateful acknowledgment.

We believe that the recommendations on the layout, design, and construction of farm buildings which we make in our Report are the best which can be made in the light of present knowledge. We have, however, been impressed by the limitations of this knowledge, particularly on the relation of housing with health for livestock. Moreover, big changes in farming practice must be expected in the not distant future and these will influence some of the essential features of farm buildings. We have, therefore, recommended for your consideration the setting up of an organization for the continuous study, with experimentation, of farm buildings. We attach the highest importance to this project.

F. L. ENGLEDDOW, *Chairman*.
W. ALEXANDER.
J. STANLEY CHIVERS.
A. DOUGLAS.
EDWIN GUNN.
E. HOLLAND-MARTIN.
HENRY T. HOLLOWAY.
W. HOLMES.
RICHARD W. TRUMPER.

P. J. MOSS, *Secretary*.

ALEC THORPE, *Technical Secretary*.

19th March, 1945.

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FARM BUILDINGS

A REPORT BY A COMMITTEE APPOINTED BY
THE MINISTER OF AGRICULTURE AND FISHERIES

PART I. GENERAL

CHAPTER 1. THE PROBLEMS

1. Our terms of reference were:

“To consider and make recommendations regarding the layout, design, and construction of farm buildings after the war.”

Farmhouses and cottages were excluded from our reference.

2. There are approximately 138,000 farms of over 50 acres and 160,000 holdings of 5 to 50 acres in England and Wales. Of the 138,000 farms, no fewer than 125,000 are below 300 acres. They occupy a country which enjoys a wide variety of soil, climate and topography, and in consequence there is an equally varied range of produce and practice.

3. The form of farming after the war and the trends of its development in this country cannot yet be foreseen with any certainty. It is evident, nevertheless, that the future of farm buildings will be primarily influenced by three major circumstances. The first is that apart from special exceptions all farms are already equipped with buildings. In very many cases the buildings were designed and constructed to meet needs which have passed or which have changed in character and importance; frequently they are of great age. It would be uneconomic and impracticable to attempt the complete replacement of such farmsteads nor is there any need; the problem will be in the main one of steady replacement of outworn or entirely unsuitable buildings, and adaptation of others to satisfy modern purposes.

4. The second circumstance is that great changes are certain to occur in systems of farming and in husbandry practice. Familiar examples of farming changes which had begun in 1939, and some of which have been accelerated by war, are: alternate husbandry or ley farming; increased use of mechanical power and of machinery; higher standards in milk production; movable units for dairy cows, pigs, and poultry. New methods and practices will continue to be devised, and when they have proved their value they will be widely adopted. It is, therefore, essential that new farm buildings should be capable of adaptation to other uses without unreasonable difficulty or expense.

5. Thirdly, changes have occurred and will occur in methods and materials of building. It is important that the usefulness of new methods and materials for farm buildings should be tested at an early stage, and that landowners and agents, farmers, builders, and architects should have ready access to information concerning them.

6. The Committee, in the light of these circumstances, set itself the following tasks:

- a. To distinguish the basic principles affecting farm buildings. These are dealt with in Chapter 2.
- b. To suggest suitable layouts for farmsteads with buildings conveniently sited in relation to each other. Chapters 6 and 7 deal with this.

THE PROBLEMS

- c. To provide examples of designs embodying these principles. These are described and illustrated in detail in Chapters 8-19, and in addition certain general aspects of buildings for livestock are considered in Chapter 4.
- d. To consider materials and methods of construction which are known or thought to be suitable for farm buildings. This subject is dealt with in Chapter 3.
- e. To consider what arrangements are necessary in order to make knowledge of developments in connection with farm buildings continuously available to the farming industry. Chapter 5 makes suggestions to this end.

7. Farm buildings have always outlived husbandry practices. No more striking example of this can be found than the corn barn. Even to within living memory these barns, which provide the grandest as well as the largest examples of farm buildings of the past, were used to store the corn brought straight from the field, loose or in sheaves. It was a regular winter occupation to flail out the corn on the floor of the mid-steel or space opposite the great doors. Where a combine harvester is used, the modern equivalent of the old barn is housing for a grain drier, and such was the excellence of the building of bygone days that it is in many of these old barns that the modern grain drier has been installed.

With the certainty before us of steady new developments in farming systems and husbandry practices, induced by science and by mechanical advances, it is more than ever essential to ensure adaptability in buildings. This characteristic can theoretically be secured in either of two ways: by very cheap temporary structures; or by normally permanent buildings so designed as to allow of easy internal conversion to different uses. Storage buildings, for implements or fertilizers, can be given a much higher measure of adaptability than others, such as cowhouses.

8. Although it has been possible to distinguish some basic principles affecting farm buildings and to draw on extensive practical experience and technical knowledge, we are obliged to record that in some important matters lack of knowledge is still a severe handicap to farm building design. This is especially the case where the comfort and health of livestock are concerned. Upon this matter we represented our difficulties to the Agricultural Improvement Council, and we learn that it is hoped investigations on the housing factors which affect livestock will be undertaken through this body, acting with the Agricultural Research Council.

The factors on which reliable evidence is specially necessary include: influence of air temperature and floor temperature on bodily comfort and health; control of humidity in pig and other stock houses and the effects of humidity on health; thermal insulation of farm buildings; the general problem of ventilation and, in particular, necessary air space allowances and the avoidance of draughts; influence of light on livestock.

9. Recognizing the wide variation necessary in every type of farm building on account of diversity in size of farm, locality and other circumstances, we pondered the practicability of preparing alternative designs and plans for each type. This course, while making our Report inordinately long, could not possibly have provided working patterns for even the chief combinations of circumstances to be found in the highly diversified farming of this country. We therefore decided to select one illustrative plan for each of the chief types of farm buildings, taking as our background of consideration the needs of a mixed farm of some 200 to 250 acres, with about a score of cows in milk, and under conditions broadly characteristic of a large part of the country. It should be noted here that the assumptions are made that ley farming will develop widely in this country; and that the 200 to 250 acres farm will continue to be a common size. By suitable extension or amendment these plans will, it is hoped, prove useful general guides.

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In addition to the illustrative plans, we have discussed for each type of building the essential purposes it is to serve and have briefly explained how these are secured by the suggested design.

10. On very large farms, or where there are specialized developments, uniquely designed buildings may be required, such as housing for corn driers, for green crop and grass driers, for fruit grading and storing, for vegetable washing and packing, or for chicken batteries. It was decided not to include designs for buildings of these kinds in this Report because of their wide variation in type, their highly specialized nature, and the fact that changes in their layout and use are likely to occur in the early future. It is suggested that knowledge of new developments of buildings of this kind should be made available by the means recommended in connection with farm buildings in general in Chapter 5.

11. The large number, however, of very small farms and of small holdings in this country led us to consider whether they have special and distinct requirements. In general the design of individual buildings for such holdings must follow the same principles as the characteristic buildings of a larger farm. The special problems are essentially those of layout and management rather than of detailed design. Chapter 19 is devoted to these problems.

12. In the course of our inquiries it has been frequently impressed on us that however urgent may be the need for additional buildings, or for the adaptation of existing ones, little can be done unless owners are enabled to find the necessary money. It has been put to us that "it is a question of ways and means"; emphasis has been laid on "the fundamental question of capital expenditure" and the fear expressed lest "the agricultural industry should be financially crippled by insistence upon a heavy burden of expenditure in this respect"; and we have been more than once reminded that the capital already invested in permanent farm equipment by a succession of owners bears little relation to the value of the holding, so that frequently the replacement value of the buildings exceeds the value in the open market of the land and buildings together. The result of this is that, if the rent is taken to represent a return on capital expended on buildings and equipment, there is no return whatever on the value of the land itself.

This problem of finance is outside our terms of reference, but it has been mentioned so frequently in the evidence submitted to us that we feel obliged to draw attention to it in this Report. The Committee welcomes the facilities of cheap long-term finance which are accorded to agriculture under the Agriculture (Miscellaneous Provisions) Act, 1944.

13. In considering farm buildings at the present time there are two great difficulties and it is important that these should be understood by readers of this Report.

First is the special situation which will prevail for some years, it may be three or five or more, after the end of hostilities. The prior claims of dwelling houses will deprive agriculture of many familiar building materials and of much skilled building labour. Some farmers and landowners will prefer to postpone building changes or additions until labour and materials are again fully available. Others will have needs which must be satisfied without delay and these will be forced to various improvisations. Although in improvised and temporary farm buildings the same basic principles apply as in permanent ones, we have thought it well to give up a separate Chapter to improvisation in the immediate post-war period.

The second difficulty though chronic is specially acute in the present age when discovery and invention are sharply affecting agriculture. Farming methods and the materials and technique of the building industry are, as we have already remarked, always undergoing change. Thus, even without the disturbances of war, ideas and recommendations on farm buildings can have only a limited validity in time. We have so far as possible avoided reliance on specific assumptions as to future farming changes while, at the same time, keeping it in mind that our

BASIC REQUIREMENTS OF FARM BUILDINGS

recommendations would be of only ephemeral value unless they allowed for changes. Briefly, our endeavour has been: (i) to bear in mind the main trends of farming and building changes and their possible effects on farm buildings, (ii) to give in full, for practical guidance, what appear to be the best current ideas on layout, design, and construction with illustrative alternatives, to allow for the great variety in local conditions, and (iii) to do everything possible to ensure adaptability in our designs, this being the best provision for meeting future changes in farming practice.

CHAPTER 2

BASIC REQUIREMENTS OF FARM BUILDINGS

14. In spite of the wide diversity in farm size and system, as well as in soil, climate and other local circumstances, there are certain principles which it should always be sought to embody in designing farm buildings. The Committee opened its investigations by considering these universal practical requirements or principles. It proved necessary to give considerable time to this study and to refer constantly to principles both when examining evidence put before us and when preparing illustrative plans. In reporting, however, no lengthy enunciation or critical examination of these principles is made, but they are described briefly below. Close attention should be given to these principles as a preliminary to final decision when landowners, agents and farmers, architects and builders are playing their several parts. This is true as much when adaptation of existing buildings is involved as when new buildings are projected. The general question of layout of farmsteads is dealt with in later chapters. It must be remarked, however, at this stage that buildings must always be regarded from two points of view—one, in respect of their efficiency for the functions each is intended to perform, and two, their relation to the farmstead as a whole.

15. The chief principles are as follows:

a. *Appropriate cost.* Figures showing the relationship between cost of buildings and productive capacity of a farm are seldom available. Nevertheless this relationship should not be overlooked since experience shows that neglect of it has frequently led to gross disharmony between expenditure on buildings and rental value of the holding. A farm should be an economic unit, and in respect of buildings and similar equipment, further capital should be invested only when necessary in order to maintain or to raise the level of profitable production. This is particularly important at a time when major changes in farming practice are taking place. In practice unwarranted capital expenditure on buildings sometimes causes a shortage of capital for other equipment or of working capital.

Additional expenditure on buildings, with the object of saving labour (referred to again in (p) below) is an important consideration. Taking the wages of one man as £170 a year it may be argued that it is justifiable to spend up to £x (the capitalized equivalent of £170) on building alterations which will ensure the reduction of the farm staff by one man. While a calculation of this kind provides a useful way of examining any proposed building programme it is seldom possible to relate design and layout of premises exactly to labour requirements. In this, as in all aspects of farm buildings, it is also necessary to remember that the suitability of some special building feature to the present working of a farm may disappear if a new working system be introduced. That is, expenditure on a specialized building or building feature, always carries the risk of shortness of useful life. The more pronounced the specialization, the greater the risk and in practice the outlay has to be duly weighed against the saving of labour ensured and the applicability of the new provision to possible variations in the working of the farm.

FARM BUILDINGS

b. *Adaptability.* The principle of designing buildings which by changes of internal fittings can be adapted to a variety of purposes should be widely applied. In the past, for instance, many specially designed and costly buildings were erected and have fallen into disuse or have proved unsuitable owing to the difficulty and expense of suitable conversion or improvement to meet other requirements. This frequently happens on a change of tenancy or through changes in farming practice. So far as possible buildings should be designed so that both structurally and in dimensions they are capable of accommodating the internal equipment required when adapted to an alternative purpose, as, for example, when a stable is converted into a cowhouse. Minimum dimensions for the original purpose may well prove uneconomic in the long run. To make expansion in size readily practicable should be a further aim in design.

It is believed by some that difficulties over buildings at a change of tenancy will not be wholly overcome unless farms in general come to be recognized as equipped with buildings for specified forms of farming. Most farms would presumably be suitable for general mixed farming: some would have, in addition to the general buildings, suitable yards and houses to allow of cattle raising or milk production or vegetable growing or other purposes as the chief activity. A tenant seeking a farm would seek one suitably equipped for the kind of farming he had in mind and would not expect existing building equipment to be specially varied for him. Any general development on these lines would allow more specialization in farm buildings, but the need for adaptability to meet big changes in farming practice, as distinct from a tenancy change, would still remain.

A specially interesting form of adaptability consists in having a single building for all purposes, the internal fittings and partitions of which can be easily moved and changed. This is mentioned more fully in Chapter 3, paragraphs 25 to 28.

c. *Appropriate permanence.* The life of a building is determined by its ability to resist the effects of weather and the strains and stresses caused by the use to which it is put. Thus buildings housing stock will generally be more heavily constructed than those housing, for example, fertilisers or implements. Buildings with specialized fixed equipment—for example the granary—should always be strongly constructed. The use for many purposes of buildings intended to have a very short life (say 10 years) is recommended in some quarters; but we consider such buildings unsatisfactory because they are expensive to maintain, too light for practical working, and often unpleasing in appearance.

d. *Standardization and mass production.* To a considerable extent it may be possible, by adopting a limited number of designs, to make use of buildings consisting in part at least of factory-made units assembled on the farms, as for example in the case of implement sheds and of grain and fertilizer stores. This principle is already widely adopted for Dutch barns, and its wider application is considered fully in Chapter 3. If fittings could be manufactured to standard sizes and designs production might be cheapened. This would require an informed initiative on the part of makers and acceptance by purchasers of the limitations imposed by standardization.

e. *Simplicity of erection.* In connection with (d), and to a less extent in other connections, the practicability of farm workers helping to erect farm buildings may need consideration. It is probable that for some time after the war skilled building labour will be in great demand. It may be important, therefore, that methods of construction should be chosen which make a minimum demand on such labour. Designs should take account of this.

f. *Economy of maintenance.* Design and material affect ease and economy of maintenance, and economy in initial cost should not be carried to a point at which economical maintenance is prejudiced.

BASIC REQUIREMENTS OF FARM BUILDINGS

g. *Anticipation of impending changes in farming methods.* The necessity for keeping this matter in mind may be illustrated by the case of corn harvesting methods and their possible influence on farm buildings. If combines with driers and grain stores displace our present methods, farm buildings may be considerably affected. Implement sheds must be large enough to take the combine, and on big farms housing for driers and grain stores will frequently be installed. Possibly combining, drying, and storing will be done by contractors with a system of public silos resembling that of country elevators in Canada; alternatively, a small combine and drier may be developed with suitable grain storage on the farm. Dutch barns would then be less important than at present. For the purpose of this Report it is assumed that farms of 150-300 acres will not maintain their own combine harvester and drying equipment. On larger farms provision may have to be made for equipment of this kind.

h. *Convenient layout.* Separate chapters are devoted to this (Chapters 6 and 7).

i. *Ensurance of animal health.* Two aspects of health must be recognized, namely, the physiological or that affecting the bodily comfort and general well being of the animal; and the pathological or that connected with specific disease.

Of the characteristics of buildings by which the comfort of animals is affected, little is known (cf. Chapter 1, paragraph 8), but the best available information has been employed in the illustrative designs which accompany this Report.

In connection with specific diseases there are numerous building considerations. Various enactments such as the Milk and Dairies Orders must be taken into account, and the recent transfer of responsibility for these to the Ministry of Agriculture should remove certain difficulties including variation in interpretation by separate local authorities. Ease of cleansing and of disinfecting buildings after an outbreak of contagious or infectious disease, and also facilities for isolation of sick beasts, are other important considerations.

j. *Conservation of soil fertility.* Full use of animal excrement, especially for rotting down straw, should be facilitated by building design, this being especially important in the case of dairy cows. It must be considered jointly with (i) above.

k. *Water supply and drainage.* The Committee has not found it possible to engage in a detailed study of the various possibilities of supplying and distributing water in farmsteads, nor of the related subject of the removal of drainage. These questions are of considerable importance, and it is recommended that studies of them should be undertaken by the organization proposed in Chapter 5. A brief note on water supply is included in Chapter 3.

l. *Protection against fire risks.* On this important matter a Memorandum from the N.F.U. Mutual Insurance Society has been received by the Committee. It is quoted in full in Chapter 22.

m. *Exclusion and control of insects, rodents, and other pests.* This subject is considered in Chapter 21 which is based on expert statements to the Committee.

n. *Improvisation.* It should not be forgotten that temporary needs can often be met by temporary measures, such as the erection of straw shelters to which reference is made in Chapter 14. The farmer with ingenuity and initiative will always have opportunities to display these qualities in providing himself with buildings. This will be particularly true in the early reconstruction period when building labour and materials for the farm may present special difficulty. Chapter 20 discusses these matters and makes certain recommendations.

o. *Appearance.* The desire expressed frequently and with warm feeling by various individuals and sections of public opinion, to do everything possible to preserve the best features of the British landscape, is heartily shared by all sections of the agricultural community. Moreover, the Town and Country Planning Act, 1944,

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brings farm buildings under planning control. In all our considerations of farm buildings we have had in mind the importance of pleasing appearance, though always recognizing that this must be duly weighed against cost of buildings and convenience in their use. We are confident that the Ministry of Agriculture and Fisheries and the Ministry of Town and Country Planning will ensure that this control is not onerous or unduly pernickety.

We feel that those who have a special responsibility in preserving rural amenities could most effectively enter upon the question of farm buildings by the following steps:

- i. Preparing for the guidance of landowners, architects, builders, and others concerned, suggestions and a statement of principles on form, colouring, material, and other characteristics of farm buildings;
- ii. Developing means for simplifying and lowering the cost of restoration work on farm buildings. There are in every part of the country buildings which for their pleasing line and materials ought to be preserved but which are dilapidated or unserviceable or unsuitable for modern purposes. With existing knowledge and existing facilities it will sometimes be financially more attractive to destroy the old building and erect a fresh one.

p. *Comfort and economy of labour.* It has been urged from more than one quarter that whereas it has been a prominent policy in other industries to aim at improved surroundings for employees while at work, little has been done in this direction in agriculture. Farm workers have of necessity to face the elements, but in the interests of labour saving and of labour keeping, and in particular if the younger generation are to be encouraged to stay in or to join the agricultural ranks, it is essential that not merely home conditions but working conditions as well should be improved. Such things as firm and dry communications between the parts of a farmstead, lighting (natural and artificial), easy loading levels, easy stairs with plenty of headroom, a warm mess or drying room and adequate lavatory accommodation, should have most careful consideration.

In this Chapter and elsewhere, frequent reference will be found to "labour saving" and "economy of labour." The Committee wishes to make it clear that their purpose in seeking these objects is not the crude reduction of the labour force. The purpose is achievement of a higher output per man, and it is sought in two chief ways: avoidance of all unnecessary expenditure of effort, and increased command of mechanical power. It must not be forgotten that on most of our farms the farmer is not only the manager, but a worker as well. Higher efficiency in the use of labour will help him to devote more time to management; good design, construction, and layout will simplify his management problems.

16. Large amounts of material, some bulky, some heavy, have to be moved into, within, and out of farm buildings. Speaking broadly, this movement involves two kinds of operation, viz. loading (or unloading) and transfer. It has a further sub-division into daily movement such as cleaning the cowshed and moving fodder, roots, and concentrates to stock; and occasional movement. The latter is varied and includes: for fertilizers, delivery from merchant's lorry in large amounts and despatch in smaller amounts at sundry times to the fields; for muck, cleaning the yards and carting out and spreading; for roots, carting off to store or clamp. Many other examples of movements readily come to mind, most of them requiring much labour often of that heavy or exacting character from which it is desired to protect the worker on the land by such resort to mechanism and mechanical power as industry employs. Now in all the kinds of movement of farm material alluded to above, it would be possible to devise apparatus to displace bodily power by mechanical and corresponding provision would have to be made in designing certain of the farm buildings. There are cases in which labour can be reduced solely by building design without apparatus, e.g. loading ramps, and these come under notice in later Chapters. But the question of specialized building

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design and use of mechanism to save labour calls for careful discernment. First comes the distinction between the daily or regular movement of material and the occasional and irregular.

17. Daily movements are all connected with stock and involve droppings and straw, concentrates, roots, hay and straw or other bulky foods, and milk. The loading and unloading of these cannot readily be mechanized. For their transfer from point to point four kinds of apparatus are available (i) hand equipment—hay forks, bags, and skips, (ii) wheel vehicles—carts or pneumatic tyred hand carts; (iii) tramways, (iv) overhead cables. In certain cases worm or band conveyors or air power (suction or blast) can be used as in Canadian practice. Choice of one or other of these aids can only be decided in the light of circumstances on the individual farm including size and farming policy. Many will occasion some special feature (cf. Chapter 6, paragraph 119) and extra cost in building, and it must be considered whether the lessening or conveniencing of labour will offset this cost. Further, the specialized provision may not continue to serve, if, later, the policy or working of the farm becomes considerably changed. Even the regular, daily, movements of material on a farm occupy but a few hours every day in contrast with the unceasing movements of material in many industries which have led to the many familiar lifting, loading, and conveyor systems. Some provisions in building design and layout to facilitate daily movements are, however, both simple and important. Concrete causeways outside buildings and around yards, with ample space, enable carts or hand-carts and barrows to be used with great effect; again, in a big crewe yard access and gates should allow cartloads of hay, straw, and roots to be taken in.

18. On large farms the food stores for the various classes of stock should be so large that purchased feeding stuffs can be delivered straight to the store and held there till required for use. The store should be divided, one part to be locked up and the other to hold the current week's rations. Storing food in a large central store and then carting to the various sections as required results in a great deal of double handling on a large farm. On a smaller farm, the central store being within reach of all departments is an excellent feature.

19. For the irregular, occasional movements such as yard clearing and requirements at the sowing and harvesting of the various crops, labour saving in comparison with cost of equipment and special building provision is of even greater importance than for daily movements. Some cases are simple, for instance the Dutch barn in contrast with stacking. More difficult cases may be illustrated by potatoes or mangolds and corn. Clamping roots is laborious and storage in buildings would be possible, while in the case of potatoes it would allow riddling and sacking to be done in comfort. But the buildings would be costly and in use for only part of the year, and only part of the mangolds and none of the potatoes (save chats) need be brought to the farm premises. The problem here is one for movable mechanical equipment rather than for special buildings and fixed equipment. Conveyor-loaders, often used now in hauling the "roadside" dumps of sugar-beet, could be much more fully developed and used. For example, it seems possible that the clearing of yards may be carried out by a bull-dozer attachment to a tractor provided yard access, gates, and internal divisions are arranged to allow this. If so conveyor-loaders could be employed to fill muck carts.

A portable shelter for potato riddling in place of the pitiable erection of poles and bags usually employed would not be expensive. For the bulk handling of grain, air suction or blast is now always employed and its use to move corn straight from the threshing drum to the granary floor has been suggested to avoid the labour of moving sacks from the drum. What this would involve in building layout is an interesting speculation, but the notion illustrates the range over which consideration of labour saving on the farm can be carried and should be carried.

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20. In the case of grain and other concentrated feeding stuffs movement may be reduced and simplified by storing above the point of preparation or consumption with gravitational fall. This involves mechanical power to take the material to its starting point. Vertical movement of this kind is recommended in Chapter 8, on the granary; the old-time stable with hay loft is a familiar example. The method is widely used in North America, and its possibilities for our conditions and requirements should be carefully investigated. If, however, it is to be used, two- or three-storey buildings are needed; and this aspect of the matter is considered in Chapter 3.

In both lateral and vertical movements, electric hoists and conveyors have important possibilities.

21. The relation of mechanical loading to farm building layout and design is so important that we recommend enterprising investigation on it by the organization proposed in Chapter 5. In principle, movable equipment is preferable to fixed equipment with corresponding specialization in buildings and consequent sacrifice of their availability.

CHAPTER 3 DESIGN, METHODS OF CONSTRUCTION, AND MATERIALS

22. The attempt made in this Chapter to review the general questions of design, materials, and construction for farm buildings brings out acutely the difficulty of foretelling future trends to which the closing passage of Chapter 1 alluded. In this review the influence on buildings from changes in farming method (attended to wherever relevant in other Chapters) will not be examined. It will be assumed that the fullest practicable adaptability of purpose is desirable whenever a new farm building is put up or an old one altered. No corresponding general safeguard on account of possible changes in building materials and methods can, however, be devised. Fresh developments in the building industry will arise in connection with dwelling houses, business, industrial, and amenity premises, and some of them will intrude themselves into the erection of farm buildings. To predict even the general course of these developments is impossible; the building industry itself seems divided even upon so apparently important a subject as mass production of dwelling houses. It follows then that time—perhaps a decade or longer—must be left to show the value of many of the new things now in use, or projected, by the builders. This is true as much of materials as of methods of construction. Some materials which can be cheaply and quickly produced may serve on the other hand for an emergency period.

23. Building industry developments in methods and materials may influence the design and dimensions of farm buildings. This possibility is most evident in connection with mass prefabrication and the standardization its economic employment requires. There may indeed be some danger, especially in the immediate post-war period, of unsuitable farm buildings being forced into acceptance.

24. The duration of what is familiarly called the "immediate post-war period" between war and normal times is unpredictable and will not be the same for all sections and all interests, even in one country. But for farm buildings it is an unavoidable supposition that there will be a short span of years in which overdue repairs, alterations, and additions—in all a great volume of work—cannot be undertaken with normal facilities. Improvisation will have to meet needs which are too pressing to wait till times are normal, and we have found it convenient to

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give up a separate Chapter to the immediate post-war period. The review, now following, sets out current knowledge and ideas and indicates some of the larger changes in design, materials, and construction by which farm buildings may be influenced in the next few years.

DESIGN

25. In design, it must be repeated, adaptability to a number of different uses must be in future a cardinal aim both in new buildings and in alterations. This quality can be ensured fairly easily in the traditional separate, single-purpose, single-storey building, and recommendations to this end will be found in the Chapters of Part II of this Report. On the Continent and in North America, there has been, however, a tendency away from the single-purpose building, and towards large, multiple-purpose buildings, in which are housed livestock and food, implements, and fertilizers. In the Continental expression of this tendency a large ground-space is surrounded with walls and covered with a roof, the interior being divided where necessary; in North America, on the other hand, the large building includes two or three storeys, and as a result it covers a relatively smaller area. These multiple-purpose buildings and their possible suitability for English conditions are discussed in the following paragraphs.

26. Extreme development of the single comprehensive building has been effected in some of the wholly new farms on land reclaimed from the sea in Holland shortly before the outbreak of war. In a substantial brick and slate building, with low walls and a vast barn roof, are housed all the stock, the hay, the corn (in sheaf), the implements and tractors, the fertilizers and feeding stuffs, the farm office and, in some cases, the occupier and his family. A simpler form of the single building is to be seen on a certain group of farms in East Anglia. One of these is 163 ft. long, 40 ft. wide, 47 ft. high at the roofridge, and 15 ft. at the eaves. Office and stables are included and the rest of the floor is undivided. All corn is stacked inside, the thresher is moved as required and a traveller working on a rail hung from the roof carries a conveyer arm which brings the sheaves to the thresher.

27. The same plan had been less ambitiously applied on a number of farms in this country before the outbreak of war. In the simpler forms a ridge or curved roof of corrugated iron was supported on stanchions, some of which were internal; the floor was earth, and post and rail partitions were made for bullocks, calves, horses or pigs; implements, roots and fertilizers being stored in convenient places on the rest of the floor. Other forms were more elaborate with roof trusses which made internal stanchions unnecessary and, in some, there were walls on three sides, of corrugated iron or asbestos cement sheets, or of concrete panels held in slots in the stanchions, sliding doors forming the fourth side.

We recommend that, at suitable opportunity, selected examples of this kind of building be described in the Advisory Service publications proposed in Chapter 5.

28. Meantime, certain principles and limitations should be noticed. Houses, yards, milking sheds, and dairies for milk production must, for reasons of hygiene, be excluded from a single general-purpose building. Where such a building has the sides filled in, a cowhouse or milking shed and the dairy could be built against it, with yards adjoining. Implements need not be walled off from each other or from fertilizers and feeding stuffs, but suitable partitions must be provided for any non-dairy stock to be housed. These partitions could be made movable by providing iron post sockets set in concrete blocks at suitable intervals. Part of the floor would have to be in concrete and with falls for drainage, to house stock on any system other than the "yard" with abundant use of straw. But this part of the floor could serve other purposes at any time if all posts were movable.

For convenience of working, the single building—floor and roof only—has obvious claims under a number of farming systems. Its cheapness of erection

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may turn decisively on mass factory production which, in turn, may involve the acceptance of a very few standard combinations of height and width. Our conclusion is that this issue cannot yet be settled. Manufacturers are not prepared to commit themselves until they know the probable demand and at present it seems only possible to wait for experience to begin to show this.

Some further observations on the single building for small farms are made in Chapter 19.

29. The North American "barn" is another example of the single building, with the important difference that two or three storeys are provided. Stock are housed on the ground floor, the upper storeys being used for storage of food, including hay. In a two-storey barn corn and cake are usually crushed on the ground floor, being delivered to the mills by gravity; in other cases the second floor is used for storage, and the first for preparation, the prepared food being delivered by gravity to points from which it can be conveniently distributed to the animals. Hay is delivered to appropriate points by one or more chutes.

It appears that the development of this system has been encouraged by two important factors: the severity of the winter climate, which makes it essential that all work should be carried out under cover; and extreme shortage of labour, which has forced the adoption of mechanical help to the fullest extent.

The circumstances which led to the evolution of the North American barn are not found in the same degree in this country, but its main features—the full use of mechanical power, and efficiency in the application of labour—are very important. It should be noted, however, that it is implicit that cows are housed in a double- or treble-storeyed building, which is not in accordance with the best practice here. Advantages of the single-storey building for all stock are: proper ventilation is easier to provide; noise from men and machines overhead is avoided (this is probably more important with horses than with other livestock); dust is not produced to the same extent. It could, on the other hand, be argued that in America the ventilation problem has been solved, as shown by their records of animal health; that noise is relatively unimportant; and that each floor can be effectively ceiled. The two basic questions, however, are: are the animals as healthy, and is the system economical? Conclusive answers to these questions can be given only as the result of experience, and accordingly the Committee recommends the early erection and trial of buildings of the North American barn type. It must be realized, however, that such a building cannot easily be converted to other uses; its functions are rigidly limited by its design. In this it differs fundamentally from the "single-floor, single building" described above.

30. Save for the single, comprehensive building, the greatest demand will be for single-storey buildings, of limited span. Typically, such buildings are put to single uses, or transverse divisions may be inserted to accommodate a number of uses. Longitudinal division is uncommon; the whole of the span of a building is usually put to one use. The problem is, therefore, one of designing and supplying large numbers of single-storey, comparatively narrow buildings.

31. A wholly different tendency in design is to the greater use of movable folding units for pigs and poultry, which is again taken up in Chapter 11 (Pigs).

METHODS OF CONSTRUCTION

32. The great issue in methods of construction is whether mass production can be widely applied to farm buildings.

New building, and adaptation and maintenance of farm buildings, have usually been carried out by local builders, often in a small way of business, though the manufacture of steel Dutch barns is a notable exception. This circumstance has affected design, materials, and construction; each building has been "unique,"

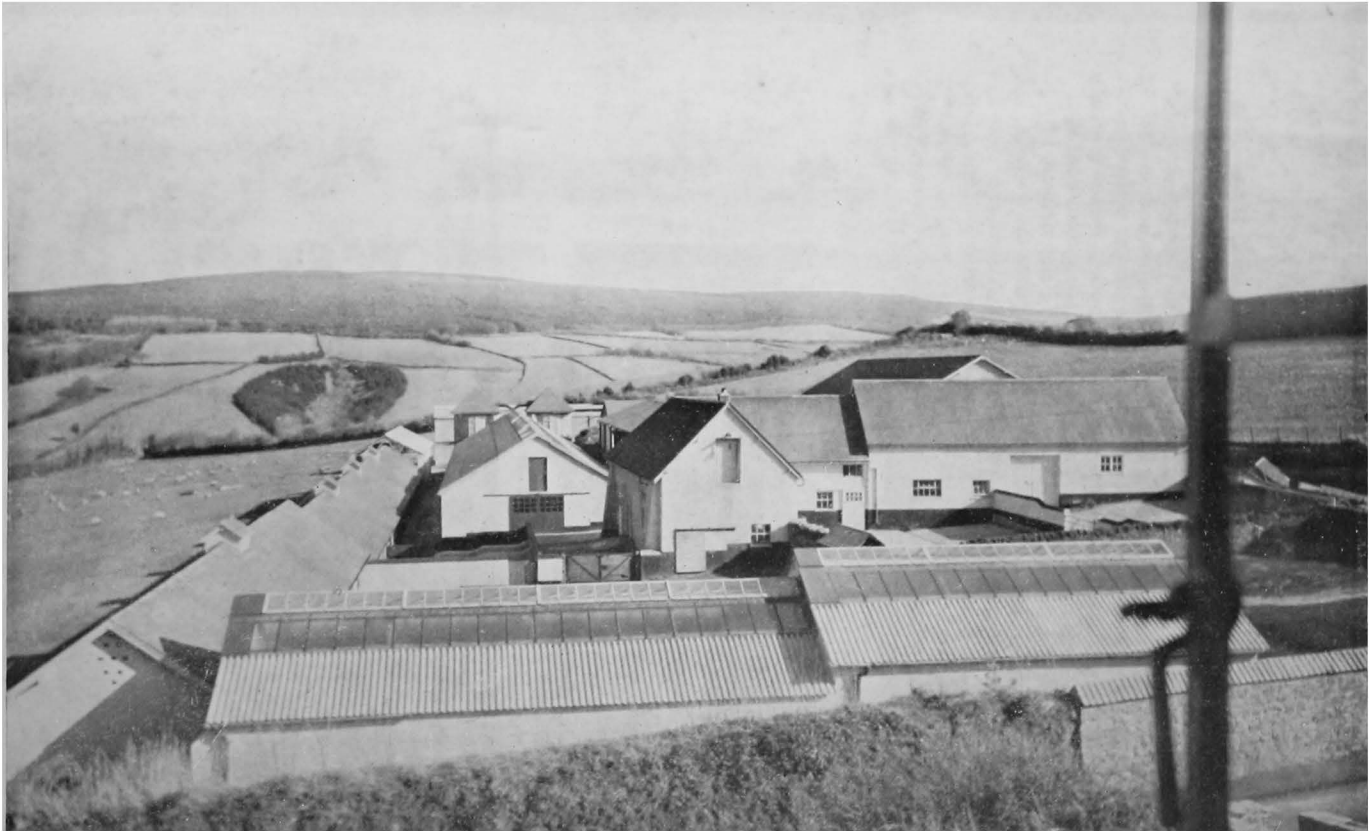


PLATE I. A MODERN FARMSTEAD IN SOMERSET: GENERAL VIEW
The walls are mainly of foamed slag.



PLATE 2. A MODERN FARMSTEAD IN SOMERSET: SILOS, COWHOUSE, AND DUNGSTEAD
Note fixed blower and conveyor.

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in that it has been specifically designed—though its design may have been influenced to a greater or less extent by existing buildings in the locality or by Ministry of Agriculture bulletins and text books on the subject. There are substantial advantages in such an arrangement. Local craftsmanship has been fostered, employment has been diversified and local farming needs and practices have been served. Certain disadvantages may be involved as well; there is some doubt, for example, as to the speed with which advances in building technique are likely to be adopted by, or even become known to, the smaller and remoter units of the building industry. Proposals are made in Chapter 5, which would, it is believed, promote efficiency in this respect.

Many believe that when things have settled down again after the war, the local rural builder will resume his place as the principal agent for construction and maintenance of farm buildings. For this reason the Committee welcomes and supports the insistence of the Rural Housing Sub-Committee of the Central Housing Advisory Committee in a recent Report to the Minister of Health that the early reinstatement of the rural builder is a matter of urgency and importance.

33. It is possible, however, that advances in building technique involving manufacture in factories of parts of buildings for assembly on the site will be or already are so great that this will become a normal way of providing farm buildings. Manufacture, as distinct from local construction, implies and requires standardization of buildings in essential dimensions; the "unique" buildings locally designed and erected can make only limited use of the services of the factory. The Committee regards standardization, within limits, as practicable; and feels therefore there is no reason why factories in normal times should not supply at least parts of a substantial number of new buildings, provided that the standard buildings satisfy the criteria laid down for good farm buildings, that they are readily available, and at least as cheap as buildings made by local builders.

34. The Ministry of Works has had very great experience in mass production of single-storey buildings during the war. The steps taken by that Ministry were:

- a. Selection of a small number of sizes of building to meet certain purposes.
- b. Wide use of a system of framed construction ("post and panel").
- c. Mass production of frames.

35. The dimensions of buildings produced on this system will depend on the design and dimensions of the frame units, and on the spacing of the posts. In the opinion of the Committee the most useful span on larger farms would be about 21 ft.;¹ buildings of this depth are suitable for all ordinary purposes, with the exception of the double-range cowhouse. Some buildings certainly need not be so deep as this—for example, a satisfactory stable can be 18 ft. 6 in., or even less in some circumstances. If, however, mass-produced buildings are to be of real service to the farmer he must be willing to accept buildings of standard size, and must not insist on minimum dimensions for specific purposes. Moreover, he will then ensure the benefit of adaptability. Special buildings will still be required on particular farms (for instance, for corn-driers), but they would not be sufficiently numerous to warrant mass production. Such special buildings can often be provided by adaptation of barns.

Some mass producers insist that to make prefabricated farm buildings cheap, there must be only one combination of width and height. By some on the farming side, this is regarded as impracticable. Theoretically, a building of say 35 ft. span could, when desired, be divided by a longitudinal partition, so providing, for instance, an implement shed on one side and boxes or other housing for stock

¹ For some methods of prefabrication and to ensure interchangeability of parts, it may be desirable to have numerical relationship between the selected spans and the spacing of posts, which should be not less than 12 ft. apart.

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on the other. There are, however, important practical doubts about such a plan:

- a. With a 35 ft. span, height at the ridge would have to be some 18 ft., which is excessive for many farm buildings.
- b. The milking shed, milk room, and other dairy rooms would have to be walled up to the roof to conform with public regulations for milk production. To have internal walls 18 ft. high would be unnecessary and expensive.
- c. Loose boxes or stables would similarly be 18 ft. at one end, which would not only be wasteful of walling and space, but exceedingly cold. It might be proposed in the case of loose boxes not to carry the walls up to the ridge, but this would involve draughtiness.
- d. To have boxes for foaling, calving, and other purposes, or a milking shed where cows fed while milking, separated by a light internal wall from other sheds where tractors might misfire or heavy implements were moved, might be seriously upsetting to livestock.
- e. In some cases configuration of the ground precludes economic use of spans as wide as 35 ft.

In the light of these doubts the following principles appear worth consideration on the question of width of standard mass produced buildings:

- i. If standard buildings are to be employed for all the buildings of the farm, the aforementioned difficulties point to the desirability of a span of some 16 ft. (one model) or of some 21 ft. (another model), so that a single line of buildings may be used instead of two lines separated by an internal wall and under the same roof.
 - ii. If standard buildings are employed under the arrangement of a single erection serving a number of different storage purposes, a wide span, say 35 ft., has the great advantages of cheaper roof trusses and a big sweep of floor unobstructed by roof supports.
 - iii. The aforementioned difficulties may be avoided and the advantages of wide span secured by using 16 ft. (about), *i.e.* single row buildings, for livestock, and 35 ft. (about) for all other purposes—fertilizers, grain, implements, etc. Few farms will require, or be able to afford, complete sets of new buildings after the war, but replacement of derelict or unsuitable buildings must be effected during the next decade or so on most of the farms of the country. It may often be wise instead of replacing buildings one by one, *e.g.* first an implement shed, then a fertilizer store . . . to put up a suitable length of wide (say 35 ft.) span for storing a variety of things, adding to this length as time goes on.
36. While about 21 ft.¹ is regarded as a suitable span for all buildings on larger farms except the cowhouse, it must be remembered that small farms are much more numerous and possibly in even greater need of new buildings. It is important on small farms to avoid capital cost disproportionate to the value of the annual output. Often, too, a smaller building than the 21 ft. span will be useful on large farms. The Committee, after lengthy consideration, has come to the conclusion that buildings of about 16 ft.¹ span should be considered for mass production in addition to the larger building suggested in the earlier paragraph. These two sizes can satisfy all normal requirements, other than special buildings, double-range cowhouses, and covered yards. If the range of sizes can be increased, a still larger building with a 28 ft. or 33 ft. span should be added.

¹ See footnote on page 17.

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37. In regard to the spacing of posts, wide openings into farm buildings are often required. The Committee therefore recommends that posts should be 12 ft. apart.

38. The standard height should be 8 ft. to the wall-plate for most purposes, although we find that in the opinion of some a greater height is desirable in buildings for dairy cows.

39. To sum up, the Committee recommends that steps should be taken at once by the Ministry of Agriculture to discuss with manufacturers the mass production of standard framed buildings of the following suggested dimensions:

SPAN	FLOOR TO WALL-PLATE	UNIT OF LENGTH
ft.	ft.	ft.
16	8	12
21	8	12
28 or 33	8	12

We are prepared to put forward ideas for examination if this consultation takes place but feel it would be premature to record them here. It is important to observe that the layouts and designs for individual buildings, in Part II of this Report, conform or could easily be made to conform to this range of cross-sectional dimensions.

40. At the same time, in order to assist manufacturers to make their plans, the Ministry of Agriculture should make an estimate of the number of buildings of this kind which can reasonably be expected to be required during the first 3 years of peace. It is possibly desirable that the Ministry itself should supervise the distribution of new buildings, in order to ensure that they are erected where they are most needed and we recommend consideration of this idea.

41. In examining the probable scope for prefabricated buildings or components for farm purposes, the problem of their carriage from factory to farm may be important. Large deliveries of a limited range of material from a factory to a big new housing estate may be less costly than separate despatches to farms widely scattered over the country, some remote and with poor road access.

The erection on the farm of mass-produced buildings might, at any rate in the immediate post-war period, normally have to be done by the farmer and his men, under the supervision of the local builder. Ease of erection is therefore an essential characteristic.

42. The Committee has carefully looked into the possibility of mass production of primary components, including not only members of frames or trusses but also rafters, purlins, and other components needed for repairs and alterations to existing buildings. A number of ideas have been put forward for prefabricated substitutes for such repair purposes as would be met by use of timber if that were available. It has been concluded that no development of these kinds is likely to be possible, however. The relatively small number of primary units of each kind and size would not justify production and stocking of supplies; material would be heavy and in some cases liable to fracture in transport; and in the case of reinforced concrete, it would usually be cheaper to cast or form the members on the spot.

43. On the other hand, if there is a shortage of timber in the post-war period, it can be expected that there will be an increased demand for roof trusses and similar parts made of other materials such as steel or reinforced concrete, for

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repairs and alterations to buildings. For the reasons given above such parts would generally be "made to measure" either on the farm in the case of concrete or in a factory or workshop in the case of steel. It may therefore be advisable for the Ministry to discuss the matter with manufacturing interests.

BUILDING MATERIALS

44. Farm buildings can be divided into two broad categories—those which house livestock, and those used for storage. The former should be reasonably warm and not liable to sudden changes of temperature, while the latter need only be dry and weatherproof. Materials for stock buildings should therefore be chosen with a view to the maintenance of a stable temperature. It is desirable, however, that even buildings designed for storage should be soundly constructed so that they may be converted, if necessary, for the housing of livestock. The walls of all buildings should be capable of resisting blows and pressure up to a height of at least 4 ft. 6 in. A damp-proof course is always essential if pervious materials are used for walls.

WALLS

45. *Brickwork* in the form of solid load-bearing walls is likely to retain its popularity. Generally speaking, 9-in. solid walls, strengthened by such piers as may be necessary under the by-laws, will meet all requirements. Where piers are needed they should be placed on the exterior of the buildings, but, wherever possible, piers and unnecessary breaks and projections in wall surfaces should be avoided. Reinforcement of brickwork may sometimes render piers unnecessary, but expert advice must be sought in each case.

Where farm buildings are to be erected in very exposed positions, or where the bricks used are unusually porous, it may be desirable to construct walls on the cavity system.

External rendering is another valuable means of increasing the weather-resisting qualities of walling. Portland cement, lime and sand, with or without the addition of pebbles to the mixture, and the many cement finishes now on the market are suitable for this purpose. A finish of this kind will often provide opportunity to give the building a colour harmonizing with its surroundings.

In framed structures, brickwork used for filling in the panels should be bonded into the steel stanchions or concrete piers.

46. *Stone*. This will continue to be one of the best materials for walls of farm buildings in districts where it is cheaply available and its use is familiar.

47. *Concrete*. Apart from its usual well-known uses in foundations, solid walls, lintels, etc., concrete is now used in the form of many types of precast blocks—solid, hollow, vibrated, or cellular—manufactured in dimensions which are usually a multiple of brick sizes. They may be used for load-carrying walls and their thermal insulation value is about equal to brickwork of the same thickness. Cellular concrete blocks have higher thermal insulating qualities than the other types mentioned. They may be used as the inner lining of cavity walls in conjunction with brickwork for panel filling, in framed construction or ordinary walling. Cellular and lightweight concrete are important developments, and one type (foamed slag) has been used successfully on at least one farm.

48. *Sheeting*. Various forms of sheeting are available for use in framed structures. Most of them are in a wide range of standard sizes and colours, and are easy to cut, but they suffer from the disadvantage that they are likely to be damaged

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on impact and for this reason when used for walls should not be taken down to the floor level, but built above a solid base or plinth at least 4 ft. 6 in. high. There are three main types:

- a. Those for internal use, such as wall boards of the less dense kinds, plaster board or asbestos-cement sheets which may be used for ceilings, and certain plywoods.
- b. Those for external use, such as flat, corrugated, or channelled asbestos cement, corrugated iron (galvanized, painted or both), protected metals, certain types of resin bonded plywoods or wall boards, weather boarding, tiling or slating.
- c. Combinations of (a) and (b), such as tiles or slates with an internal lining, or double or treble asbestos-cement sheeting. These provide both external and internal faces and some thermal insulation resulting from the air space between the components.

49. *Internal finishes to walls.* A smooth and unbroken surface is necessary in such buildings as the cowhouse and dairy and other stock buildings; it is also desirable in food and grain storage buildings where cracks and crevices may harbour insect and other pests.

In most cases brickwork or concrete jointed to a regular face and colour washed is adequate, while the addition of a smooth impervious rendered dado, to a height of 4 ft. 6 in. and coved at the floor, provides a clean finish to walls of buildings housing livestock.

Condensation can be minimized by adequate ventilation.

ROOFS

50. For structures erected in the traditional manner, roofs covered with plain tiles, pantiles, or slates may be desirable to conform with local custom.

Cedar shingles properly laid form a satisfactory roof covering.

Various types of corrugated sheetings and protected metal sheetings are more economical and, of these, forms of double sheeting are preferable for their insulating qualities in buildings housing stock.

It will be appreciated that, while sheeting requires the support of trusses and purlins only, tiles and slates require a heavier structure including rafters and battens, and an internal lining may be necessary in buildings erected for the housing of livestock and for the dairy.

FLOORS

51. Cement concrete is now generally used for floors and foundations in farm buildings. Concrete floors in all cases should be laid upon a bed of good hardcore, particularly on heavy soils. They should not be thicker than is warranted by their purpose, because of the tendency of concrete to sweat.

In buildings for the housing of livestock, floors should be insulated. This is often done by laying hollow terra-cotta blocks or land tiles between the concrete and the hardcore, but the open ends of the rows of blocks or tiles should be sealed. Insulation of floors is especially important for pigs (see Chapter 11). Stable floors must resist especially heavy wear, and their treatment is described in Chapter 10. The floors of cowsheds again have special requirements which are dealt with in detail in Chapter 9. Some form of surface finish is usually desirable either for hardening or to form a good foothold, or both; and a finish of this kind is preferred to grooving. Granolithic is a satisfactory floor finish as it is hard-wearing and can be left either smooth or slightly roughened.

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FRAMED STRUCTURES

52. Framed structures of steel, reinforced concrete and timber may (as described in paragraphs 32-43) form the structural basis of mass produced buildings, components being made in the factory or workshop ready for assembly on the site and clothed with such materials as may be suitable and available.

a. *Steel* is a well-tried material, components being easily erected. Careful painting both before and after erection and at regular intervals is essential to avoid rusting and corrosion, which is most severe where steel is exposed to sea-air or industrial fumes. Ammonia, as in the air of livestock buildings, will also encourage corrosion of unpainted steel. The effect of corrosion may become serious in a few years if very light, thin components are used, unless the steel is adequately protected.

In covered yards and Dutch barns stanchion bases should be encased in concrete up to a height of say 1 ft. 6 in. and flanchied off. In this way the base is protected from ground moisture and the casing may act as a spur or bollard to prevent damage from hubs of wheels. If there is no fear of damage from this cause a height of 9 in. is sufficient.

b. *Reinforced Concrete*. Many firms are now specializing in the manufacture of precast concrete units for the framework of farm buildings. This material is not so flexible as steel and except for small spans the members tend to become unduly heavy, necessitating special tackle, careful handling and much skill and experience in their erection. The limit of spans for which precast reinforced concrete units can conveniently be used is approximately 35 ft.

For wider spans and exceptional stresses reinforced concrete poured *in situ* is better, but it must be both designed and erected by specialists.

c. *Timber*, although likely to be scarce for some time, will probably retain its popularity for roof trusses and members over smaller spans particularly for adaptation of buildings.

Timber has the advantage that it is easily handled, and it seems likely therefore that if supplies are available, it will continue to be used for such buildings as cattle yards and implement sheds. It must be remembered that the cost of maintenance of timber structures is comparatively high.

In these cases, supporting posts should be raised from the ground on concrete stools. If soft woods are used, they should be preserved against rot by creosoting under pressure.

d. *Asbestos Cement*. Owing to the scarcity of timber and steel, roof trusses of tubular asbestos cement have been evolved during the war, and it is possible that this form of construction may be developed further to serve post-war needs. Trusses have been constructed for spans up to 30 ft., and they are usually spaced at 10 ft. centres.

For cattle yards, columns of tubular asbestos cement filled with concrete provide clean and satisfactory support for any form of roof truss. For attachment of the roof structure a special member designed for the purpose must be made.

e. It seems possible that, in the future, other materials suitable for framed structures such as light alloys or laminated wood may become available, but, as yet, little information on the subject can be put forward with any assurance.

SOME RECENT PREFABRICATED TYPES

53. Considerable research is now being made by various firms on the question of prefabrication generally, but little information is yet available on post-war possibilities. Certain prefabricated sectional buildings are however available. These

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have been prepared to meet wartime needs; the following types may be found useful on the farm:

- a. The Ministry of Works has experimented with and produced various types of huts, some of which might prove sufficiently substantial for farm use. Generally speaking, those which consist of reinforced concrete frames (with wall panels of brickwork or concrete blocks and with roofs covered with asbestos-cement sheeting) are the most suitable. It may not be practicable to take down and move huts already erected, but unused components may be available.
- b. Asbestos-cement huts 18 ft. in span and semi-circular in section or of cranked trough units are now made. These huts can be made of any length. The lack of height against the outer wall limits their usefulness unless they are raised on a plinth. Another disadvantage is that the sheets of which the huts are built up are very difficult to replace if fractured. If the building is placed on a brick plinth the sheets are not so liable to fracture.

The ends of both types of hut can be filled in with brickwork, hollow terra-cotta or concrete blocks, weather boarding, or in fact any available materials.

- c. A structure of reinforced concrete units has been designed for use on the farm. This gives a span of approximately 20 ft. in which centre posts are erected at 10 ft. 6 in. centres in either direction, and on these are placed concrete rafters and purlins. The rafters and purlins are standard units which are interchangeable, and are of such a weight that they can be lifted by one man. The roof is covered with asbestos-cement sheets and the wall panels between the posts can be of brickwork, concrete blocks, or concrete *in situ*. The wall panels can also be filled in with asbestos-cement sheets, but owing to the risk of fracture, it is advisable for the lower portions of the walls, say for a height of 4 ft. 6 in., to be of concrete or brickwork. Huts with very low pitched or flat roofs are not recommended for the housing of livestock but would be useful for storage.

RECENT METHODS OF CONSTRUCTION

54. Experiments have been carried out during the war with a number of novel and ingenious methods of construction, though rarely for farm buildings. The evidence in our possession does not enable us to make recommendations as to these methods for farm buildings, but as we have stressed elsewhere, it is of the utmost importance that the proposed Advisory Service should keep a careful watch on new developments in building technique, however revolutionary they appear, and should experiment with those which may be useful to agriculture.

WATER SUPPLY AND FITTINGS

55. The following general notes may be found useful; detailed information on wells, pumps, and other aspects of water supply will be found in Post-War Building Studies No. 9, *Mechanical Installations*, published by His Majesty's Stationery Office for the Ministry of Works, which includes a section on farm water supplies.

56. For all the uses of water on the farm it is now necessary to provide much more abundant supplies than formerly sufficed. With increased milk production and improvement in its cleanliness the importance of water supply for farm buildings will steadily grow, while for the development of ley farming and for more efficient grazing, constant water supply to fields will be a prime necessity. When planning a water installation to a farm or to a building, or arranging an alteration

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in water supply, the first step is to estimate daily needs. This is particularly important where milk is produced and a daily allowance of about 30 gallons a cow in milk is customarily accepted as an average need. In these notes some essential points are briefly dealt with, but when an installation is to be arranged, competent advice should always be taken.

SOURCES OF SUPPLY

57. The common sources of water supply on farms and some of their characteristics are now set out:

- a. *Public mains.* This is usually the best supply, for the water is dependable in quality and also under pressure. In rare instances the temperature of main water in some months may be too high for milk cooling. The difficulty is best met by underground storage tanks from which the cooling water can be drawn. Whenever main supplies are to be laid on, the Company's recommendation should be followed as to type and diameter of pipe and other circumstances.
- b. *Wells.* These should be at a safe remove from any source of contamination. Method of construction varies with local conditions, but the upper part of the well should always be impervious to surface water and the mouth should be raised well above the level of the surrounding ground. Whether a bored well or a more shallow dug well is preferable depends on the depth of the water-bearing stratum and other circumstances. Bored wells are naturally less liable to surface pollution.
- c. *Springs.* Water from springs may be conveyed direct by gravity or by first pumping to elevated tanks or to reservoirs on high ground.
- d. *Conservation of roof water.* This requires specially constructed tanks, for the installation of which competent advice should be sought. The tanks should be underground, well ventilated, and with suitable arrangements for filtering the water as it enters the tanks. Rain should be conveyed from roofs to the tanks by iron, glazed stoneware, or asbestos pipes, and as a precaution against contamination all underground pipes should be set in concrete. The rain-water down pipes should discharge into bends connected direct to the underground pipes, not discharging into gulleys.
- e. *Hydraulic rams.* Where there is a suitable supply of water in a low part of the farm, such as a spring or brook, it can frequently be pumped to higher ground by a ram. Rams may be single action, in which a portion of the driving water is forced to a pre-determined position. The amount of water raised depends on the working fall and the height above the ram to which the water is to be raised. Rams are capable of adjustment to work with any quantity of driving water from their maximum capacity to about half of it. In the second type of ram impure water can be used as motive power, forcing the purer water to the point where it is to be used. Once installed, hydraulic rams are trouble-free and require very little maintenance.

WATER PIPES

58. Pipes are an important feature of water supply. Their material and diameter must be suitably related to the pressure and nature of the supply and to water consumption. They should never be laid in the ground at less than 18 in. of cover and the commonest practice is to have mains at 3 ft. with branches at 2 ft. depth. Considerations which govern depth include:

- i. Frost damage.
- ii. Liability to fracture by heavy traffic.
- iii. Danger of injury from deep cultivations where pipes run through fields.

It is expensive to re-lay pipes and consequently advisable to ensure adequate

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diameter, bearing in mind possible future extensions. Stop-cocks to troughs and at all draw-off points are desirable to enable alterations and minor repairs, such as washer renewals, without disturbing the working of the rest of the system. Exposed pipes should be suitably lagged for frost protection. The best method is by lagging the pipes in hair felt with a hessian backing and binding this round with rot-proof string or copper wire; or the pipes may be cased in wood with a filling of slag wool, hay, or straw. Various proprietary materials are also available, the most convenient being cork or magnesia sectional insulation. This latter is made in two semicircular sections with varying diameters for different sizes of pipes, these being secured to the pipes with metal clips. For external pipes the lagging is usually coated with bituminous solution. All piping within buildings should be on the surface and readily accessible. It should never be laid under floors.

59. Pipes for farm-water systems may be of wrought-iron, steel, or asbestos-cement. Advantages claimed for asbestos-cement pipes are freedom from incrustation and corrosion, giving a long life with full efficiency. These pipes may be drilled and tapped or cut with a hack-saw. The joints are slightly flexible which enables the piping to withstand a certain amount of vibration and to be laid to curves of easy radius. Asbestos-cement pipes are satisfactory when properly laid. It is essential that they should be evenly bedded and the refilling of the trench should be done carefully. If the ground is not suitable a bed of sand should be provided in the bottom of the trench.

60. In soils free from rock or large stones and particularly in clays, wrought-iron or steel pipes may be laid expeditiously with the mole plough. Details of procedure have been described in the Journal of the Ministry of Agriculture for September 1942. The depth at which pipes can be laid by this method is limited to the maximum depth of the mole, and heavy-weight pipes should be used to avoid risk of fracture. A mechanical trencher is said to do the job more cheaply than the mole-plough.

PUMPS

61. Pumps for use in water supply vary according to the depth of the water below the surface and the height to which it is to be forced. In some cases an additional booster may be necessary, and competent advice should be obtained whenever pumps other than the simplest have to be installed. Instead of using an elevated reservoir it is possible to pump into a pressure cylinder.

62. Pumps may be driven by petrol or heavy oil engines, by electric motor, or by wind power. Windmills render good service for farms of medium size not having specially heavy water demands. As their action is intermittent, ample storage accommodation must be provided to allow for calm days (an allowance of four to seven days' supply is customarily made). Modern pumping windmills have an automatic cut-out which acts when the wind reaches gale force.

DRINKING TROUGHS

63. Drinking troughs for stock may be of galvanized iron, concrete, or asbestos-cement.

a. *Galvanized iron troughs* are convenient when there is a possibility of their having to be moved periodically. They should be of heavy gauge with beaded edges and galvanized after manufacture. Those with a separate ball valve compartment are convenient. They can be obtained with the compartment at the end or in the centre when the troughs are long or are serving two fields.

b. *Concrete troughs* have, during the war period, largely superseded galvanized iron troughs, and when well made are very satisfactory. The only drawback is that they are heavy to transport, but once fixed are not so liable to be shifted by

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stock. Concrete troughs should taper from top to bottom as this reduces the danger of damage to the troughs in the event of severe frosts. It enables the expanding ice to rise in the trough.

c. *Asbestos-cement troughs* have been largely used and with success during the war period. They should be securely fixed to prevent them being moved by stock. They are easier to handle than concrete troughs, but more liable to fracture through rough usage. They should be provided with suitable guard rails and if placed on the ground have a suitable concrete foundation.

64. Few cattle troughs are provided with a draining plug, but this is a desirable feature enabling the troughs to be easily drained and cleaned.

Concrete or hardcore aprons, where the subsoil justifies such precautions, are desirable round all open-air troughs. They should slope from the troughs and be about 6 ft. wide. The position of troughs, taps, etc., is a matter which must be determined on the individual farm.

Troughs and other drinking appliances in buildings are dealt with in the Chapters of Part II.

CHAPTER 4

ACCOMMODATION FOR LIVESTOCK

65. Basic principles for farm buildings of all kinds have been dealt with in Chapter 2. The application of some of these is particularly important and intricate where accommodation for livestock is concerned. In the Chapters of Part II on the various kinds of farm buildings full constructional detail is given with short notes on their characteristics. In deciding on the necessity for and the design of any building for livestock, it is, however, essential that study of detail should be infused by an understanding of general principles, and the purpose of this present Chapter is to examine principles specially connected with accommodation for livestock.

66. For many centuries the barn was the chief farm building, apart from the dwelling house, and the most costly. As the livestock of the country increased, their housing became steadily more important. During the past forty years there has been a rapid expansion of milk production, with a rise in hygienic requirements, while in the same period corn harvesting machinery has made the old style corn barn unnecessary. Through these and other changes accommodation for livestock has come to represent now a very substantial fraction of the total capital value of the buildings on typical British homesteads. And it is not only because of initial outlay that buildings for livestock require special attention, for they have a direct influence on working costs. All housed livestock require some attention every day of the year, and the laboriousness or ease of this may be considerably affected by the building. Moreover even for well-bred stock, well-fed, growth and production may be restricted by unsuitable housing.

67. Although they are dealt with for the several classes of stock in the Chapters of Part II, the general requirements in livestock housing may now be stated, thus:

a. *Comfort.*

Adequate floor space.

A warm bed.

Ample trough room.

Good drainage.

Adequate fresh air with freedom from draught.

Freedom from vermin.

Freedom from projections (on which an excited animal might injure itself).

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b. *Working convenience.*

Food supplies close by and approached under cover.

Feeding (for pens, boxes or yards) *from outside.*

Doorways and approaches concreted or on firm ground.

Water laid on.

Good lighting by day and night.

Easy access for carts—draw-in if possible—in order to minimize handling of fodder and manure.

c. *Animal health.*

Facilities for cleaning and for disinfection when needed.

Ample boxes for sickness and parturition, and very young animals.

68. Although practice in housing the different classes of stock during rearing and in later life varies a good deal with locality, there are certain generally prevalent attitudes towards it by which ideas about buildings are primarily determined.

Many milk producers still feel that except when the weather is really warm and grazing is plentiful, their cows should be inside, provided there is enough accommodation and feed. This feeling becomes so strong in cold weather that on a great many farms the milking herd is closely shut in for six months or more on end. Where the cowhouse is commodious and can be kept clean, or where yards are available for a daily outing, there may be little to say against this confinement. But many cowhouses are crowded, low-roofed, dark, with wholly inadequate windows, doors, and other means of ventilation. Moreover, in fear of the possible ill-effects of draughts and cold air, ventilation is rigorously prevented and in many districts the foetid, clammy atmosphere of the cowhouse in winter is familiarly characteristic. Pigs, also, are often kept in close confinement at all ages. With horses there is less solicitude as to protection from colds and draughts, though the natural hardiness of the horse is recognized much more in the practice of some parts of the country than of others.

It is true that on many holdings the method of housing stock is primarily determined not by the farmer's views but by the buildings of which he finds himself in occupation, their design possibly reflecting the outlook of a century or even more ago. There is, nevertheless, a widely prevalent fear of the danger of too much fresh air for livestock.

69. A great alteration in outlook on housing livestock is, however, beginning to set in, presaged, it may be, by the changes the twentieth century has brought in belief and practice concerning light and ventilation in human dwellings. Or it may be that lessons have been learned from the improved health of captive animals in zoological gardens, where free range and fresh air have partly displaced the confined, sheltered cage. Scientific insistence on the importance of ample air space and good ventilation for the control of tuberculosis has had much to do with the changing attitude to housing of stock on farms.

A reply by a farmer to a question about housing for horses shows how firmly the belief in outdoor treatment may be held. His widespread fame for successful farming is matched by his reputation for judgment and all-round ability with horses, and his opinion was sought as to horse yards versus stables. It was "Why bother about either? All my horses have lived out for the last 15 years."

70. Saving of labour and other aims not primarily connected with health have led to the development of a number of open air forms of accommodation. Important examples are folded poultry units, outdoor farrowing huts for pigs and the movable bail for dairy cows. Systems of this kind, beside cutting down labour, are claimed to promote the health of stock and limit danger from internal parasites. Their use also may notably improve grassland. It is to be expected that movable units will in the next ten years or so make rapid progress, and the possibility of

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using them should always be considered when restoration or replacement of old fixed buildings for stock has to be faced.

71. The outstanding question in magnitude and urgency in this tendency to the open type of accommodation for stock is the greater use of yards, covered, with a shelter, or completely open. Wide inquiry has convinced us that in this are important possibilities to which wholly inadequate attention is being given. They concern cattle, horses, and pigs. Yarding of all these classes of stock is no new development. In the Eastern Counties especially, horse yards and store and fattening yards for pigs are well known, while yards and a small relay milking shed for cows are now being tried in many localities.

72. Climatic circumstances, in the north and north-west, are certain to make the use of yards less successful and widespread than in the east and the south but equally certain not to preclude a wider use than is now customary. Rainfall rather than temperature limits the use of open and even covered yards, for two reasons. With abundant rain, adequate shelter for beasts is necessary; and secondly, corn growing tends to be limited to oats which seldom ripen fully and are fed with the straw (after chaffing). In such circumstances there is not, as in drier wheat and barley areas, an abundance of straw for litter. If yards should be used they must have concrete floors and these may be necessary even in implement sheds for which, in drier areas, an earth floor is often satisfactory. If there are no yards the layout of farm buildings in a [] or other shape to provide a central wind-protected area (cf. Chapter 6, paragraph 115) is not of importance. These effects of rainfall on farm buildings, including yards, are plainly shown in Wales where much of the farming is done with a rainfall of 50 inches a year or more, and most of it with not less than 40 inches, and yards are rare.

73. Yarding requires ample straw which is, and is likely to remain, available in most areas of the east and south. With the war-time restoration of land to the plough in all parts of the country, straw is at present plentiful in many other localities and will continue to be in measure as mixed farming retains its place in post-war agriculture.

74. An important ground of advocacy for yards for dairy cows and their followers—our predominant class of stock—is that the full value of animal excrement, both mineral and organic constituents, can be conserved, whereas with ordinary housing it is largely dissipated. The urine can be conserved by liquid manure tanks, though these are not only costly to instal but also laborious to work.

75. In addition to conservation of excrement, there must be considered the question of the suitable returning of straw to the land for the maintenance of soil fertility. The part that farmyard manure has traditionally played in maintaining soil fertility on farms where substantial amounts of corn were grown must not prevent critical consideration of other possible ways of returning straw to the land. Interesting examples now under practical trial are: heavily strawing land folded with sheep; strawing a ley due for ploughing up and either working a movable bail across it or sprinkling with sulphate of ammonia and ploughing in during the spring; direct ploughing in of straw left by the combine and later spread or chopped. The stimulus to development of this kind is avoidance of the heavy labour of carting muck from yards and spreading it on the land, but here a countervailing possibility must be considered. Ingenious methods are being tried for using a bulldozer or some type of dragline equipment for clearing yards. It will be some time before the possibilities of mechanical aids of this kind can be assessed, but meanwhile it is important to note that their employment will require either specially wide gates for yards or removable side fences. On balance of circumstances yards mechanically cleared may prove the best way of dealing with straw in some areas, while its return to the soil without conversion to muck may prove better

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in others. Mechanical yard clearing should be a subject for the experiments recommended in Chapter 5, paragraph 85.

76. The yard and relay milking shed for dairy cows are fully discussed in Chapter 9; in Chapter 11, yarding for pigs is dealt with; and Chapter 10 discusses horse yards as an alternative to stables.

77. Advocates of yards in suitable displacement of closed housing urge the following advantages which should be carefully considered when accommodation for livestock, especially dairy cows, has to be provided or increased:

- a. Less initial capital outlay.
- b. For the immediate after-war period, less difficulty in obtaining necessary material and skilled labour.
- c. The most effective way yet found for conserving animal excrement and for restoring straw to the land, the laboriousness of which promises to be greatly reduced by mechanical aid.
- d. Greater comfort and health of stock, especially through avoidance of pulmonary diseases.
- e. For dairy cows, the full ensurance of hygienic conditions at less initial cost and with less daily labour than in normal cow standings.
- f. Convenience for feeding bulky fodder and roots (plenty of room for mangers and easy access to them compared with a cowhouse).

78. Cases abound in which heavy expenditure has been incurred by the addition to farm premises of a building to serve the needs of the sitting tenant and which, on a change of tenancy or production policy, has become unwanted for its destined purpose and has proved of little use for any other. In most of these cases the building is a cowhouse or a large pighouse. It should be the invariable aim in future planning of farm buildings to provide against such happenings by every possible ensurance of adaptability, and in the chapters in Part II on the several kinds of farm building, this matter is attended to. We repeat our conviction that the characteristic adaptability of yards is an asset which should be most thoroughly weighed when fresh building for stock is being planned.

79. It is frequently asserted that for the proper feeding of the people of this country our dairy herds must be increased by not less than one million cows with necessary followers. In the three to ten years following the end of hostilities it may be less difficult to increase the cow population than the accommodation for them. So long as dwelling houses have high priority in building, materials and labour, farm buildings may have to depend on improvisation. In the steps necessary for improvisation with which Chapter 20 deals, the preponderating requirement will arise from accommodation for more livestock.

80. The erection and management of accommodation for livestock, especially cows, has for many years been subject to well-intentioned official regulations. In some respects, *e.g.* requirements as to ventilation of cow sheds, these regulations have been based on insufficient knowledge, and since they have been applied throughout the country with a marked lack of uniformity the results have often been unsatisfactory, and at times exasperating. Recent legislation will no doubt enable greater uniformity throughout the country, but only advance in fundamental knowledge of animal health and production hygiene in relation to environment can cope with the real difficulties. This knowledge must not be left to flow slowly from practical experience but must be sought by continuing experiment. As it is gained, it must be applied with enlightenment, the decisive test of livestock accommodation being recognized as the health of the beast and the hygienic condition of what it yields.

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81. In the best grass feeding areas, it was formerly the custom to provide a "hovel" or open shed in many of the fields. This was regarded as essential to the well-being of cattle, whether store or fattening, since it gave opportunity for shelter from wind and rain in winter, and coolness, with protection from flies, in summer. Many of the old hovels, in brick and tile or slate roofed, are now in very bad order. Extension of ley farming will bring many new fields into grazing and thus both repairs to old hovels and erection of new ones may be required. Suitable dimensions and designs would be similar to those for the shelter buildings in open yards (see Chapter 13). Belief in the necessity for field hovels is localized, being in some places strong.

CHAPTER 5 AN ADVISORY SERVICE ON FARM BUILDINGS

82. In every country the evolution of agricultural systems has involved corresponding change in the function, design and construction of farm buildings. This change has also been promoted by influences outside agriculture such as mechanical invention, progress in the art and industry of building or alteration in communications and social conditions. The pioneers of farm building development have been landowners or agents, farmers, builders and architects, who from time to time have conceived some new idea or seized on some new possibility arising from non-agricultural activities. Such enterprise, when successful, has slowly influenced the immediate neighbourhood, and, later, other parts of the country. Some attempted new developments have been costly failures, and of these certain, at a later time and in another locality, have been repeated.

83. This history of change in farm buildings will go on, but it may be that for one or two decades the pace of change will be much faster. The chief moving forces will be: new developments in agricultural systems and farming practices, especially through mechanization; increasing knowledge of the best conditions for animal health; and progress in methods and materials in the building industry. It is the certainty of change which has led us to insist on the importance of adaptability to different uses of new and re-modelled farm buildings in Chapter 2, paragraph 15 b, and to endeavour to ensure it in all the designs and recommendations of Chapters 6 to 19.

84. In both the alteration of existing buildings and the erection of new ones individual genius and enterprise will continue, as formerly, to show itself in the farming community. But in a period of rapid, all-round change the general farming interest will not be well served unless means are taken to make widely available knowledge of new successful attempts and also warnings derived from unsuccessful attempts. The time has come, too, when new ideas should be developed not only by the enterprising individual wholly at his own risk, but by continuing experiment. It should be the aim of experiment to discover principles, for eventually it is from these that development will follow most economically and quickly. The existing lack of knowledge of principles, which experimentation alone can remove, has already been referred to in connection with factors influencing animal health and well-being in Chapter 1, paragraph 8. In Chapter 4, paragraph 75, experiments on mechanical methods of mucking out yards are recommended.

85. We recommend that provision be made as soon as possible for an Advisory Service and for experiment on farm buildings, and in the paragraphs which now follow we make suggestions for suitable measures.

AN ADVISORY SERVICE ON FARM BUILDINGS

86. An appropriate organization would be a headquarters unit in the Ministry of Agriculture for assembling and publishing information and to give advice. With this should be an advisory service on a regional basis. This regional provision should be part of the National Advisory Agricultural Service, though one Provincial Advisory Centre might be able to act in this matter for more than one province. At each responsible Advisory Centre one officer, possibly an architect not necessarily on a full-time engagement, would be required, assisted by a small voluntary advisory panel drawn from the interests concerned, namely, architects, builders, landowners and agents, and farmers.

87. Many of the problems thrown up by the work of the Advisory Service will involve matters of building technique. It is, therefore, of high importance that the Service should have full access to the technical knowledge and experience of the Ministry of Works and of the Building Research Station of the Department of Scientific and Industrial Research.

88. The matters on which information should be systematically collected and periodically disseminated include:

- a. Results from the proposed experiments.
- b. Developments initiated on farms and estates in layout, design, equipment, methods and materials of construction, and systems of working of farm buildings, with particulars of cost.
- c. Reconditioning or adaptation to new uses of existing farm buildings, with detailed accounts of successful examples.
- d. Relevant information from other countries, especially the Dominions, the United States and the continent of Europe.
- e. Procedure, materials and resources or facilities newly arising in the building and associated industries.
- f. Materials and methods for fencing, water supply to fields and buildings, roads, drainage and other matters such as sheep-dips which are not strictly farm buildings.

89. The appropriate form for the publications would probably be occasional reviews together with special accounts of particular developments as these arose.

90. A comprehensive library service, including the maintenance of a bibliography and the preparation and circulation of abstracts of published material should be an important activity of the proposed service.

91. We do not attempt at present to make proposals for the organization and the scope of the experiment on farm buildings and other equipment, such as water supply, which we have suggested, though we are fully satisfied as to the necessity for experiment and as to its practicability. It is important to distinguish between controlled experiment on farm buildings on the one hand and set trials on the other. This may be illustrated by the case of specialized pig houses frequently referred to as of the Scandinavian Type. During the past twenty-five years a considerable number of such houses have been built in this country each incorporating special ideas, arrangements and fittings. Some, though of much theoretical ingenuity in the provision for ventilation, for disinfection and daily cleaning, have failed in practice. The failure has sometimes been costly. But from all these failures has emerged no understanding of basic principles of ventilation, or comfort, or health of the pigs. Even if successful, a single trial does no more than show one successful way; it may leave the possibilities of greater success or of higher working efficiency undisclosed. From the unsuccessful trial it is by no means easy to deduce the causes of failure and what should be avoided. This kind of experience is not peculiar to farm buildings; it is well-known with factories and processing plants, including flour mills, tea factories and silos. To enable controlled experiments

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from which alone, in general, basic principles can be derived, genuinely experimental buildings are necessary, that is, alterable at will in their several characteristics.

92. In the U.S.A. there have been a number of recent and interesting farm building developments and some important experiments are in progress, one of which is a comparison of cows in tie-up houses and cows in a form of covered yard. We recommend that representatives of the proposed Advisory Service should visit certain countries in Europe, North America, and Australasia as soon as possible to study such developments.

93. When by experiment or from successful trials some new development in farm buildings is reached, it may require to be tested and demonstrated in the varying climates, circumstances and farming systems of the different parts of the country. Such distributed testing should be arranged through the Provincial Centres which have been proposed.

94. In the period immediately following the end of the present war much farm building work will have to be done. It will include deferred repairs, adaptation of old buildings to new uses and some wholly new buildings. Skilled labour and building material will be under prior claim for housing, so that for farm buildings improvisation and perhaps standardized mass production will be necessary resorts. Sheds, huts and other things may be available from camps and other war sources, and the adaptation of these to farm uses will make an Advisory Service and resourceful experimentation immediately necessary. We enter more fully into the needs of the immediate post-war future in Chapter 20.

95. We understand that it is proposed to establish a number of Husbandry Experiment Stations in various parts of the country. Some of these may require substantial alteration of existing farm buildings or even erection of completely new sets of premises. The need for adaptability to varying uses which we advocate for farm buildings is, we find, desired by agricultural experimenters and research workers in both the farm buildings and the buildings for experimental work on agricultural field stations. This adaptability is specially important in buildings for livestock.

96. In equipping the new Stations with buildings there will be a fine opportunity to gain experience and to test ideas in layout, design and structure. This opportunity, we feel, should be fully exploited and to this end the proposed headquarters unit of the Advisory Service in the Ministry of Agriculture (see paragraph 86) should have sole charge of building work on the Husbandry Experiment Stations. The prime consideration in designing farm buildings is the farm purposes to be served; design, structure and materials must subserve purpose. It is for this reason we feel it would be a mistake and a serious loss of opportunity to hand over the provision of these new buildings to another Department or to any unofficial agency.

97. It has several times been represented to the Committee that the number of architects fully acquainted with the needs of agricultural buildings is small. This is perhaps inevitable in view of the comparatively small amount of building on farms which has been carried out during the years of depression. It is believed, however, that a greater interest in farm buildings on the part of architects will lead to improvements, and the Committee is firmly of the opinion that everything possible should be done to encourage architects to interest themselves in the subject. A point which is of considerable importance, and which is dealt with more fully elsewhere in this Report, is that architects can give great help in ensuring that the planning of new farmsteads or the addition of new buildings to existing farmsteads is carried out with a minimum of damage to the appearance of the countryside.

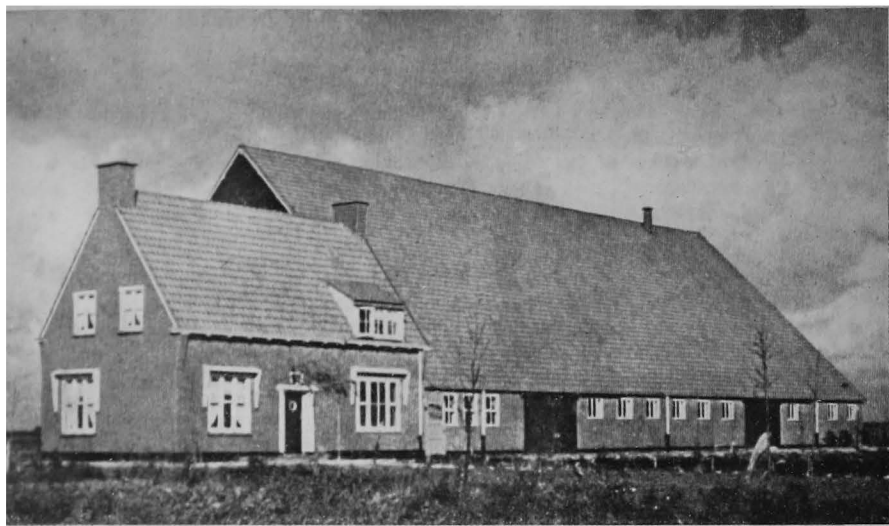


PLATE 3. THE SINGLE BUILDING IN HOLLAND

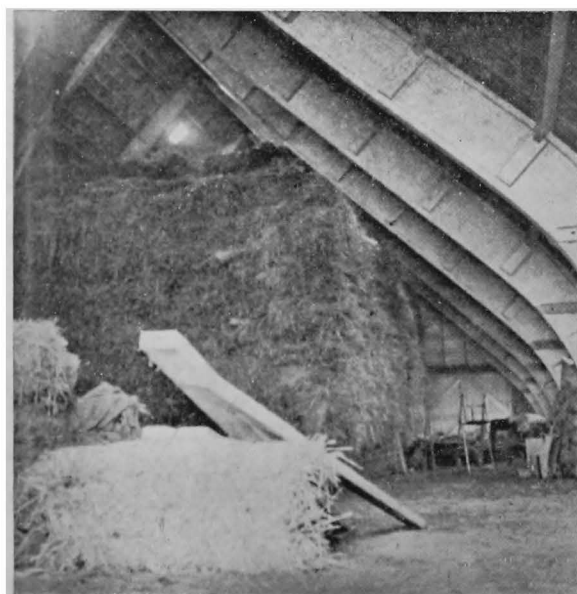


PLATE 4. INTERIOR OF
SINGLE BUILDING SHOWN ABOVE



PLATE 5. ADAPTATION OF BARN INTO MILKING SHED AND OPEN YARDS
NORTH SIDE: MILKING SHED
The new brick building is for milk storage.



PLATE 6. ADAPTATION OF BARN INTO MILKING SHED AND OPEN YARDS
SOUTH SIDE: YARDS FOR DAIRY COWS
For plan see Fig. 26.

THE LAYOUT OF THE FARMSTEAD

98. That the functions of the architect are often misunderstood or disregarded in the planning of farm buildings, has also been represented to us. This view, which we consider important, may be thus stated. Even as regards the small amount of new construction which has taken place, the special training of architects as planners has seldom been made use of; either hampering directions as to planning requirements (often repeating established faulty practices) have been given, or more frequently still, no properly qualified architect at all has been employed. In some cases where wealthy landowners have engaged architects, their services have been directed to "dressing-up," in what were conceived to be more aesthetically satisfying forms, buildings of which the layout had already been decided—a complete misconception of the true functions of an architect. What an architect requires to receive is a clear statement of the aims and uses of the buildings and the course of the operations which will be daily conducted therein. This he receives when instructed to design a factory, and the improvements in factory-design which have followed the employment of architects (at one time unusual) speak for themselves.

99. Estate Agents, whether resident or members of firms, also have a prime responsibility with architects in layout, design and structure of farm buildings. If they are to be equipped for this their training must consist in much more than design, specification and quantity survey for buildings on accepted models. They must have a good understanding of the essential functions of farm buildings and their relation to farming systems with a realization of the influence of changes in farming on building requirements.

We venture to commend these considerations to bodies responsible for the teaching of rural Estate Management at all levels. In our view a general training in building design and construction which seeks to serve the needs of both urban and rural practice can no longer be regarded as satisfactory.

PART II. LAYOUTS AND DESIGNS

CHAPTER 6

THE LAYOUT OF THE FARMSTEAD— GENERAL CONSIDERATIONS

100. A farmstead is satisfactory if it is on a suitable site, if the individual buildings are properly designed for the functions they serve, and if their grouping is properly planned. The primary objects of good planning are: health and well-being of stock; economy in labour and management; economy in prime cost and cost of maintenance.

101. It will not often happen that an entirely new farmstead is to be built, with a free choice of site. Nevertheless, it is useful to consider briefly the chief features of the ideal site because adaptations and extensions of existing farmsteads should be planned with the ideal in mind.

102. A principal aim should be to select a site which will accommodate both farmhouse and farmstead reasonably near to each other. It should be warm and open, though not exposed, and preferably should have a southerly aspect. Exposed positions and hollows should therefore be avoided. The site itself should not only be well drained, but should also allow of easy disposal of the considerable volume

FARM BUILDINGS

of farm drainage and surface water. These requirements will be met without great difficulty on level or on gently sloping land. An ideal site may be more difficult to select on hilly or undulating land, but even so, advantage may often be taken of varying levels to facilitate the loading and unloading of supplies.

103. It is most important that the site should be selected primarily by reference to the considerations mentioned briefly above, and temptation to give first importance to access to the highway and to the easy and cheap provision of services such as piped water and electricity should be resisted. The farmstead must have these services, but within reasonable limits it is often better and cheaper in the long run to choose the best site and to bring roads and services to it. The final choice must depend on the numerous circumstances of each case. The site should be so related to the land of the farm as to make for convenience in working.

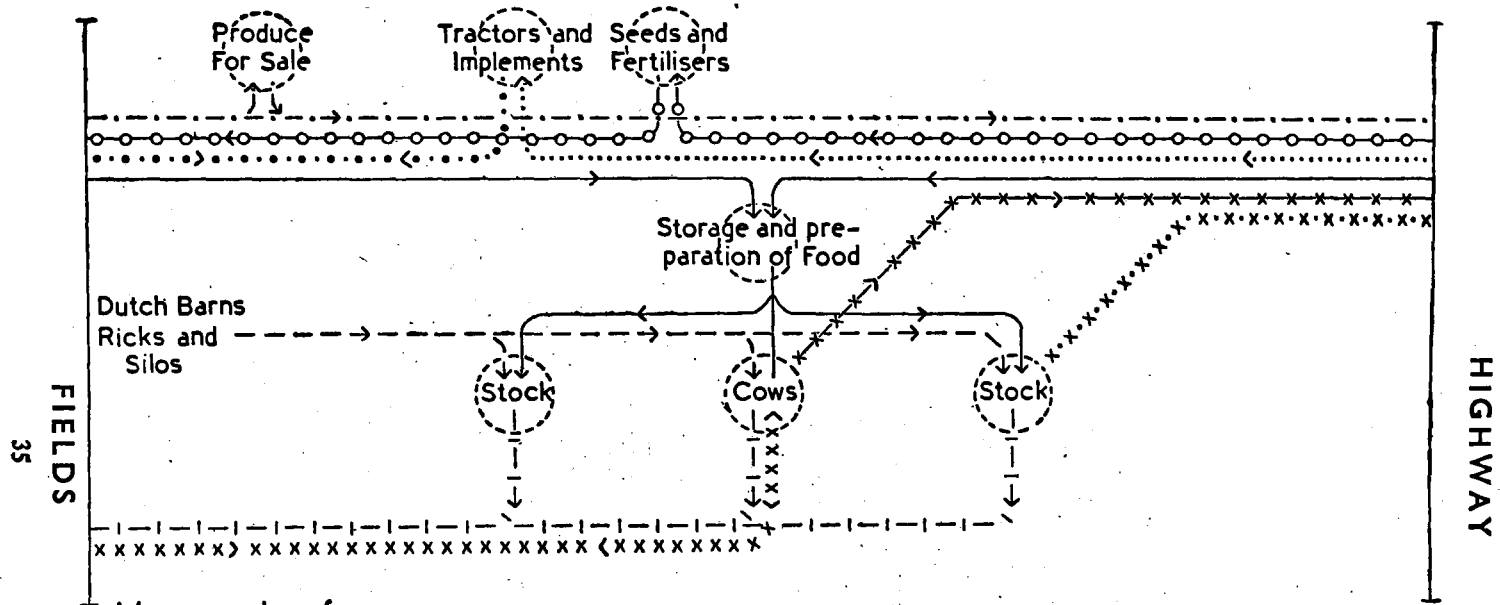
104. A suitable site having been chosen, the location of the individual buildings within the farmstead must next be considered. The over-riding consideration is that nearly all traffic on the farm begins, ends at, or passes through the farmstead. Conversion of food, whether homegrown or imported, into stock products, and conversion of straw into dung are largely concentrated there. The farmstead receives other raw materials—for example, fertilizers—which are stored until required; and it houses implements and machinery. All this makes it a place of movement, and good planning must ensure that movement is as simple and direct as possible.

105. It is therefore important that considerable study be given in each case to the kinds and volume of traffic in and around the farmstead. They will vary from farm to farm with the production policy; but precise examination of traffic requirements is fundamental to proper planning and siting, and this applies whether a complete new range or an additional building or even the adaptation of an existing building is being considered.

106. The main lines of traffic in and around the farmstead of the 250-acre mixed farm, with 24 cows in milk, have been set out in Fig. 1. Points where two or more lines begin or end have been enclosed in broken circles, but it should be emphasized that the diagram merely indicates the movements which take place, and is not a plan of a farmstead.

107. Certain general guides can be distinguished by examination of the diagram. Traffic is of two kinds: first, traffic which is directly related to the conversion by stock of raw materials into produce and, second, traffic which uses the farmstead as a convenient stopping or storage place. In the first category would come such operations as the receipt of concentrates, home produced food, straw and hay, the despatch of milk, and the return of dung to the fields; and in the second, the storage of fertilizers, seeds, and fuel and the housing of implements and tractors. Although, for example, tractors must be able to enter stock yards it is broadly true that these two kinds of traffic are virtually independent. It follows that to a certain extent buildings which cater for one kind of traffic can be sited and grouped without reference to buildings serving the other. Thus the first principle for the layout of the farmstead should be that buildings and yards accommodating live-stock, stock food, and bedding should be planned as a group; while other buildings, which will be mainly for storage can, if desired, be planned and grouped separately. The fundamental requirement is that there must be no confusion of traffic lines.

108. The diagram makes it clear, moreover, that a main access road from the highway and running through to the far side of the farmstead to the point to which there is access to the fields, can carry a great part of the traffic, including bought and home-grown foods, implements, and materials reaching the farmstead for storage. Such an arrangement keeps internal separate from external traffic, and avoids such nuisances as the arrival of a delivery or collecting truck at a time when



Movements of:-

Produce for Sale —————
 Seeds and Fertilisers ○-○-○-○-○-○
 Tractors and Implements
 Fuels Oils etc.
 Dung -|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|
 Hay and Straw -|-|-|-|-|-|-|-|-|-|-|-|-|-|-|-|

Food (home produced and purchased) _____
 Cows x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x
 Stock for Market x-x-x-x-x-x-x-x-x-x
 Milk x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x

FIG. 1. TRAFFIC IN AND AROUND THE FARMSTEAD

FARM BUILDINGS

cows are passing along the same length of road. In this there is a break from the traditional arrangement of buildings in a quadrangle enclosing the "farmyard" when the main access road frequently ended in a cul-de-sac. Such a layout is not adequate to-day when the volume of traffic passing through the farmstead is vastly increased, and for other substantial reasons. The second principle of good layout might therefore be to provide a main access road, well made and as direct in line as possible, from the highway through the farmstead and leading to the fields beyond.

109. Buildings for storage or shelter of materials, implements and tractors can be sited anywhere on or near to the main farm road, though preferably not nearer the highway than the buildings to which stock foods are delivered or from which produce such as milk is discharged. The general principle is that buildings most frequently concerned with external traffic should be sited nearer to the highway than those which cater mainly for internal traffic. Convenience, the circumstances of the site, and siting of stock buildings will indicate the precise location.

110. Traffic routes for stock, food, bedding, and animal produce must clearly be designed as a whole, except in special cases such as large-scale intensive pig-keeping which can be treated as a separate entity practically distinct from the rest of the activities in the farmstead. This traffic has six main elements: concentrated food, home-grown and imported, arriving at the point of preparation; hay, straw, and roots arriving at the point of storage; prepared food being distributed to points of consumption by stock; hay and straw being distributed to yards and stock buildings; stock arriving from and returning to fields; dung leaving for the fields or dung heap. Provision must also be made for cows going to the milking place, if this is additional to other accommodation for them; milk leaving the farmstead; and stock leaving for market or disposal in other ways.

111. It is convenient to consider first the series of movements involving the arrival and preparation of food, the distribution of prepared food, and the removal of dung. It is desirable that this final product—dung—should not return by the route taken through the farmstead by the food. Not only will this ensure smooth and simple movement, but it has the advantage that the food routes will be kept cleaner. A similar consideration indicates that stock should not arrive or leave by the same route as the food, though there is not the same objection to one route providing for traffic of stock and dung.

112. Hay and straw, which are bulky, cannot always be accommodated on routes designed for the more concentrated foods, and it is probably best to arrange that they are delivered separately. It is often desirable that they should be available from more than one point, each convenient for a yard or stock building. It is desirable that the route taken by the hay and straw should not oppose the movements of stock and dung.

113. The only point which need be noted on the movement of milk and stock for sale is that the route should be clean, and should join the main farm road nearer to the highway than the point at which food is delivered.

114. The general conclusion reached from a study of the considerations dealt with in the foregoing paragraphs is that the farmstead should be laid out on the basis of a through main farm road from which a loop road should run, re-joining it on the other side of the farmstead. Stock buildings and yards would be grouped on the island enclosed by these roads. Such an arrangement, with suitable internal traffic routes, will ensure simple and direct movement of stock and materials. Other buildings can also be placed in the island if this is convenient and there is sufficient space; otherwise they should be sited on the other side of the main farm road. Topography or existing buildings may make it impracticable, but whatever layout is finally adopted, the advantages of the island site should always be borne

THE LAYOUT OF THE FARMSTEAD

in mind. Although at first this may appear to involve a considerable outlay on roads, there can be no doubt of the necessity for a far greater provision of hard surfaces for heavy traffic than has been customary in the past.

115. The southern part of the site should, if possible, be reserved for stock yards and stock buildings leaving the northern part to be occupied by storage and other buildings. It is often convenient for the main farm road to separate the two groups. It is advisable that yards should be open to the south in order that stock may have the full benefit of the sun. At the same time it is desirable to give shelter to yards from cold winds. Where possible, therefore, yards should be flanked on the north by a continuous range of buildings, including the granary, which is a two-storeyed building. Dutch barns and ricks can also provide a windbreak but the siting should be consistent with economy in labour; they should not be placed to the south of yards, unless they are some distance away. These aspects of the location of yards and adjacent buildings are also discussed in Chapter 4, paragraph 72.

116. It is also important that the layout of the farmstead should allow for possible extensions of buildings. The traditional quadrangle, often seen, being a closed system of buildings, enables extensions of existing buildings, or additions to them, to be undertaken only at the cost of complicating the layout and the movement of stock and materials. An open south side to the farmstead therefore not only gives stock the maximum of sunshine and protection from cold winds, but also allows extensions to take place without loss of these benefits provided the south side is still kept open.

117. In deciding which should be the master principle for layout of a farmstead, primary allowance may be made for traffic and movement, for general working convenience, for low initial cost, for shelter for the yards or for some other objective depending on local situation or personal predilection. Buildings in two parallel lines with a road between or in a single line have sometimes found favour. It is wise, before deciding on any layout for an entirely new or for an altered farmstead, to visit a set of premises which conform as closely as possible to what is contemplated. This is equally the case if a unique or very unusual plan is in mind.

118. All the foregoing discussions have been concerned with the planning of new farmsteads, and it has already been stated that the number of these is expected to be comparatively small. Nevertheless the principles elucidated are of fundamental importance even in the adaptation and extension of existing buildings. Such changes, if they are to be fully satisfactory, must conform to the general system of movement in the farmstead; suitability of the building for adaptation is not enough. Moreover, the addition of a new building or the adaptation of an existing one may well provide an opportunity to improve the layout as a whole. It is strongly recommended that full attention should be given to this subject. It is desirable that for each farm there should be a block plan of the farmstead, drawn to scale and including drainage and services; and also a similar plan of the ideal towards which to work in a series of improvements and additions, spread perhaps over a considerable term of years.

119. It is appropriate in this Chapter to refer to actual systems of transporting materials in the farmstead. They are these: on tram-lines, by overhead conveyors, or in trucks, carts, or barrows. The Committee has not thought it necessary in this Report to make a detailed and comparative study of these and other possible systems, though such a study is very desirable. If, however, it is proposed to use one of the first two systems, the decision must be taken into account in the location and construction of buildings. Tram lines should be laid with the floor; an overhead system may require stronger and heavier roof members, and this may influence the construction of walls; moreover, the routes followed on these

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mechanical systems should be straight from point to point and this may affect the location or internal arrangement of buildings. In the opinion of the Committee the use of pneumatic tyres on farm vehicles has had a profound influence on the question of transport within the farmstead, and has made the use of carts, trucks, and barrows much more efficient and attractive. Conveyance of materials, from the point of view of labour saving, has been dealt with in Chapter 2, paragraphs 16 to 20.

120. The following extract from Bailey Denton's *Farm Homesteads of England*, published eighty-one years ago (1864), shows that the general principles remain very much the same and that even in those days adaptability was not left out of consideration. Though some of the recommendations need modernizing, they are quoted because of their interest.

- i. That the whole of the homestead should be within the range of the master's eye, and that as few outlets or backways as possible should be allowed for the egress of idlers.
- ii. In open-yard arrangements, all the higher buildings should, if practicable, occupy the north side or back range, in order that they may afford, by their height, the greatest amount of protection from the cold winds of the north. This rule coincides with the plan of having the granary and food-preparing chambers in a line with the threshing-barn, as they, being double-floored buildings, admit of a considerable range of high buildings in one line. The range of buildings, thus connected, should be of one uniform width. The outside width must vary according to the materials used, but the best width, measured from the internal walls, is 24 feet. This is found to admit of alterations with the least disturbance of the external shell, and it is well to anticipate a possible redivision of the buildings consequent upon improvements in machinery.
- iii. All animals thrive in the presence of sun and light in winter; stock yards should consequently have a southern aspect. In stalled buildings and boxes for fattening a means of regulating the admission of light in summer should be retained, as the fly ceases to irritate stock when light is excluded, and repose is best secured by a modified light resembling twilight.
- iv. All lateral single-storied buildings should, if possible, be made of one breadth; 20 feet, outside measurement (brickwork), is considered the best width. The advantage of a uniform width is found to consist in the capability of conversion from one purpose to another, as necessity for alteration or extension arises.
- v. As ploughman and horses are the first to move in the morning, the windows of the stable should have an eastern aspect, and the stables themselves should be as cheerful as possible. They should, moreover, be adjacent to the cart and implement sheds.
- vi. The cart shed should have a northern aspect, and the same remark applies, in a less degree, to the implement shed, as the sun's rays warp and crack the woodwork of both, but more especially of carts used for the carriage of manure, its moisture being absorbed by the wood.
- vii. In all situations much exposed to prevailing winds, it is better to lose the warmth of the sun, than to expose stock to the coldness of the wind.
- viii. Food should not be stored in lofts over stock standing in closed stalls or boxes, as the heat and effluvia is pernicious to it. This remark applies to corn, hay, and straw in varying degrees. Animals housed under lofts, particularly those containing hay and straw, are found to be more susceptible of cold than when housed under outer roofs, owing no doubt to the extra warmth and defective ventilation.

THE FARMSTEAD—SPECIMEN LAYOUTS

- ix. Cows, pigs, and poultry should be placed in convenient proximity to the house, and in proportion as the feeding stock require increased quantity of food so should they be placed nearer the buildings where it is prepared.
- x. All buildings should be spouted, and the water from the roofs should be conveyed to an underground tank, near the motive power by which it will be raised for use.
- xi. All yards, except sheep yards, should be 'dished,' and the drainage therefrom conveyed to a tank, from which it may be pumped over, and mixed with, the burnt earth and other refuse collected under a compost shed built for the purpose whenever it would be unprofitable to convey it direct to the land in its liquid form.
- xii. In all farms where circumstances render it economical to have shops for the blacksmith, wheelwright and carpenter at the homestead, a dry yard, or 'working court,' connected with these offices, and with the cart and implement sheds, is desirable."

CHAPTER 7

THE FARMSTEAD—SPECIMEN LAYOUTS

121. To illustrate the application of the principles prescribed in the preceding Chapter, three specimen layouts are described and studied below. They are intended for a 250-acre mixed farm keeping 20-25 cows in milk. Assuming that replacements are reared on the farm, this means that accommodation is required for about 50-60 head of horned stock. Differences between the layouts are due to variations in stock management; for example, farm A uses a covered yard and a milking shed, while farms B and C have cowhouses. Equipped with buildings as shown, farms B and C ought to be used for milk production. In the case of farm A a change from milk to beef production would not involve expensive adaptation or waste. Bullocks and young stock on farm B are kept in open yards with shelter, while in farms A and C yards are covered or have merely a central opening.

122. Layout is of course affected by other factors as well as by stock management; local climate, aspect, relation of the site to the farm and roads, and variations in ground level are perhaps the most important. There are so many possible circumstances of this kind that it has been found impracticable to illustrate the influences of all of them. A level or fairly level site has therefore been assumed. The features of actual sites will frequently present problems in the application of the principles enunciated in Chapter 6, and it may often be necessary to compromise or to choose between two desirable but incompatible characteristics. An example is that it might be impossible to arrange shelters in open yards so that they face south without unduly complicating the distribution of food. Then again, personal predilection often influences the choice between one possible layout and another when advantages and disadvantages are being balanced. There is no perfect layout of farm buildings for any set of circumstances; a number of competent judges would not be likely to find themselves in full agreement on the matter. We have therefore sought in this and the preceding Chapter to call attention to the principles involved and to give such illustrations as would stimulate thought when questions of layout were being considered.

123. An important feature common to all the layouts is a main farm road which takes all traffic external to the farmstead, except stock, though there is less insistence on this provision in farm C than in the other two. Two other common features are that the farmsteads are all open to the south and can be indefinitely extended in any direction.

FARM BUILDINGS

124. Gates are provided at strategic points in order to ensure that an animal escaping from control is prevented from getting clear away. These gates will also be useful when stock are being moved in the farmstead.

125. The following Table shows the areas occupied by the various buildings. It will be seen that, apart from Dutch barns, in each case stock buildings represent about five-eighths of the total area of buildings, food buildings about one-eighth, and storage buildings about a quarter. It is not suggested that there can be fixed proportions or ideal ratios for this allocation, but the figures emphasize the relative importance and expense of buildings for stock. They also show the need for ensuring that stock buildings are suitable, with appropriate fittings, for more than one class of stock.

	LAYOUT		
	A	B	C
	sq. ft.	sq. ft.	sq. ft.
<i>Stock Buildings and Yards :</i>			
Yards	8,400	3,825	5,400
Cowshed	—	2,312	2,380
Loose Boxes	1,150	1,150	570
Bull Box and Yard	720	550	700
Calfhouse	300	385	380
Dairy (and Milking)	880	500	400
Stable	380	1,060	760
Isolation	750	540	500
Total	12,580	10,322	11,090
<i>Food Buildings :</i>			
Fodder	880	700	760
Granary	1,760	1,200	1,760
Total	2,640	1,900	2,520
<i>Other Buildings :</i>			
Carts, Implements, and Workshop	2,770	2,830	2,370
Garage	250	240	250
Office and Welfare	250	240	250
Fertilizers	—	—	1,008
Total	3,270	3,310	3,878
<i>Dutch Barn</i>	2,700	2,700	4,500
SUMMARY :			
<i>Stock Buildings and Yards</i>	12,580	10,322	11,090
<i>Food Buildings</i>	2,640	1,900	2,520
<i>Other Buildings</i>	3,270	3,310	3,878
<i>Dutch Barns</i>	2,700	2,700	4,500
Total	21,190	18,232	21,988
Paved Area outside Buildings	18,203	18,184	23,565

LAYOUT A

Figures 2 and 3

126. On this farm the cows and followers are kept in four covered yards, having a total area of 8,400 sq. ft. To the north of the yards, the dairy, milking shed, and

THE FARMSTEAD—SPECIMEN LAYOUTS

fodder store are grouped, with the granary above them. Other accommodation for stock includes:

- A range of six loose boxes, each with an area of 192 sq. ft.
- A bull box, area 192 sq. ft. with yard.
- A calthouse, area 300 sq. ft.
- Stabling for 2 horses in stalls, and a loose box.
- 3 isolation boxes for sick animals and animals under observation.

Further accommodation for bullocks or young stock would be provided either in off-lying buildings or in temporary yards perhaps constructed of straw.

127. The farmstead occupies a site on the main farm road which leads from the highway. There is direct access from the main farm road to the farmhouse and fields. A secondary loop road encloses the area occupied by stock and food buildings. On the opposite side of the main farm road is a 6-bay Dutch barn, placed centrally, and with its long axis parallel to the road. Ample space for turning and threshing is provided. Buildings for implements, carts, and fertilizers are placed in a group to the east of the Dutch barn with access to this space and to the main farm road. Welfare and office accommodation is grouped with the isolation boxes and the garage on the west of the Dutch barn.

128. The following points should be noted:

- a. The Dutch barn is conveniently placed for threshing and for the delivery by cart of straw and hay to the yards and boxes.
- b. The fodder store and granary are placed conveniently both in relation to the yards and boxes and to the farm roadway.
- c. The milking shed is close to the covered yards, while the dairy is entered from the farm road so that milk churns may be speedily loaded.
- d. A "pull through" implement shed, a workshop capable of dealing with running repairs and replacements, and a garage and cart shed are placed in convenient relationship to the farm road.
- e. Manure from yards (unless moved direct to the fields), loose boxes and stables would be taken to a dungstead on the south.
- f. Food is distributed to the covered yards by means of two feeding passages.
- g. Stock buildings and yards face south and are protected from the north.
- h. The covered yards would be sheeted on three sides, the south side being enclosed by an open fence.
- i. Gates are so arranged in the yards and across the space between the yards and the buildings north of them as to convenience movement of cows to the milking shed and back again. The arrangement shown is, however, only one of a number of possible ones and careful thought should always be given to this matter in planning buildings.
- j. The stable is near the carts and implements.

129. It should be noted particularly that a change from dairy farming to, for example, fattening, or rearing store cattle, will require only a few comparatively simple alterations to the buildings. The set of buildings, with minor changes, is also suitable for commercial pig rearing and fattening.

LAYOUT B

Figures 4 and 5

130. On this farm the four covered yards are replaced by a cowhouse and an open yard with shelter. Other accommodation is similar to that provided in Layout A.

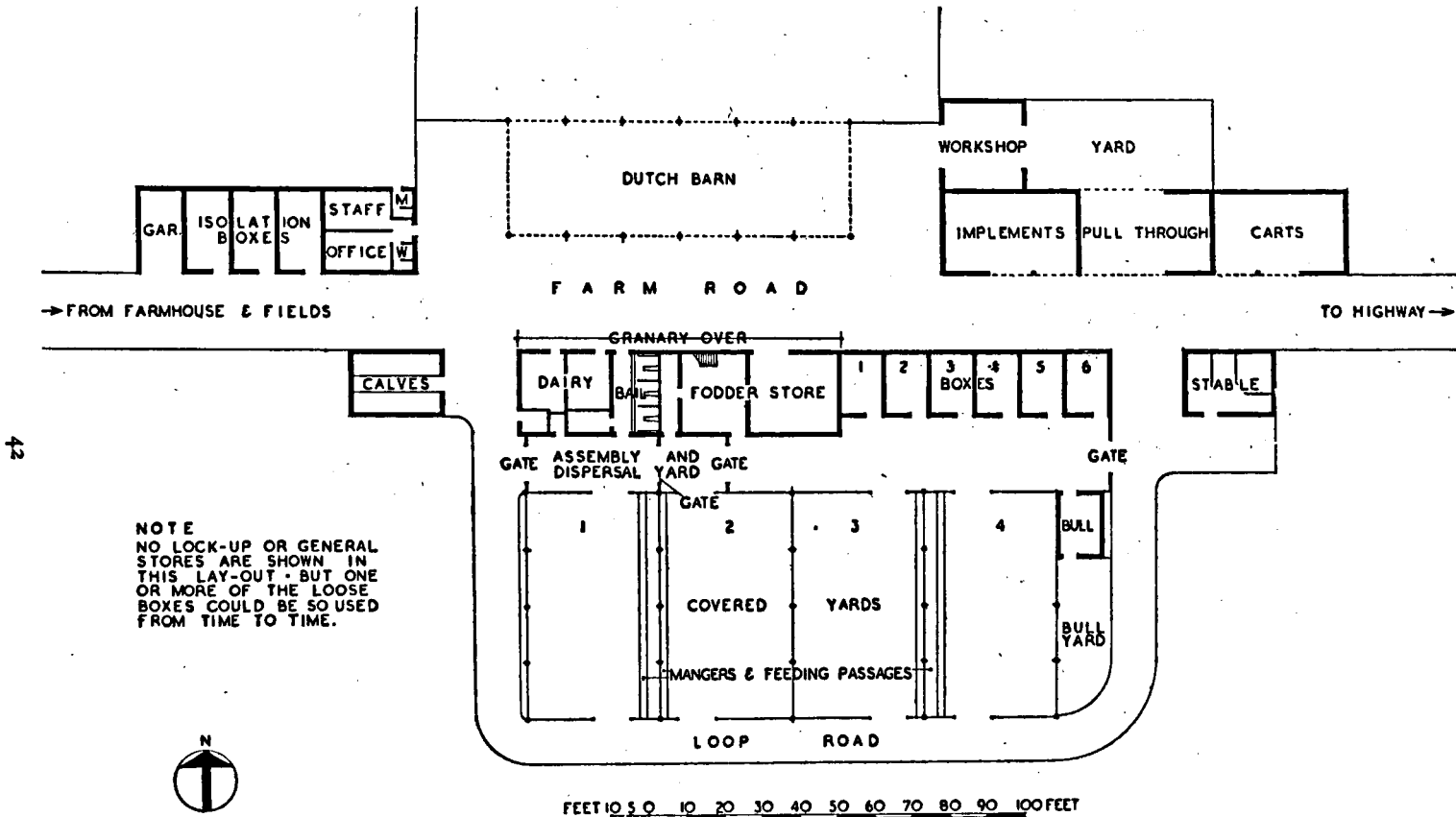
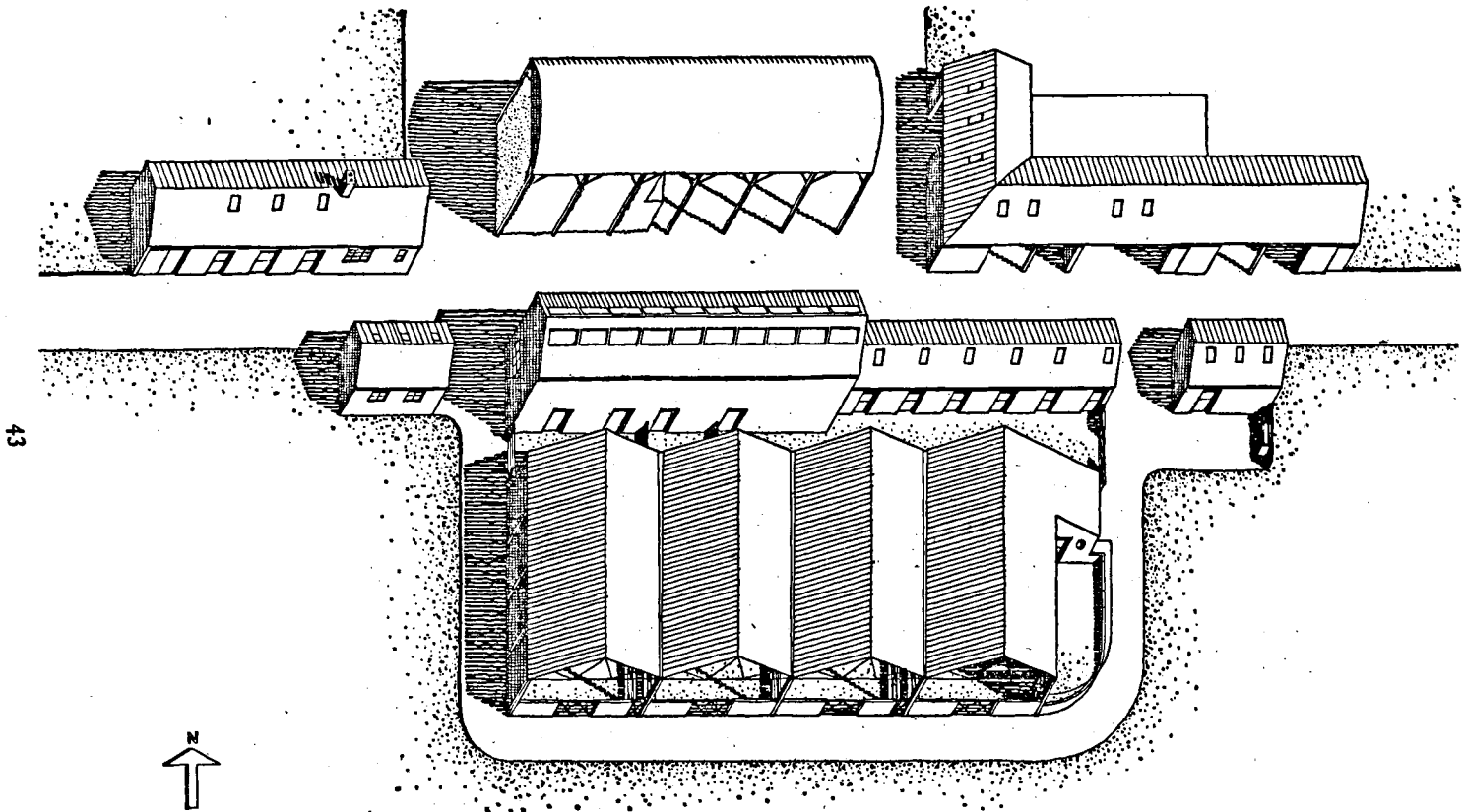


FIG. 2. LAYOUT OF THE FARMSTEAD, PLAN OF EXAMPLE A



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FIG. 3. LAYOUT OF THE FARMSTEAD, SKETCH OF EXAMPLE A

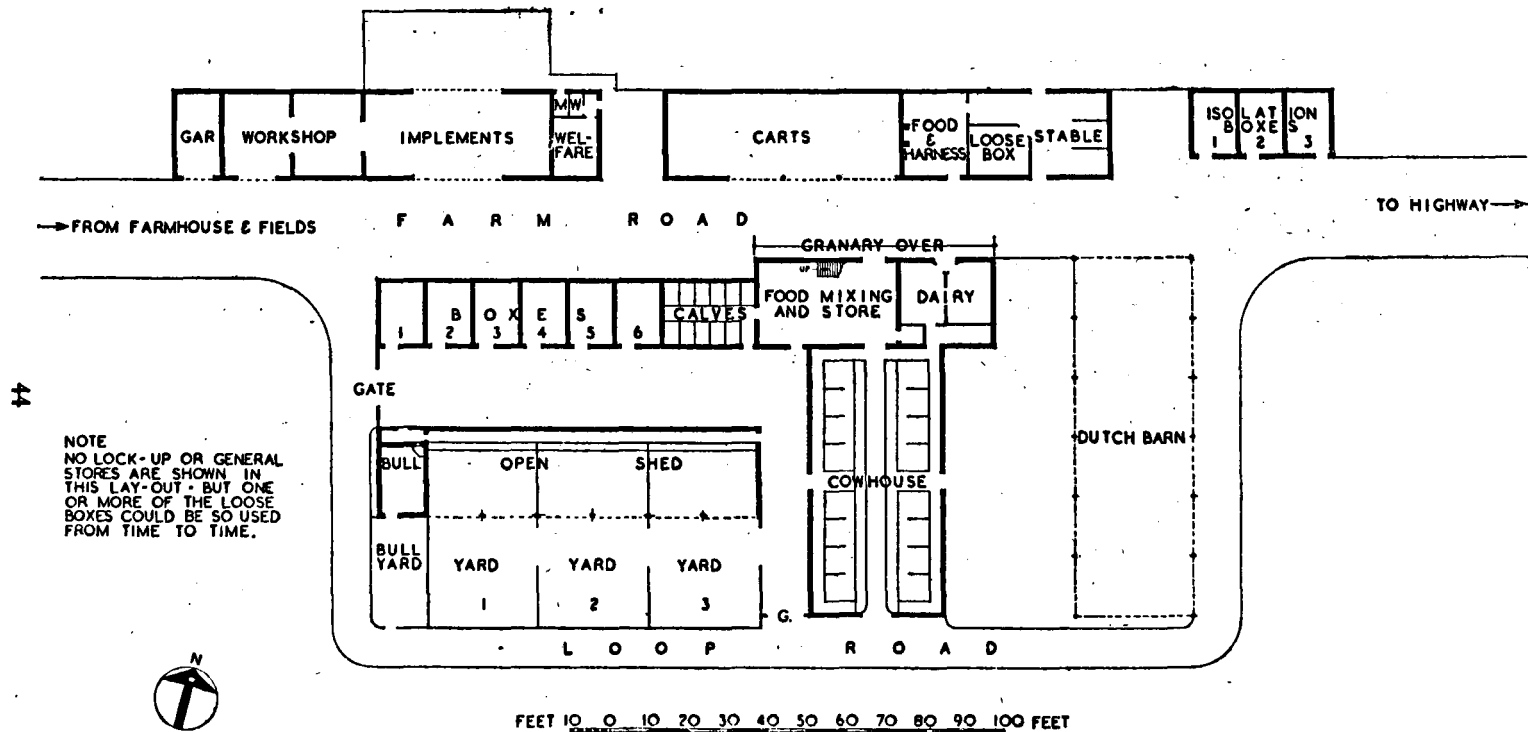


FIG. 4. LAYOUT OF THE FARMSTEAD, PLAN OF EXAMPLE B

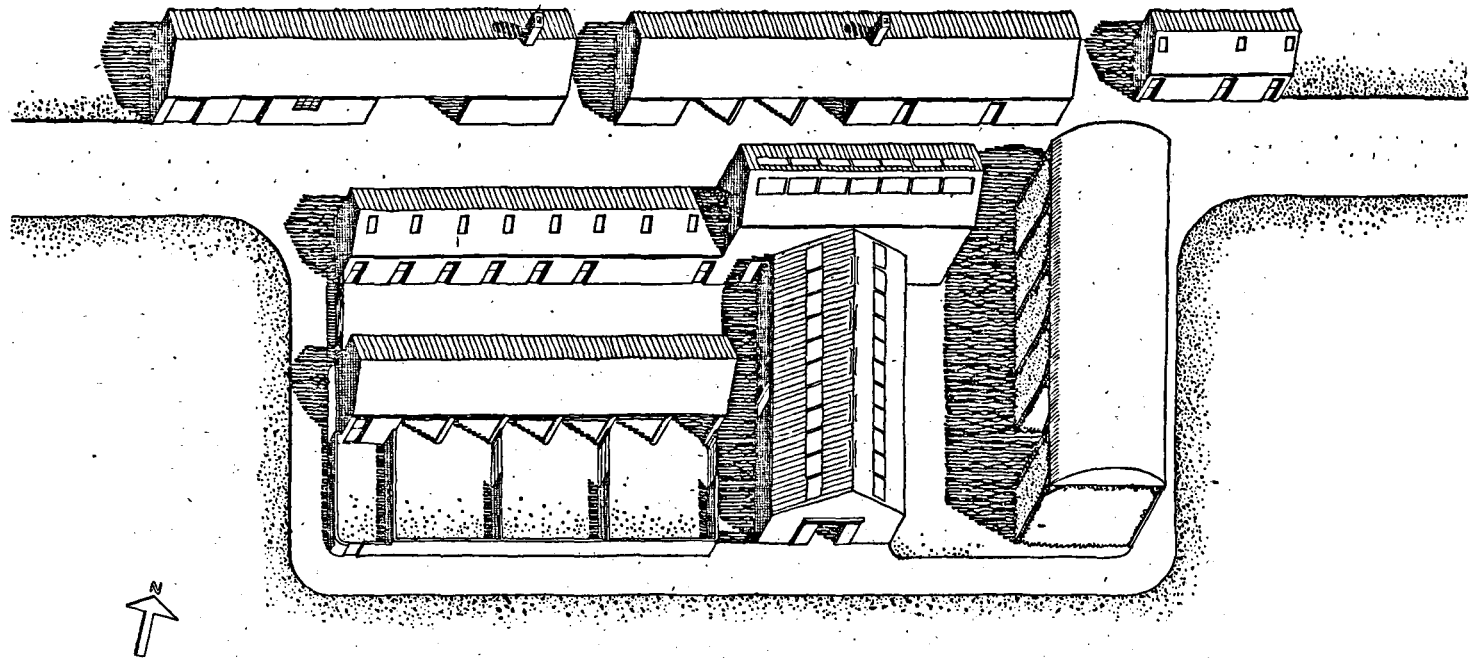


FIG. 5. LAYOUT OF THE FARMSTEAD, SKETCH OF EXAMPLE B

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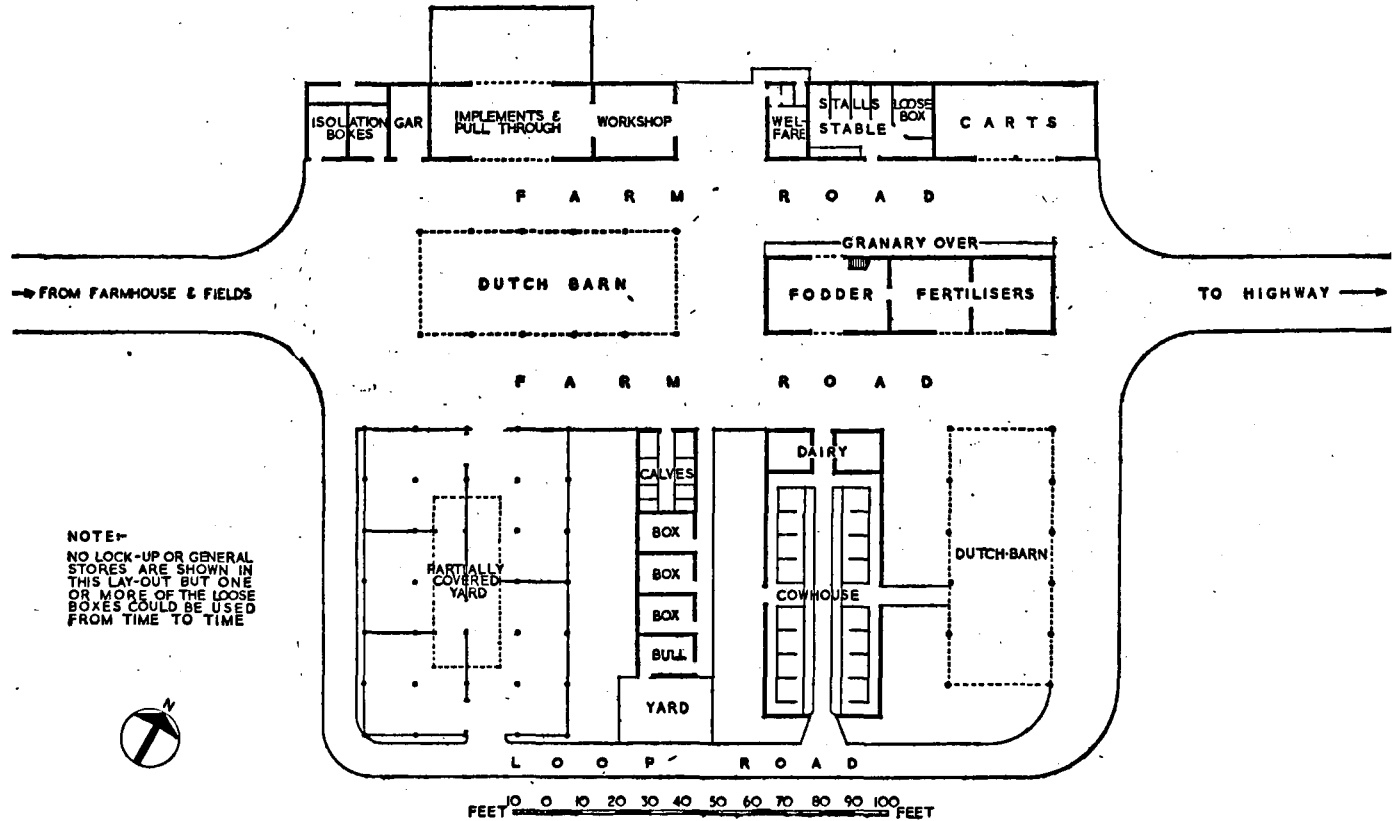
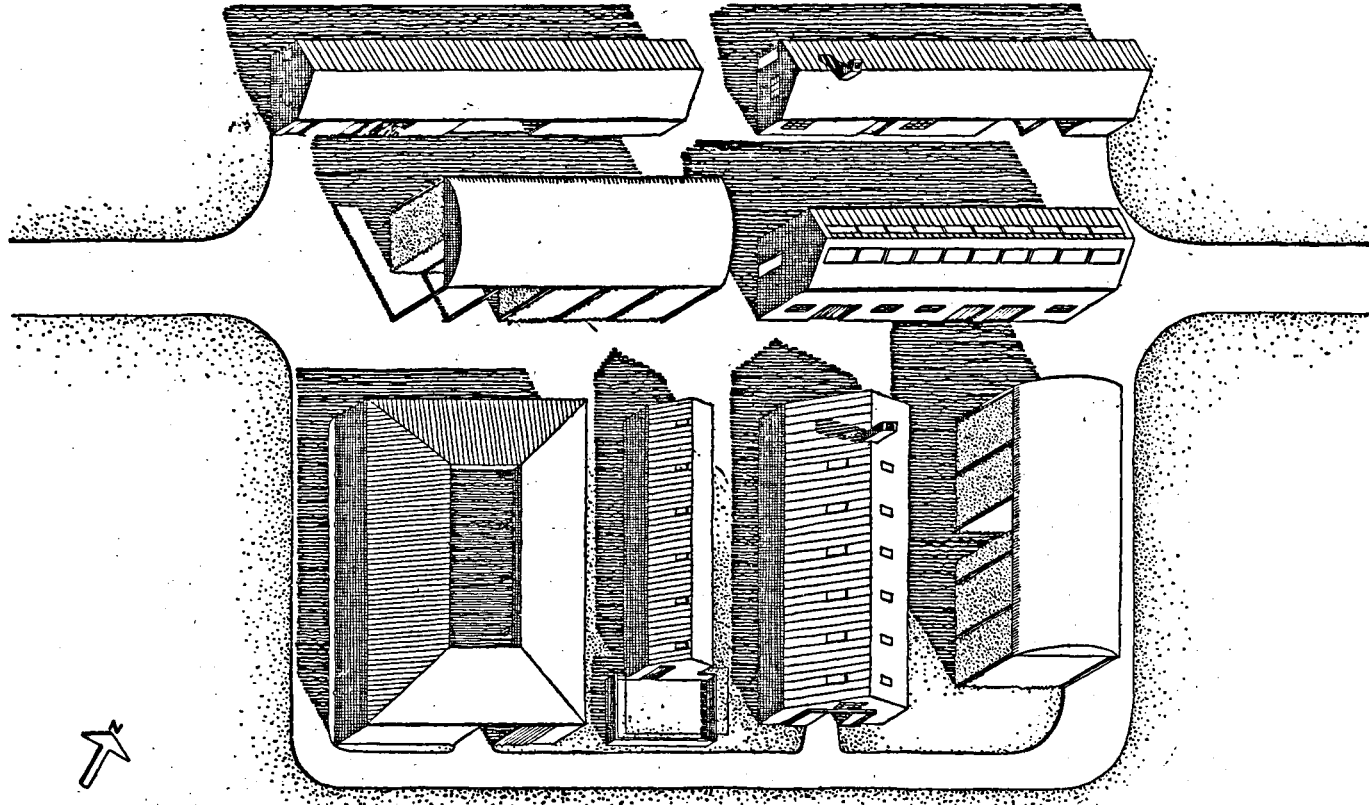


FIG. 6. LAYOUT OF THE FARMSTEAD, PLAN OF EXAMPLE C



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FIG. 7. LAYOUT OF THE FARMSTEAD, SKETCH OF EXAMPLE C

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131. The following points should be noted:

- a. Yards and boxes face south.
- b. Cowhouse, boxes, and yards are easily served from the food store and the Dutch barn.
- c. The open yard would be sheeted on the north, east and west sides. The south side of the open yard can be an open or close fence according to the climate and the degree of exposure of the site. Yard divisions would be chosen on similar grounds.
- d. As illustrated, the open yard is provided with a feeding passage under the shelter, with access at three points. The bull is fed through a hatch at the end of the passage.
If a feeding passage is not liked, hatches in the back wall could be provided, or a door into each would allow mangers to be supplied from inside the yard.
- e. The Dutch barn affords protection from the east, and ample threshing space is provided.
- f. The calfhouse is close to the dairy, and is reached under cover.
- g. Dung from cowhouse, yards, and boxes can be taken to a dungstead to the south from which easy access is provided to the fields.

LAYOUT C

Figures 6 and 7

132. The dairy herd is housed and milked in a cowhouse with 32 ties. Other accommodation for livestock includes:

- A range of 3 loose boxes with an area of 190 sq. ft. each.
- A partly covered yard with an area of 5,450 sq. ft.
- A bull box of 192 sq. ft. and yard.
- Stabling with 4 stalls and a loose box.
- 2 isolation boxes.

133. The layout differs from the others in this Chapter in two important ways:

a. The main farm road from the highway divides on reaching the farmstead. The first branch serves the buildings used for storage of implements and carts, together with the workshop and garage. The stable is also placed on this road. The second branch serves the group of livestock buildings. Between the branches is a Dutch barn and a food store and granary together with storage for fertilizers.

b. There is no attempt to "compose" the farmstead in the architectural sense and less use is made than in layouts A and B of other buildings for shelter for the yard. Consequently the yard is sheeted to 11 feet on all four sides. A site for each building has been selected solely from the utilitarian point of view.

134. The livestock group of buildings comprises a cowhouse, a calf rearing unit, a range of loose boxes (including the bull box), and a partly covered yard, in that order. A 6-bay Dutch barn for hay is placed next to the cowhouse and a similar barn for straw near the large partly covered yard. There is thus twice as much barn space provided in this layout as in the first two.

135. The following features of this plan should be noted:

- a. The transport of hay to the cowhouse and straw to the covered yard is easy and short.
- b. Extension of the farmstead or of any particular activity can easily be accommodated by expansion of the site in the required direction.
- c. The large partly covered yard is divided into five so that stock can be grouped according to age and sex.

CHAPTER 8

THE MAIN STORAGE BUILDING OR GRANARY

OBJECT

136. A main storage building or granary is designed to provide cover for stock food, and space for preparing food. It is sometimes possible also to provide space in the building for the storage of seeds and artificial manures.

The building should provide cover from the elements, be dry internally, well ventilated, and proof against vermin. It should be so sited that raw material, whether home grown or purchased, can be easily conveyed into the building and easily handled into bins for storage or into machines for treatment. There should be good lighting, both natural and artificial. The building should be constructed in two storeys for convenience in treating and preparing feeding stuffs.

SITING

137. In selecting a site for the granary, regard must be paid to the ease of delivery and distribution of food, and to arrangements for the loading and off-loading of vehicles. The granary should be readily accessible from the highway and allowance must be made for lorries to turn. For these reasons it is often desirable for the granary to be near the dairy so that the same road and turning space can be used; frequently corn barns can be served as well. In addition the granary should be sited so that prepared food can be delivered to livestock by short and convenient routes, which should be under cover if possible.

On hilly or broken land it is often possible to choose a site which allows the ground floor to come about three feet above the road, so that sacks may be wheeled directly off the floor on to lorries and carts. In some cases it may even be possible to arrange access of this kind to the ground floor on one side or end of the building and to the first floor on the other. Further reference is made to loading levels in paragraph 148 below.

DESIGN

Figures 8 and 9

138. Such a building lends itself to construction in standard units; the size required will naturally depend upon the size of the farm and the type of agriculture practised. Points to bear in mind are that there should be adequate accommodation for storing grain and roots for stock. The grain would normally be stored on the upper storey in bins so arranged that it can be easily carried into the bins and as easily carried to the machine for grinding. The first floor must, therefore, be constructed to carry substantial weights.

139. In calculating the size of floor required an estimate must be made of the amount of home produced grain which it is intended to consume on the farm and for which storage room will be required at any time of the year. If the general practice is to thresh out the home produced grain for home consumption at intervals during the year only a proportion of this grain will have to be stored at any one period. It is necessary also to allow for purchased feeding stuffs, having regard to the amount which is likely to be purchased and for which storage will be required at any one period.

FARM BUILDINGS

It is assumed that this building will not be used for storing grain apart from that required as stock feed. The use of combines on the many small or medium sized farms in this country is as yet in its early stages and it may or may not develop. If it does not develop the type of building we have in mind will be adequate for ordinary purposes. If it does develop and if no district or communal arrangements are made for drying and storing the grain, a separate building may be needed to house the bulk of the grain produced on the farm. The greater part of this grain may often be sold off the farm and will not need storage for more than a limited time, if at all. Bulk grain storage is dealt with in Chapter 17.

140. The building illustrated in Figs. 8 and 9 is suitable for a 250-acre mixed farm carrying 30 cows. Its main dimensions are length—84 ft., depth—21 ft. Clear heights recommended are at least 8 ft. from the ground floor and 8 ft. for the floor above.

The ground floor should have a concrete surface, thoroughly insulated against damp and well united with the walls to prevent invasion by vermin. Good lighting is required and in the upper storey this can be most suitably provided by roof lighting either by means of a continuous strip or by fixed lights. On the ground floor lighting should be by windows which should be wide and shallow placed high up on the wall rather than narrow and high so as to provide the maximum amount of wall space for storage beneath the window.

It is essential that there should be both internal and external access to the upper storey.

141. *Doorways.* The situation of the ground floor doorway will depend on the size of the building, but in the building illustrated in our layout plan it would be convenient for the doorway to be in the middle of one face of the building, leaving room for storage and mixing on either side. The upper doorway should not be over the lower, in order that they may be used simultaneously. It may be more convenient to have the upper doorway in the centre of the building and the lower doorway at one end. This gives room on the ground floor for the bulk storage of roots and for a mixing floor clear of the doorway, while on the upper floor grain and cake are handled more easily from a central doorway to storage space on either side. The lower door must be wide enough to admit a cart or lorry.

142. *Machinery and Shafting.* In locating the bins on the upper floor it is essential to bear in mind the situation of the machinery and to take advantage of gravity flow as much as possible. It is possible to have the machine on the ground floor feeding direct from the hopper shutter in the upper floor, and meal can be blown from the machine either on to the upper floor again for storage or along the lower part of the building to the mixing floor. When a fixed engine is used fireproof accommodation is necessary for the engine and fuel. It is not possible to lay down any hard and fast rule as the internal layout of these buildings will depend on the requirements of each farm. Firms which supply these machines will generally give advice about layout and management.

CONSTRUCTION

143. In view of the weight to be carried the building will need to be of substantial construction.

144. *Walls.* Both framed and weight-bearing walls are suitable. If framed construction is employed the panels may be filled with bricks or lightweight slabs; sheeting should be avoided because panels filled in this way may provide harbourage for vermin.

145. *Roof.* There are no special requirements, and tiles, slates or asbestos-cement sheeting can be used.

THE MAIN STORAGE BUILDING OR GRANARY

146. *Lighting.* On the ground floor steel framed windows with hoppers opening inwards with side cheeks should be placed as high as possible. A suitable size is 6 ft. long by 3 ft. deep, set in wood or precast concrete outer frames.

On the upper floor roof lighting is preferred, as it gives a better distribution over the entire floor. All windows in the granary that can be opened should be covered with small mesh wire netting to exclude birds and vermin.

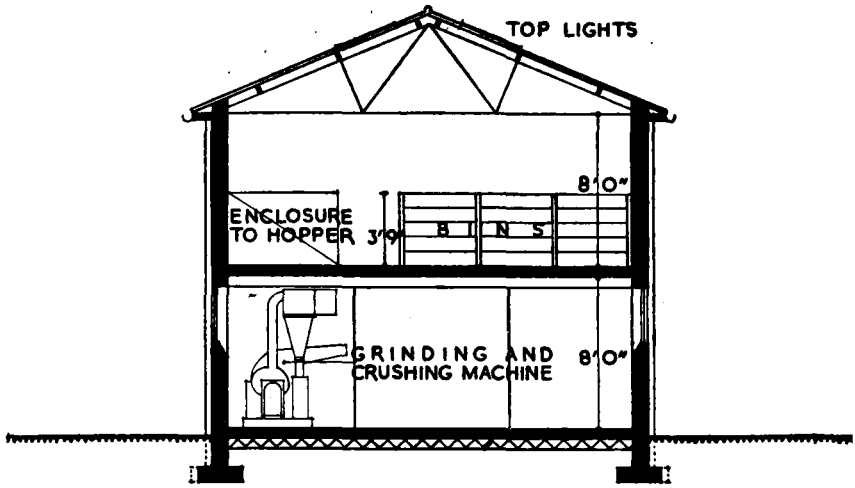
147. *Ventilation.* With modern machinery provision must be made for extracting dust. This is best done by a blower for each machine with metal trunking connected to the outside. In cases where this is not practicable provision must be made for adequate ventilation. This can best be done on the ground floor by a proper control of the hopper type windows. On the upper floor it is best provided by ventilation cowls fixed in the ridge of the roof.

148. *Floors.* The ground floor should be of concrete, and if possible should be raised sufficiently to allow easy loading and off-loading of vehicles, as described in paragraph 137 above.- On level sites it may be too expensive or otherwise undesirable to raise the whole building three feet above the external level; in this case a loading ramp should be provided, inside or outside the building. Much greater care should be exercised in future to avoid unnecessary manhandling, and particularly lifting, of heavy loads. The ground floor, however, should always be above the finished external level in front of the door. The greater the difference between internal and external levels the less the risk of flooding in thunderstorms and other sudden flushes of water but entry of vehicles is proportionately more difficult, though this is less important with pneumatic tyred wheels. Weatherboards or raised thresholds or a metal water-bar are other protections against rain-water. There should be a sandwich damp-proof course in the concrete or the floor should be finished in asphalt. An impervious joint should be made between the damp-proof course in the wall and the damp-proof course or water-proof finish of the floor. The concrete floor should be finished with granolithic cement rendering in view of the wear from shovelling and from trollies. It should be strengthened where required to take the load of machinery; and holding-down bolts should not be overlooked when the floor is being laid. The makers of the machinery should be consulted in advance about floor strength.

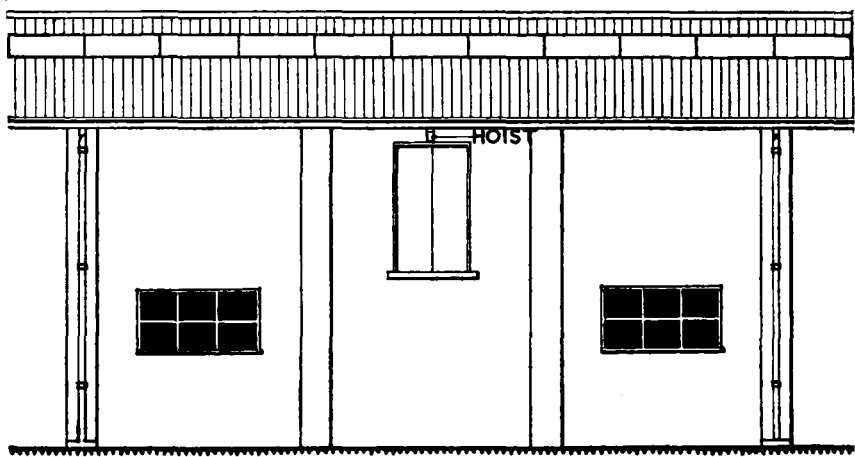
The first floor can be of patent hollow tiles or of precast or *in situ* concrete; or timber joists covered with tongued and grooved flooring may be used. The ends of the joists should be plugged to reduce risk of invasion by vermin but in this case they may require protection from damp.

A practical suggestion which has been brought to our notice and which is suitable in many cases where there are existing timber floors of strong construction is to cover the floor with a 2 in. thickness of fine concrete finished with a float and reinforced with $\frac{1}{2}$ in. mesh galvanized wire netting. This adds appreciably to the strength of the floor and forms a good surface on which to store grain. It also makes the floor impervious to rats and mice. A floor dealt with in this way must not be ceiled on the underside owing to the danger of dry-rot.

149. *Bins.* The number of bins will naturally depend on the amount of corn for which storage is required. The side walls of the bins may be of brickwork, concrete *in situ* or prefabricated slabs with a height of 4 ft. 6 in. against the wall of the building and 3 ft. 6 in. in the front of the bins. Timber is also satisfactory, especially if loose boards are fitted into grooved posts. A height of 3 ft. 9 in. all round is suitable. Fronts of bins should never be more than 3 ft. 9 in. high; a greater height imposes an unnecessary strain on men carrying or manipulating heavy bags of corn. Partition walls should be so arranged as to give large and small bins unless the partitions are removable; and the best sizes seem to be from 5 ft. to 3 ft. wide by 5 ft. or 4 ft. deep.



SECTION



PART ELEVATION
SCALE OF FEET

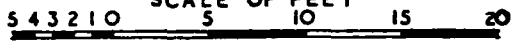


FIG. 8. GRANARY

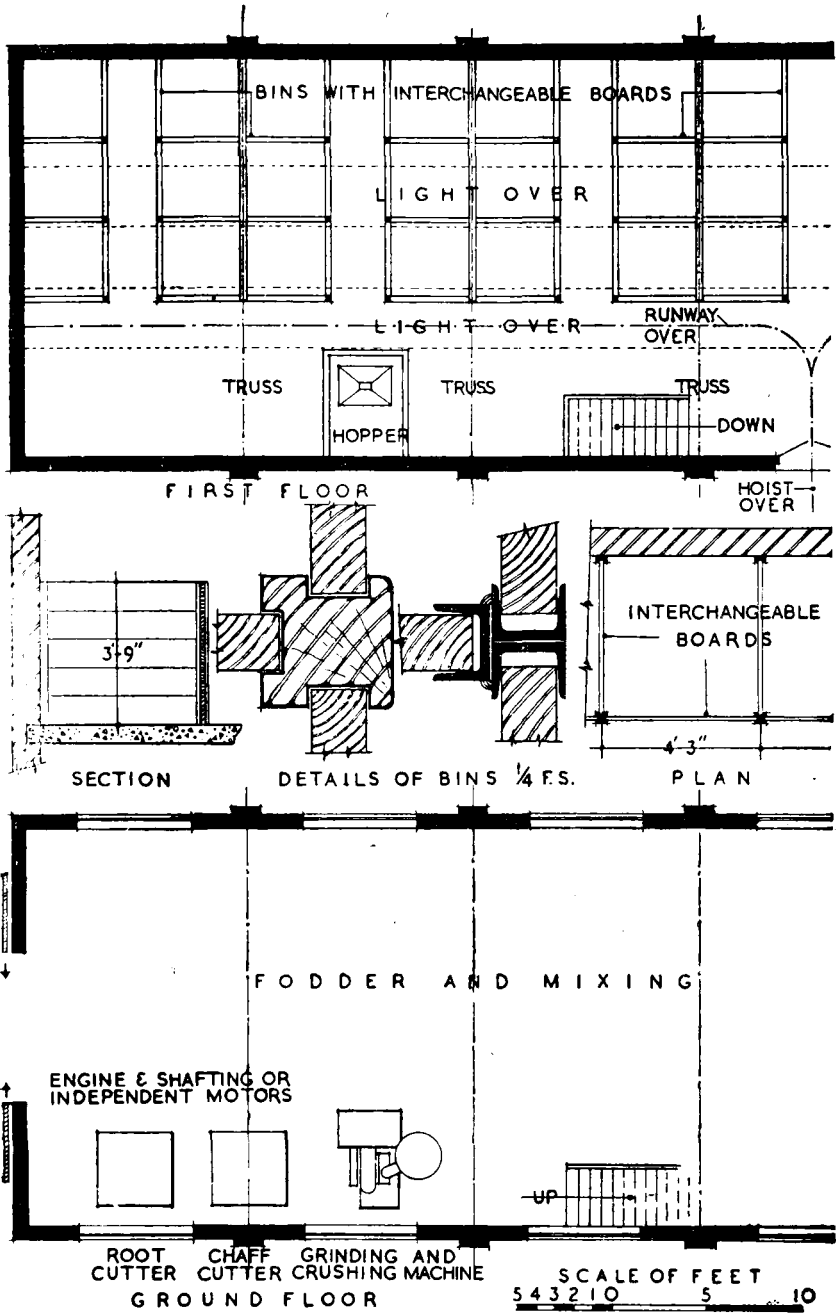


FIG. 9. GRANARY

FARM BUILDINGS

The capacity of the timber bins illustrated in Fig. 9 is 60 cubic feet each, or very roughly about one ton on the average of grain and cake. The following figures of volume per ton will be useful in deciding the number of bins required:

Wheat	45 cubic feet per ton
Barley	50 " " "
Oats	70-80 " " "

It should be noted that the dimensions of the building affect the optimum sizes of bins and their layout if maximum capacity is desired.

The front of the bins should be constructed of $1\frac{1}{2}$ in. boards which can be slipped into position between grooved uprights. The boards should be close fitting so as to keep out vermin, and it is advisable to cover the top of the bin with a light wooden frame over which wire netting of $\frac{1}{2}$ in. mesh is stretched. Timber is regarded by some users of bins as more suitable than other materials because it does not "sweat". With all timber construction sliding boards, as suggested for the bin front, can be used also for the sides. Fig. 9 shows bins 4 ft. x 4 ft., made of timber, all boards being removable and inter-changeable.

An effective system of overhead conveyors will save a great deal of manhandling. There is also evidence that grain threshed by a combine harvester and in good condition can be dried by being moved at intervals from one bin to another. Such an operation is carried out much more easily by means of conveyors, but a spare bin is required.

150. *Exclusion of vermin.* Particular attention must be paid to the exclusion of vermin from this building and reference should be made to Chapter 21 on this subject.

ADAPTABILITY

151. The building which we have described is adaptable for many other purposes in accordance with local farming practice. It is a wise "adaptability provision" in any building for the stanchions to be at least 12 ft. apart.

ADAPTATION OF EXISTING BARNs

152. There are many existing barns in the country which can easily be adapted to conform to the general requirements which we have stated. Typical amongst these is the old timber and thatched barn common in Essex and Kent amongst other parts of the country. This building can be adapted by building up as a lining independent thin walls of cast concrete slab or $4\frac{1}{2}$ in. brick, strengthened where necessary to support the first floor. An alternative method which is not so satisfactory is to line the existing walls with sheet metal or expanded metal with cement rendering. In this case a light steel framing or other support will be required to carry the upper floor if the main structure is not sufficiently sound. A thatched roof should be lined with a material sufficiently flexible to conform to the variation of the surface of the under roof timbers. Care must be taken to prevent vermin getting between the roof and the lining. This can be done by stretching wire netting over the thatch, particular care being paid to the finish at the eaves verge. Extra lighting in such a converted building is usually necessary. It may be difficult to provide adequate natural lighting on the upper floor; if so, additional artificial lighting should be provided.

153. It should be noted that many of these barns are of great architectural interest and competent advice should be sought before alterations are made. There is a danger that unwise alterations may result in rapid decay of the original structure.

CHAPTER 9

ACCOMMODATION FOR MILKING COWS, THEIR FOLLOWERS, AND THE DAIRY

SYSTEMS OF HERD MANAGEMENT FOR MILK PRODUCTION

154. The main product of dairy farming in this country is milk for human consumption. This milk should be of good keeping quality and free from disease. Its production is continuous—twice a day, seven days a week—demanding reasonable working conditions and a regular routine. Although milk production is more intensive in some districts than in others it is very widespread and local conditions vary considerably. The average unit of production is not large—two-fifths of the dairy herds contain two-thirds of the cows and produce three-quarters of the milk—hence the large proportion of small herds is a pronounced feature of the industry.

155. Few farms possess ideal buildings, equipment, and water supplies, but suitable additions and improvements have enabled many dairy farmers to evolve a system of routine management suited to the particular conditions on their farms and, although wide variations in detail occur, there are now three main systems of herd management for milk production.

- A. The Cowhouse System: in which the cows are housed and milked in the same building.
- B. The Milking-House System: in which the cows are housed in covered or partly covered yards or other available buildings, but are milked in batches in a special milking-house adjoining the farm dairy.
- C. The Open-Air System: in which no housing is provided; the cows live in the fields and are milked by machine in a movable milking bail.

Each system with its advantages and limitations will be described in more detail in the sections which follow. The responsibility for deciding which system is the most suitable for any particular farm must rest with the milk producer himself, after carefully studying his own special circumstances in the light of the information contained in this Chapter. He will naturally first consider what may be done with his existing buildings before deciding if new buildings are necessary. An endeavour is made in this Chapter to deal with some alternative ways of improving existing buildings, but the general principles and many of the details are applicable in all cases.

156. It should be clearly understood that the general recommendations and structural details are intended to serve as a guide to all concerned with milk production, and not as an official interpretation of statutory requirements relating to the production and distribution of milk. If the recommendations are adopted, however, there should be no difficulty in meeting these requirements.

A. THE COWHOUSE SYSTEM

157. The advice contained in this section of the Chapter is intended to apply to tie-up cowhouses in which cows are milked throughout the year and housed and fed during the winter months. This is by far the most prevalent system, particularly in the West and North, where the climate is wet, and where in many

FARM BUILDINGS

cases the herds and farms are relatively small and alternative accommodation is not available. It is a specialized, single-purpose building in which the conditions of housing and individual management can be carefully controlled, and the necessary facilities and equipment conveniently provided, but it requires an adequate supply of labour and water to keep it clean. On the other hand, a new cowhouse is expensive to erect, or to adapt for other purposes.

OBJECTIVE

158. The main objects are to ensure that the herd is housed in comfort under healthy conditions with an adequate supply of light, fresh air without draughts, and pure water; that the cows can be fed, milked and kept clean with a minimum of labour and expense; and that facilities are adequate for the efficient handling and storage of milk, and for the cleansing and storage of equipment and utensils. It is necessary also to provide efficient isolation quarters for sick cows and special accommodation for calving and for housing young stock. For general health reasons it may be desirable to house exceptionally large herds in units of about 50 cows rather than in one large cowhouse.

In view of the importance of conserving farmyard manure in the interests of soil fertility, adequate provision should be made for the efficient handling and storage of both dung and liquid manure produced by the dairy herd.

SITING

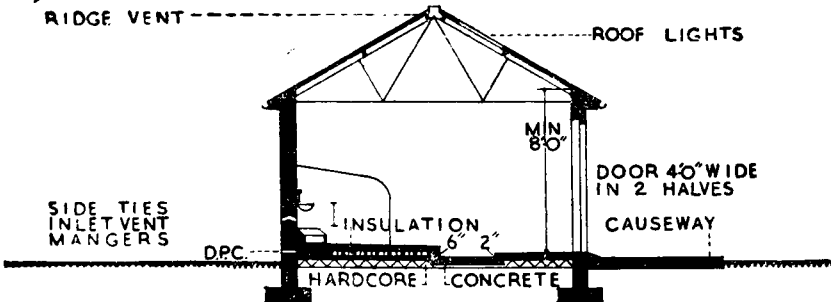
159. The cowhouse will usually be a unit of the homestead and as such its situation will be governed by the general layout of the farm buildings. It is important to consider easy approach to a roadway and to pastures and convenient access to the dairy, foodstores, and a water supply. Where it can be arranged, the cowhouse should be placed so that roof lights can be provided facing north or east, preferably north. The site itself should, if possible, be moderately high in relation to its surroundings and have a convenient fall for drainage and for removal of manure. The general layout of dairy farm buildings is dealt with in Chapter 6.

PLAN

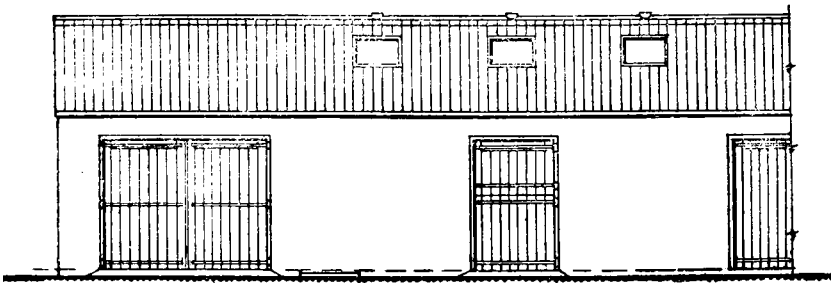
Figures 10 and 11

160. Cleanliness and the health of the herd being the important considerations, it is necessary to plan the buildings so that these may be attained with a minimum of labour. No amount of expenditure on buildings can eliminate the necessity for scrupulous and unremitting care by the staff. Important features of cowhouse planning are wide, clean and dry approaches for the cows and a free passage for the milk, well removed from all sources of contamination. The old arrangement so often found, by which cows make their entry across a manure yard should be avoided; where such means of entry is unavoidable, a firm approach to the cowhouse is essential and this should be railed off. If manure removed from the cowhouse is to be stored in a dump, a pit should be provided; this should be placed well away from the buildings and should be protected from access by cattle.

161. In all but the smallest cowhouse, it may be desirable to provide three ways of access, one for cows to enter and manure to be taken out, another for the fodder and concentrates, and a third for the passage of milk to the milk room or dairy. In a double range cowhouse an additional outlet is often provided so that the cows may enter by a different door from that by which manure is taken out. In planning entrances to the cowhouse, weather conditions should be taken into account so that when the cows are in the stalls they are not subjected to the prevailing cold winds.



SECTION



PART ELEVATION

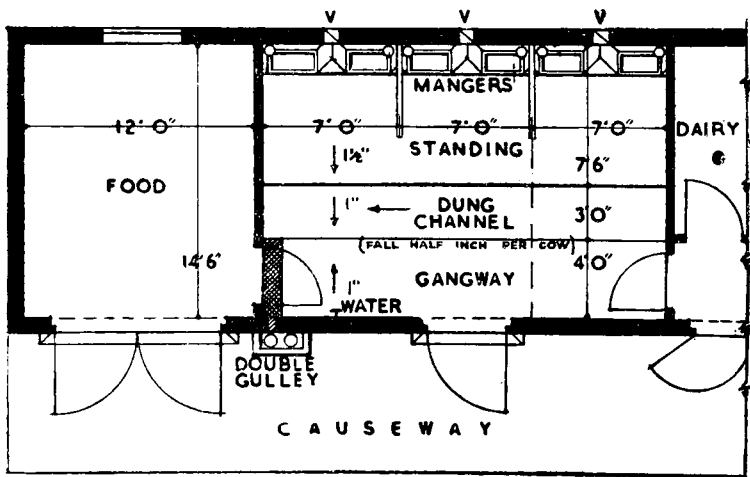


FIG. 10. COWHOUSE, SINGLE RANGE WITHOUT FEEDING PASSAGE

FARM BUILDINGS

While the ideal arrangement is to keep the side walls and one end of the cowhouse free of all other buildings, circumstances will arise, particularly in the adaptation of existing buildings, where this is difficult. No definite rule can be laid down to cover all circumstances, except that light must be ample and well distributed, ventilation free through all parts, and the building kept as far as possible free from contamination.

SINGLE OR DOUBLE RANGE HOUSES

Figures 10, 11, and 12

162. Single or double-range cowhouses may be equally efficient. Where there are more than 16-20 cows, or where there are possibilities of increasing the herd, the double-range cowhouse should be considered on the grounds of convenience, saving of labour and economy in both floor space and building costs.

Whenever possible double-range cowhouses should have central gangways with or without feeding passages along the side walls. The heads of the cows are thus kept near to the fresh air inlets in the side walls; the dung is confined to one passage and labour can be saved by using a cart for its removal; the cows can be tied up more easily; and milking can be supervised with greater efficiency.

OTHER GENERAL CONSIDERATIONS

163. For the safety and comfort of the cows it is obviously desirable that there should be sufficient floor area to allow free movement into and out of the building, and to permit the cows to be milked and to rest in comfort. Provision should be made for gangways wide enough for cows to turn in and for the staff to carry out their work efficiently. A minimum allowance of 50 sq. ft. of floor area per cow (45 sq. ft. per cow in double-range houses) is needed to ensure comfortable conditions for both cows and staff.

164. Adequate cubic space is necessary to allow fresh air to circulate freely without creating draughts. Space is of greater importance when the herd is kept indoors night and day for a considerable part of the year.

Fresh air and well ventilated quarters are essential both for the well-being of the cows and for clean milk production. The problem is to remove used and foul air and to replace it with fresh air without causing draughts or excessive variations in temperature. A continuous circulation and renewal of air in the cowhouse can be achieved by providing foul air outlets in the roof and fresh air inlets at lower levels. (See paragraphs 177-179.)

165. Light is of importance for healthy conditions and efficiency in milk production; it is required in all parts of the cowhouse and particularly at the hind quarters of the cows. Lighting from the roof is more effective and economical than wall lighting, and particularly in double-range, tail-to-tail cowhouses, it is efficient in giving light where it is most needed. Proper provision must also be made for artificial lighting for the winter months. (For further details see paragraphs 180-183.)

166. Modern methods of milk production demand a plentiful supply of good, clean water, the quantity required being much greater than is generally realised. On an average the daily requirement for stock drinking, cooling, and cleansing is about 25 to 30 gallons per cow. Thus an adequate water supply is a primary consideration. Water should be laid on to the cowhouse and the dairy, with taps fixed at suitable places and wash basins for the staff. (See also paragraphs 198-200.)

THE COWHOUSE SYSTEM

167. Drainage is another important item to consider when designing a cowhouse. The system of drainage must comply with the requirements of the Local Sanitary Authority. The essentials are to provide an adequate fall for drainage and facilities for dealing with the effluent. (Details are given in paragraphs 201-204.)

ESSENTIAL, INTERNAL DIMENSIONS

Figures 10 to 14

168. *Length.* The length of a cowhouse will depend on the number of standings, each of which should allow 3 ft. 6 in. for a cow the size of an average Shorthorn: for smaller breeds 3 ft. 3 in. is sufficient. On this basis 7 ft. (centre to centre) will normally be required for each double stall, but in many districts it is the practice to reduce this to 6 ft. 6 in. For a single stall 4 ft. should be allowed so as to give room for cleaning and milking operations.

169. *Width.* Assuming the cows are of average Shorthorn size, and that central ties and wide continuous mangers with low fronts (see Figs. 17B and 18) are installed, minimum inside dimensions for a single-range cowhouse are as follows:

Gangway 4 ft.; dung channel 3 ft.; standing 5 ft.; manger 3 ft.; feeding passage (optional) 3 ft. Total width 15 ft. (or 18 ft.). Similar minimum dimensions apply to a double-range cowhouse of the same type, except that the central gangway should be 5 ft. wide. Total width 27 ft. (or 33 ft.).

In a cowhouse with side ties and low individual narrow mangers as illustrated in Figs. 10 and 17A, the distance from the wall or feeding passage to the dung-channel should not exceed 7 ft. 6 in. With mangers up to 2 ft. wide, the point of tying should be 2 ft. from the wall or feeding passage. Wider and continuous mangers up to 2 ft. 6 in. (see Fig. 16B) may be used but with these the point of tying must be in line with the front kerb of the manger. Other dimensions are the same as for central tying. Total width 14 ft. 6 in. (or 17 ft. 6 in.) for single range; 26 ft. (or 32 ft.) for double range.

170. For breeds larger than the average Shorthorn the standing should be 3 in. longer and this entails a corresponding increase in the overall width of the cowhouse. For smaller breeds the standing should be shortened by 3-6 in., the extra inches being used to widen the gangway. Where there are cows of markedly different sizes in the same herd, some variation in the lengths of the standing is necessary. This can be provided by constructing the standings so that the back step does not run parallel with the manger front but the standings taper from one end of the building to the other, the adjustment being taken up in the dung channel so as to retain a constant width for the gangway.

The dimensions given above indicate minimum requirements. If a building allows extra width, this should be used to widen the gangway but not for the standings or the feeding passages. If the dimensions for the standings are exceeded the cows have too much freedom and tend to foul the standings.

171. *Height.* A convenient height for the inside of the wall of a new cowhouse is 8 ft. Excessive height without adequate air outlets may lead to faulty ventilation.

WALLS

172. Stone, brick, or concrete are suitable materials and a damp-proof course should be inserted in all walls. The internal surfaces of the walls should be smooth so that they can be easily cleaned and disinfected. Rough brick or concrete walls,

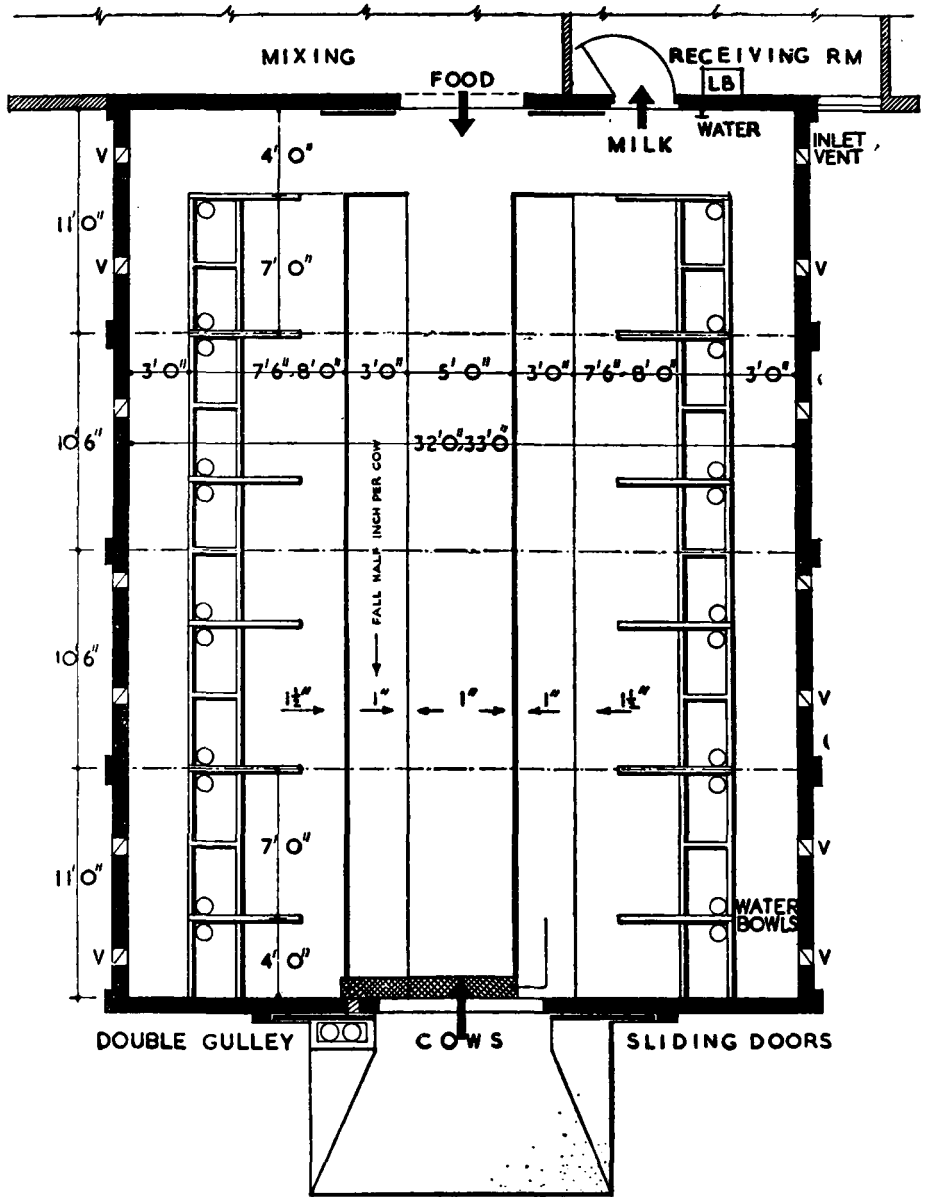
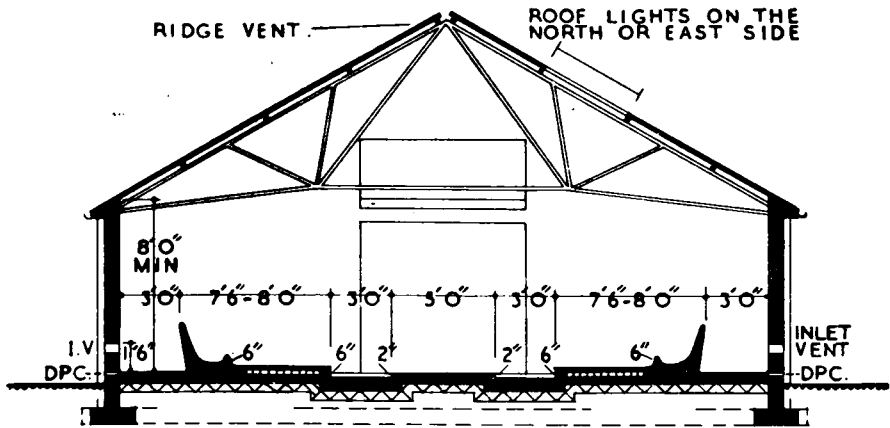
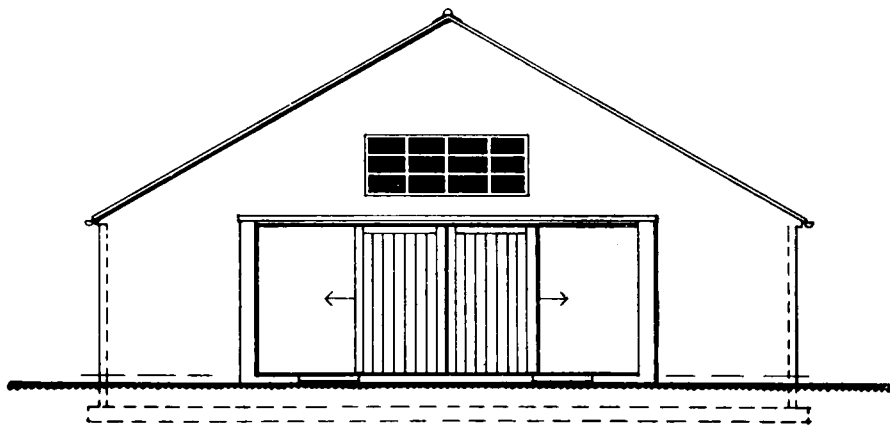


FIG. 11. COWHOUSE, DOUBLE RANGE WITH FEEDING PASSAGES



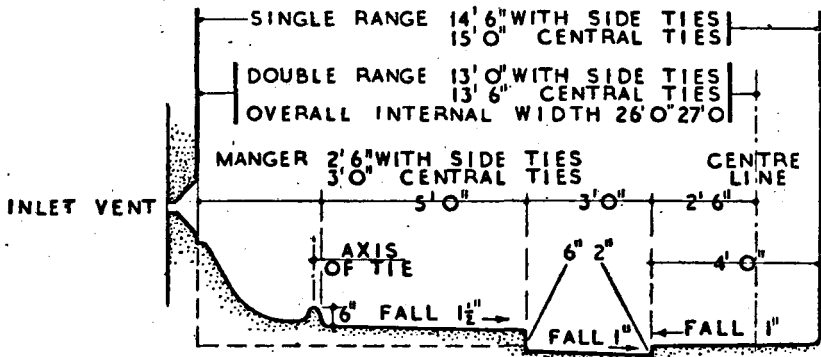
CROSS SECTION



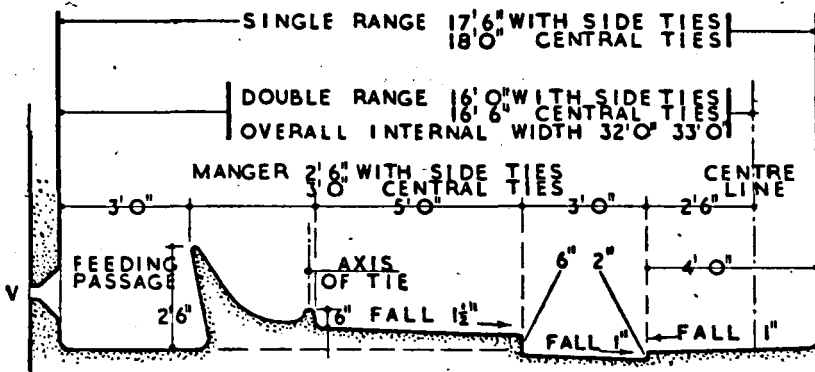
END ELEVATION



FIG. 12. COWHOUSE, DOUBLE RANGE WITH FEEDING PASSAGES

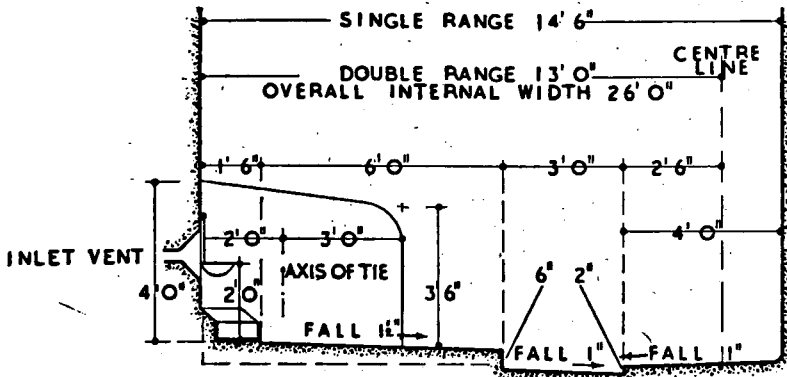


WITHOUT FEEDING PASSAGE

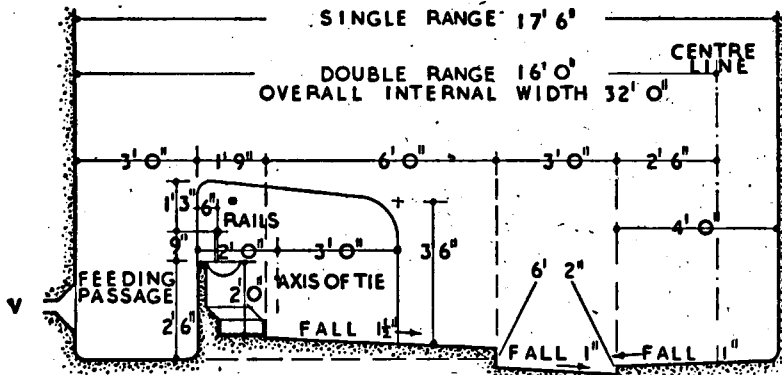


WITH FEEDING PASSAGE

FIG. 13. COWHOUSE, INTERNAL DIMENSIONS WITH CONTINUOUS MANGERS



WITHOUT FEEDING PASSAGE



WITH FEEDING PASSAGE

DETAILS OF TIES
AND OF MANGERS

FIG. 14: COWHOUSE, INTERNAL DIMENSIONS
WITH SCOTTISH TYPE MANGERS.

FARM BUILDINGS

therefore, should have a cement dado, at least 4 ft. 6 in. from the floor, with a smooth steel float finish. Stone or brick surfaces above the dado should be neatly pointed and concrete should be given a smooth steel float finish and all internal angles slightly coved.

DOORS

173. In a single-range cowhouse doors used for entry and exit of cows should be 4 ft. wide and 7 ft. high in the clear, hung on strap hinges in two halves, the lower half being 4 ft. high. For a double-range cowhouse the doorway should be 8 to 9 ft. wide in the clear and double hung or sliding doors should be used; if an overhead manure carrier is used, the doorway must be high enough to allow for this.

Doors should be strong, and either solid flush or "ledged-and-braced," or preferably "framed-ledged-and-braced." The sharp angles of door frames should be rounded off and, where doors are fixed in brickwork, the brick angles should be bull-nosed. Where doors open outwards they should be hung so that when secured they do not interfere with the cows as they enter or leave the cowhouse. Sliding doors should, if circumstances permit, be on the inside of the building as this protects the doors. Single hung or sliding doors should be used for connecting with the dairy and the food store.

ROOFS

174. Roof principals may be constructed of steel, timber, reinforced concrete, or tubular asbestos cement. Timber is easy to handle and familiar to builders in country districts but the heavy forms of framed king post and queen post truss hitherto generally adopted are seldom necessary in new work. The need for light and airy buildings is against the use of heavy, dust-collecting timbers and points to the light steel truss as a neat and practical method of supporting roofs of wide span. The availability of so many anti-corrosive paints goes far to remove the principal objection to the use of steel, *i.e.* liability to rust. Painted steel offers the least possible opportunities for collection of dust, but whatever material is used, roofs or ceilings should be so constructed that they can easily be cleaned at frequent intervals. It is generally convenient to space roof principals 10 ft. 6 in. from centre to centre, *i.e.* the width for 3 cows. Internal pillars or posts are undesirable, but if unavoidable, they should be placed so that they do not stand out in passages, or interfere with the clear run of the gutters or mangers.

175. Suitable materials for roof coverings are tiles, slates, asbestos cement, good protected metals, or cedar shingles. Tiles and slates require a heavier roof construction and are relatively expensive to lay; but they are easy to replace and are comparatively efficient heat insulators, thus ensuring even temperature in the cowhouse. Where slates of good quality are available at a reasonable price they are probably preferable to tiles. Asbestos cement of good quality in the form of either slates, tiles, or sheets is a useful and efficient material for roofing: it is reasonable in price, easy to handle, light in weight, and can be used on a flatter pitch than is required for tiles or slates, but it must be adequately ventilated to prevent condensation. Protected metals, other than galvanized iron, form a very good and durable roof covering; they have advantages over asbestos cement in that they are not likely to fracture and purlins can be spaced at greater intervals. Cedar shingles form a satisfactory covering and are particularly suitable for adaptations, but they require a steeper pitch. Galvanized iron is not recommended as it permits extremes of heat and cold and gives rise to undue condensation: it is also subject to rapid deterioration. Thatch should be avoided because it harbours dirt, dust, and vermin.

THE COWHOUSE SYSTEM

176. Eaves gutters, and down pipes should be provided on all buildings and connected to drains or preferably to covered storage tanks so that the rain water can be used for washing down the cowhouse and watering the stock. Storage tanks should be so constructed and placed that they may be easily kept clean.

VENTILATION

Figure 15

177. Research work is needed before definite recommendations can be made on the best methods of ventilation. A regular renewal of the air in a cowhouse is necessary for the health of the herd and general experience suggests that the system of ventilation should be based on the following principles:

- a. Air warmed and moistened by the cows' respiration tends to rise to the upper parts of the cowhouse and if suitable outlets are provided in the ridge, foul air should escape there. If, however, the roof is too high, the foul air may become cooled before reaching the ridge outlets and may then fall again. Warm air escaping from the upper part of the building is replaced by cool air entering the cowhouse.
- b. The point at which fresh air is most required is low down near the head of the cow, and the provision of inlet openings in this position will reduce the flow of air into the house at undesirable points.
- c. Inlets and outlets need to be provided and their relationship adjusted so that air circulates freely in the cowhouse without causing draughts or excessive variations in temperature and so that condensation is avoided.

178. *Inlet ventilation* is best provided by inlets with an area of about 12 to 18 square inches or by 4 in. sanitary bends curved downwards—one inlet for every two cows. The inlets should be placed at a low level in the outer walls near the cows' heads and should communicate with external air not contaminated by proximity to manure dumps or other sources of infection.

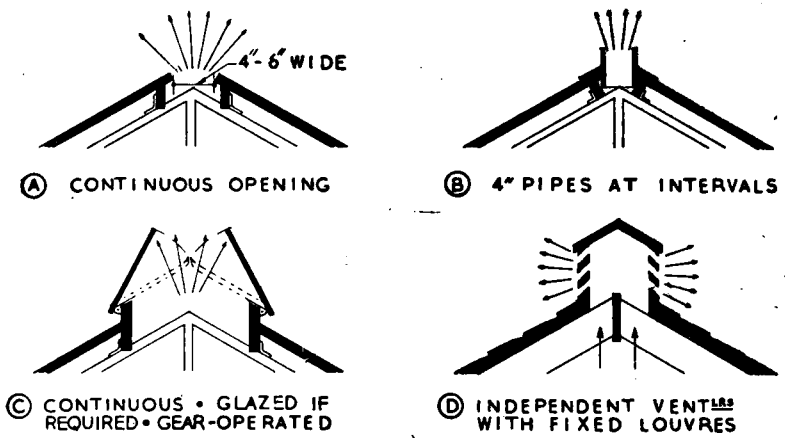
Where there is a feeding passage against an outer wall, the top of the inlet should be about 12 in. below the top of the manger or the manger wall. Where the cows' heads are against an outer wall, a baffled inlet or a sanitary bend should be placed just above the top of the manger in the middle of each double stall.

The most difficult cowhouses to ventilate are those in which the heads of the cows are close against an inner wall. These conditions should only be met with in the adaptation of existing buildings. In such circumstances fresh air can be provided by vents placed in the benching between the two mangers in a double stall and connected to a flue pipe running the length of the building and communicating with the open air (see Fig. 15 H). Possible positions for the flue pipe are behind or beneath the manger. Gratings should be fitted as a protection against rats and mice but the gratings should be removable so that the flues can be cleaned out when necessary.

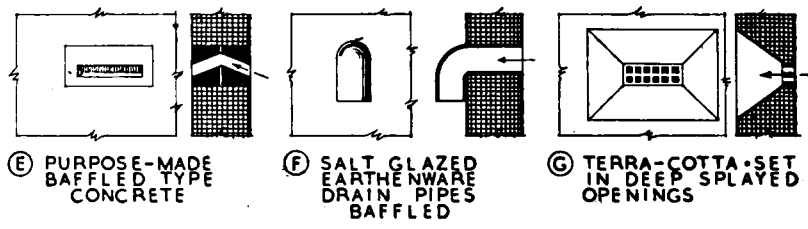
In exposed positions a proportion of the inlet ventilation should be adjustable or baffled, but provided draughts can be avoided, the freer the circulation of air in the cowhouse the better for the health of the herd.

179. *Outlet ventilation* in the roof is essential for the escape of used and foul air. The outlets should be evenly distributed throughout the length of the cowhouse and preferably placed in the ridge. Owing to the many variable factors it is not possible to give details of dimensions but the area provided for outlets should be greater than that for inlet ventilation.

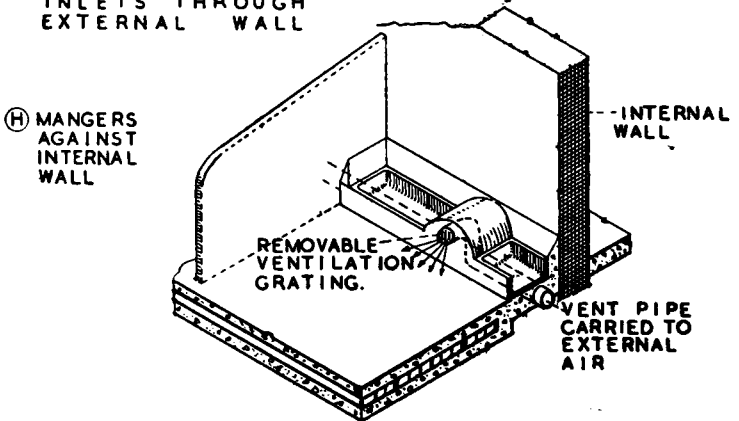
For roofs with a covering of tiles or slates, simple outlet ventilation can be provided by fitting specially designed ridge tiles. For asbestos cement or sheeted roof coverings there are specially designed ridge tiles or ventilation can be provided



OUTLETS AT RIDGE



INLETS THROUGH EXTERNAL WALL



INLET VENTILATION

FIG. 15. VENTILATION OF COWHOUSE

THE COWHOUSE SYSTEM

by leaving a 4 in. to 6 in. space uncovered along the entire length of the apex (see Fig. 15A). Other types of outlet ventilation suitable for all roof coverings are (a) various kinds of purpose-made louvres placed at intervals along the apex (see Fig. 15D), (b) 4-in. pipes inserted vertically at intervals and projecting 2 in. above the ridge (see Fig. 15B), or (c) the adjustable ridge ventilation system in which sashes, hinged on their lower edge, are fitted along the whole building on both sides of the ridge. The sashes may be opened or closed, as required, by a lever or winch at one end of the cowhouse (see Fig. 15C). If the sashes are glazed they also serve as roof lights, no other windows being necessary either in the roof or the walls.

ROOF LIGHTS, WINDOWS, AND ARTIFICIAL LIGHTING

180. Good light is required in every part of the cowhouse, and in greatest concentration on the hindquarters of the cow, but strong sunlight directly on the cows and milkers should be avoided. For these reasons the most desirable method of natural lighting is by roof or ridge lights. Experience also has proved that roof lights are more economic in maintenance as well as being far more effective than windows in the walls. In existing buildings with windows in the walls, roof lights can be added and placed so as to make good any deficiency in the wall lighting.

The total area of glass required will depend to some extent on the situation of the cowhouse but, generally speaking, it is hardly possible to give too much light. About 3 square feet of roof light per cow is necessary in a single-range house and rather more in a double-range house. If wall lighting only is provided, at least 4 square feet of window area is needed for each cow.

181. *Roof Lights.* Light can be provided by glass slates or tiles placed in the roof slope and evenly spaced throughout the length of the building or by a system of combined ventilation and lighting by adjustable glazed sashes along the entire ridge of the roof (See Fig. 15C). Lights should face north or east; roof lighting on one side only may thus be an advantage provided the amount of light is adequate. The old types of skylights made to open are not recommended.

182. *Windows.* Wall lighting is less efficient than roof lighting but where windows are provided they should be placed so that they throw light on the rear of the cows and they should, if possible, face north or east. Tall windows are not so satisfactory as narrow ones running the length of the building. They should be of the hopper type, opening inwards. The sills should not be lower than 4 ft. 6 in. above floor level and all windows should be set flush with the inside walls. Cast iron or galvanized steel frames are more costly but are cheaper to maintain. A large, easily opened window in the gable end is useful both for lighting and ventilation.

183. *Artificial Lighting.* For several months in the year, cowhouse operations must be carried on with the aid of artificial light. Where electricity or gas is available the advantages are obvious; points should be fixed to provide maximum light for milking. Thus in a single-range cowhouse the lights should be fixed at a height of about 7 ft. on the wall behind the cows but in a double-range building they should be suspended over the central gangway. Failing this, there should be a sufficient number of portable lights to provide adequate lighting for milking and other operations to be carried out efficiently.

FLOORS

Figures 13 and 14

184. Floors must be impervious to water, smooth enough to be easily cleaned but not slippery. The whole floor of the cowhouse, including the manger and

FARM BUILDINGS

feeding passage (if provided), must be laid to an inclination following the fall of the dung channel, so that the channel remains of uniform depth throughout. This requires a slope of $\frac{1}{2}$ -inch per cow, and economy naturally results if the original ground surface slopes in the required direction. The finished floor level should be above the surrounding ground.

The flooring should be laid on a foundation of suitable hardcore, 4-6 inches thick. It is important that the ground below should be well drained and rammed and consolidated to the proper level. The main flooring material should be cement concrete, laid not less than 4 inches thick and composed of one part Portland cement, two parts of clean sharp sand, and four parts suitable aggregate broken to pass through a $1\frac{1}{2}$ -inch mesh. This may be finished with a 1-inch layer of granolithic concrete. To give a good foothold the surface should be roughened with a stiff broom or a straight-edge or sprinkled with carborundum powder. There are many types of cement hardeners on the market which may be useful in certain cases.

STANDINGS

185. The construction of a concrete standing requires special consideration. The object is to provide a clean, impervious, non-slippery surface overlying a bed which will remain reasonably warm and dry. A fall of 1 to $1\frac{1}{2}$ inches from the manger to the step should be provided. It is essential that the site should be well drained, and that the surface concrete should be laid on a suitable foundation with ample air space to provide insulation. Coarse rubble may be used, but at slight additional cost insulation can be provided by hollow building blocks or land drain pipes laid side by side on a rubble or concrete foundation and covered with $1\frac{1}{2}$ -2 inches of fine cement concrete as previously described. Good hard bricks laid in cement on a firm smooth bed and well-grouted are favoured in certain districts, but concrete with insulation as suggested above is recommended. Compositions of cork, rubber, and asphalt, either in the form of bricks or laid *in situ*, present advantages in the way of resilience and warmth, but no material of this sort has yet been devised which is entirely satisfactory from the point of view of durability and economy.

It is essential that the combined length of standing plus width of manger should permit the cow to stand and lie down in comfort without becoming fouled. Dimensions for standings are given in paragraphs 168-170.

DUNG CHANNELS AND GANGWAYS

Figures 13 and 14

186. A dung channel or gutter, formed of concrete, should be provided at the rear of the standings. It should be 3 ft wide and should have a cross fall of 1 inch away from the standing, in addition to the fall of $\frac{1}{2}$ inch per cow throughout its length which is provided by the general slope of the floor. The flow of liquid may be encouraged by giving a smooth finish to the surface of the concrete in the dung channel for a width of 4 inches from the edge of the gangway. The vertical step from standing to dung channel should be 6 inches to 8 inches deep, whilst the rise from dung channel to gangway should never exceed 2 inches. The edges of the steps should be only slightly eased from the sharp edge—not bull-nosed or rounded off.

In many districts the step from dung channel to gangway is omitted, and the dung channel and gangway sloped towards a shallow gutter 6 inches wide and $1\frac{1}{2}$ inches deep at its lowest point; the gutter surface being finished smooth to facilitate the flow of liquid manure. This modification, whilst only favoured in certain districts, is definitely preferable where the width of the dung channel and gangway is somewhat restricted in adapting existing buildings.

THE COWHOUSE SYSTEM

Cross channels should be avoided unless the dung channel is longer than about 70 feet. If they are provided they should be about 12 inches wide covered with movable gratings, and lead straight through the wall to discharge into an outside trapped gully placed as near the external wall as possible. The longitudinal falls should be arranged to carry the liquid towards the cross channels.

187. The gangway in a single-range cowhouse should be at least 4 feet wide with a fall of 1 inch towards the dung channel. A stand for milking equipment is an aid to cleanliness, and this can be provided by a narrow, raised concrete block, against the back wall, of sufficient size to take the equipment. In a double-range cowhouse there should be a central gangway slightly cambered and not less than 5 feet wide.

MANGERS

Figure 16

188. Mangers should be made of hard, impervious material and so constructed that they may be cleaned easily. Wooden mangers are not recommended for cowhouses. There are two main types of mangers, individual glazed stoneware mangers (see Fig. 16A), and continuous mangers with high backs (see Figs. 16B and 16C).

189. *Individual narrow mangers (Scotch type).* Each cow is provided with a glazed stoneware manger which need be no more than 2 ft. 6 in. long, 18 in. wide and 8 in. deep (external measurements). The manger should be set in concrete, with the base on the level of the standing, and finished with a raised concrete benching at the back and sides. If there is a feeding passage the manger should be backed by a dwarf concrete wall to the height of 2 ft. 6 in. above the feeding passage, to prevent the cow nosing her food over the back of the manger. In addition two or three rails placed, as shown in Fig. 14, may also be desirable and will prevent the cows attempting to move forward into the feeding passage. One of the rails could be used as a water supply pipe for pressure feed water bowls.

190. *Continuous mangers* are made of stoneware or concrete and fitted with metal or concrete divisions to make a section for each cow. Where, as is usual, they are installed for cows secured by central ties they should be 3 ft. wide. If used with side ties, the width may vary between 1 ft. 6 in. and 2 ft. 6 in. A convenient height for the back is 2 ft. 6 in. above the feeding passage. The height of the front kerb above the standing should in no case exceed 6 in. to enable the cow to lie down or rise in comfort. The kerb should be about 4 in. thick and smoothly rounded. The lowest point of the manger should be $1\frac{1}{2}$ in. above the level of the standing, and not more than 9 in. from the front of the manger in order to permit the cow to reach her food without undue movement or straining.

Continuous mangers may be constructed of concrete laid in proper forms shaped inside with a template, and finished as smooth as possible with a steel float. The formation of the manger back with a slope, as shown in Fig. 16, saves concrete and gives toe-space for the cowman when charging the manger. Acid resisting cement should be used. Fixed or movable divisions should be provided in order to assist the accurate rationing of each cow and to reduce waste and the temptation of cows to reach beyond their particular section—a frequent cause of injury. The division should be strong enough to withstand normal wear and its construction should permit the manger to be easily cleaned. Glazed-ware mangers and manger linings are now available, and if they are laid continuously in concrete and are accurately jointed they are more satisfactory than a concrete finish which tends to become rough after a few years use. They are obtainable in half-round sections or shaped similarly to the standard type of manger and may be built in with concrete, finished smooth in the normal way.

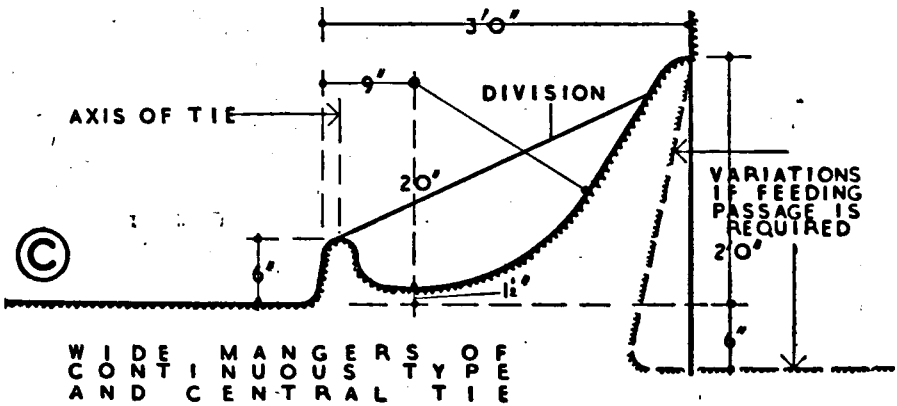
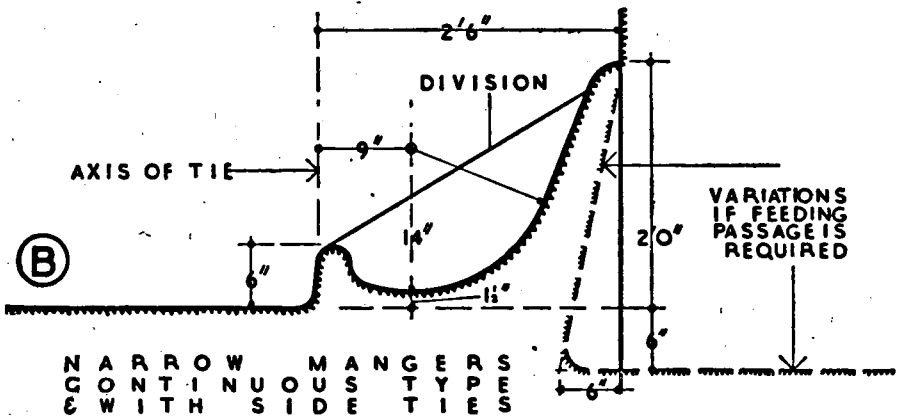
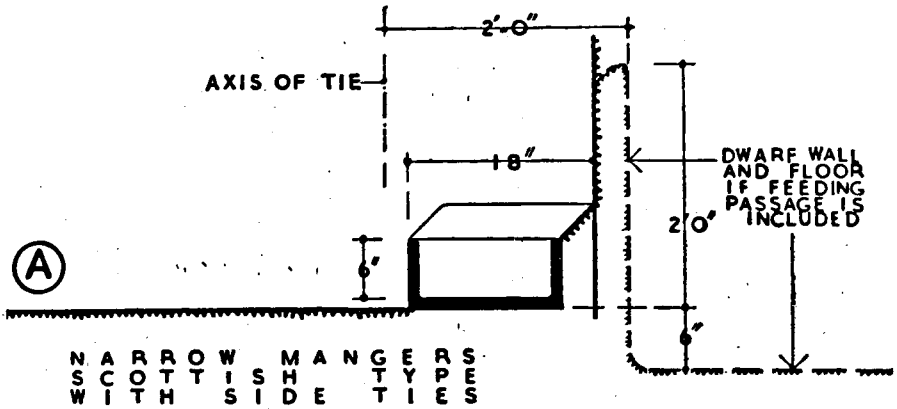


FIG. 16. MANGERS

THE COWHOUSE SYSTEM

191. All food, including hay, should be fed in the mangers. In carrying out adaptations, any existing hay racks should be removed. Hay racks must be unreservedly condemned as an unnecessary expense, and as productive of dusty conditions generally.

STALL DIVISIONS

Figures 17 and 18

192. Both in the construction of new cowhouses and in the adaptation of existing buildings, the provision of stall divisions is strongly recommended. Single stalls are sometimes used but double stalls are recommended. The stall division should not be longer than 3 ft. from the point of tying.

Two types of divisions are recommended:

- i. Solid divisions of precast concrete suitably reinforced, 2½ in. thick, 4 ft. high at the head sloping to 3 ft. 6 in. at the heel, and firmly set in concrete (see Fig. 17A).
- ii. Tubular divisions of galvanized iron for use with central ties (see Figs. 17B, 18 C, and 18D).

TIES

Figures 17 and 18

193. Although there are numerous designs there are only two main types:

- i. The side tie (single chain or single rope) for use with solid stall divisions.
- ii. The central tie (yoke or double chain) which restricts the movement of the cow backwards or forwards.

194. The side tie (see Fig. 17A) has often been criticized because it permits the cow to move too freely in all directions, to interfere with her neighbour, and to drop dung on the standing. If, however, this type is associated with a somewhat longer standing and a corresponding reduction in the width of the manger it is claimed that it provides the maximum amount of comfort for the cow. The tie should be secured by a ring sliding on a bar, and be capable of adjustment to suit the length of cow. It should be fitted with a device to ensure quick release under all circumstances.

195. Of the central tie type, the double-chain tie is generally suitable; it restricts to some extent any forward or backward movement of the cow. It may be used with single or double standings, and may be suspended centrally as in the Dutch type (see Fig. 18D) or by rings sliding freely on vertical bars (see Fig. 17B). The all-metal yoke tie (see Fig. 18C) is favoured by some milk producers, and is obtainable with various modifications in design from many leading firms.

WATER BOWLS

Figures 17 and 18

196. It is important to provide an automatic system of supplying drinking water to the stalls. There are two satisfactory types of water bowls:

- i. Those with a pressure feed and perpendicular tongues.
- ii. Those on gravity-feed with a non-return valve.

In cowhouses with solid stall divisions, side ties and narrow mangers a separate bowl for each cow is desirable; it should be placed against the stall division at

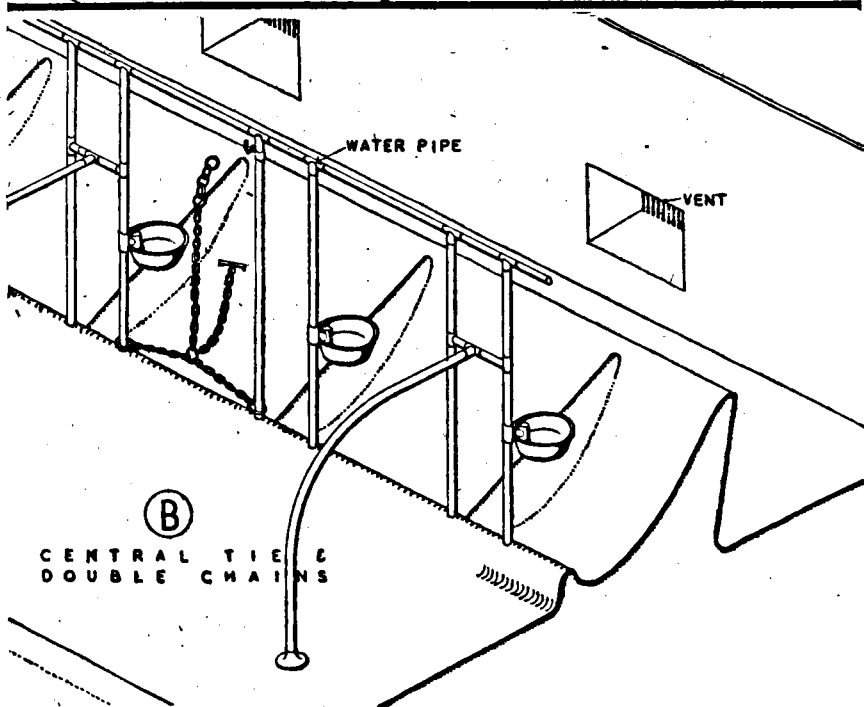
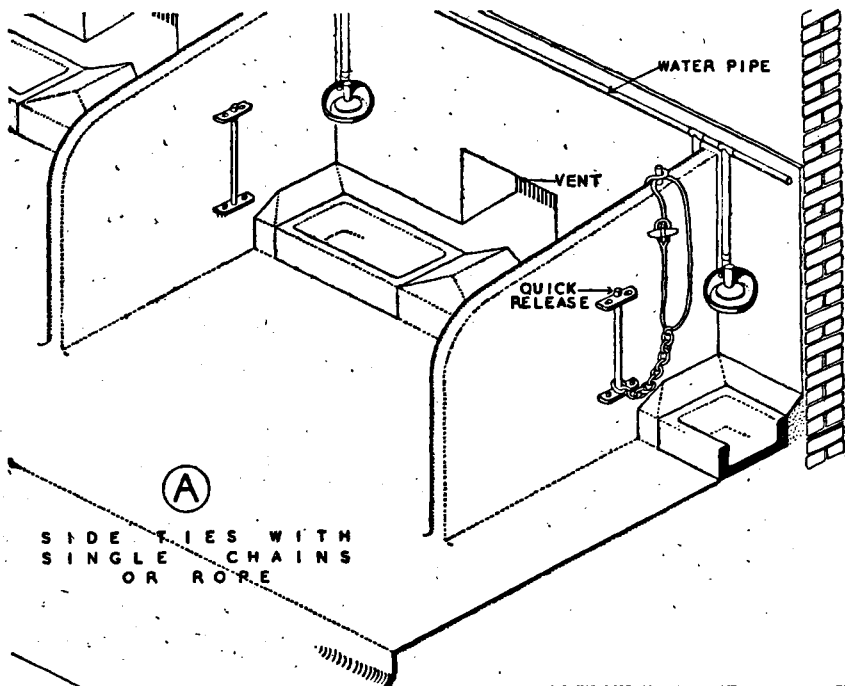


FIG. 17. TIES FOR COWS

THE COWHOUSE SYSTEM

the back of the manger. Where yoke or similar close ties prevent interference between the cows, one bowl (single or twin) may serve two cows, although a separate bowl for each cow is the ideal; the bowl or bowls should be placed between the two cows in the same stall. With this type of stall, the bowls should be at the front, not the back of the manger; they are usually fitted to the tie standards on the manger side with the top of the bowl about 2 ft. above the manger front. It is possible to buy combined stoneware mangers and water bowls.

It is important to choose bowls that are easily cleaned and to place them where they are easily accessible. Continuous water troughs or gravity-feed bowls that are not fitted with non-return valves are difficult to keep clean and they may spread disease; they are not recommended.

FEEDING PASSAGES

197. Whether feeding passages should be provided is a matter for individual preference. Opinions differ and the layout of buildings has to be considered. With some buildings access to the food store would be easier but with others access to the feeding passage would entail the loss of a stall. Feeding passages enable better observation and individual attention to the cows and may facilitate the feeding of roots and bulky fodder. Where central ties are used, feeding is usually easier from a feeding passage than from the standings. On the other hand, cowhouses without feeding passages are smaller, cheaper, more easily ventilated, and more readily adapted for other uses. Feeding passages should not be contemplated in adapting a building that is too narrow, and in no circumstances should they be provided at the expense of the dung channel or gangway.

Where a feeding passage is provided it should not be more than 3 ft. wide. There is an undesirable tendency for feeding passages to be used as food stores: the wider the passage, the greater the temptation to store hay and bags of feeding stuffs.

WATER SUPPLY

198. An adequate supply of water is essential for dairy farms, and the scarcity experienced in some country districts is a great handicap. As a rough guide to water requirements it is worth while to remember that a cow will drink approximately 8 gallons a day for maintenance and a further 2 or 3 gallons for each gallon of milk produced; cooling may take 5 or 6 gallons of water for each gallon of milk; and cleansing some 10 gallons per cow. Thus a daily supply of approximately 30 gallons per cow is desirable. This quantity may be reduced by double usage of the cooling water. Water should be laid on to the cowhouse and to the dairy for the milk room and the washing and sterilizing room. Taps with hose connexions should be placed at convenient points in the cowhouse and basins should be provided for milkers to wash their hands.

199. A main water supply has many advantages. In hot weather, however, the temperature of main water may be somewhat high for the satisfactory cooling of milk; therefore if well water of suitable purity is also available it should be used for cooling. Shallow well water in certain parts of the country is apt to fluctuate in quantity, and is for this reason often less efficient, while great care is necessary to avoid surface contamination. Deep well water, *i.e.* water drawn from beneath impervious strata, is generally suitable as it is more likely to be free from contamination and is uniformly low in temperature, an advantage when used for cooling the milk.

Where water for cooling has to be pumped to a storage tank, arrangements should be made so that the period of storage before cooling can be reduced to a minimum and the tank easily kept clean.

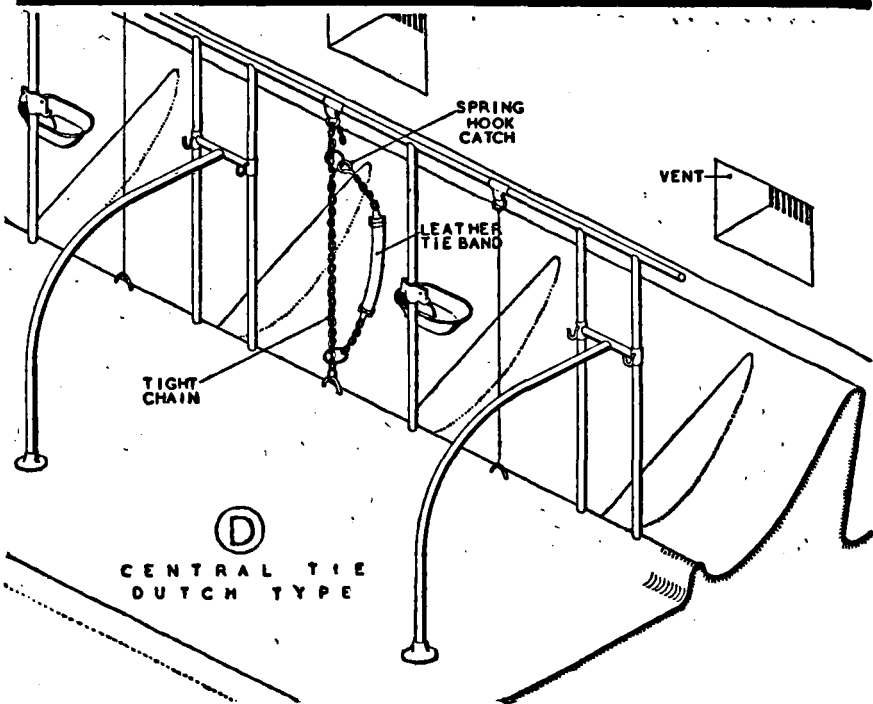
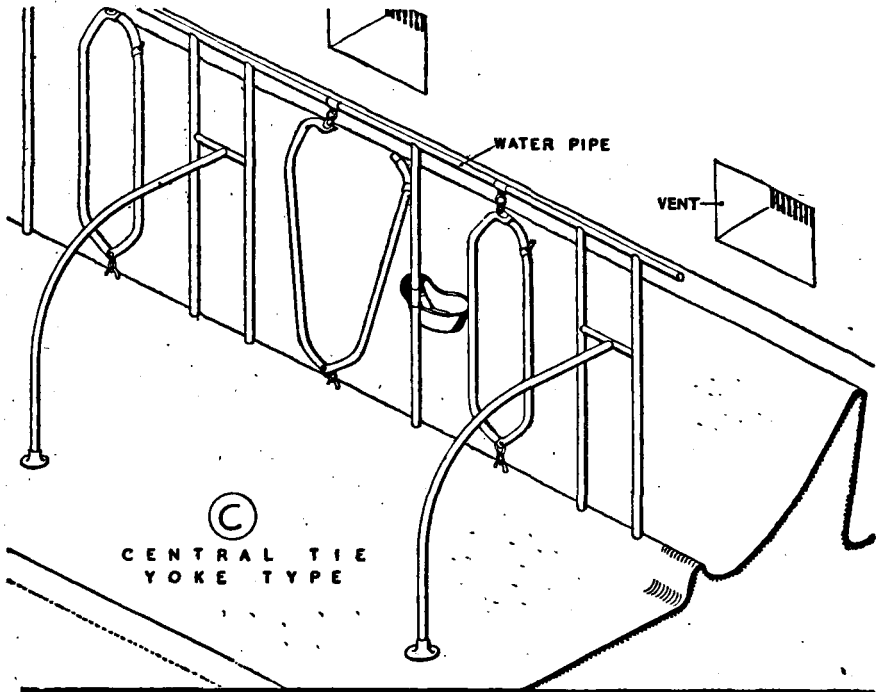


FIG. 18. TIES FOR COWS

THE COWHOUSE SYSTEM

200. It is an economy if water that has passed through the cooler is made available for further use either for washing the cows or cowhouse or for watering the stock. Similar use may be made of rainwater collected from the cowhouse and adjacent buildings and stored in covered tanks. With a main water supply, double usage of the cooling water is made easier by arranging for the water that has passed through the cooler to flow to a storage tank raised to about 7 ft. above floor level and large enough to hold the cooling water from two successive milkings. Care must be taken to prevent pressure of water damaging the cooler. This can be done by taking a $\frac{1}{2}$ -inch connexion from the main on to the cooler with a stop valve and fitting a $\frac{3}{4}$ -inch discharge pipe from the cooler to the storage tank. A pressure relief valve should be fitted to the cooler on the discharge side so that if the $\frac{3}{4}$ -inch discharge pipe should become blocked the valve will release the pressure and prevent damage to the cooler. This valve can be adjusted so as to obtain the right pressure of water through the cooler. This method has the advantage that the water can be passed quickly through the cooler; as main water may be of a relatively high temperature, the milk is cooled more effectively if the water passes through quickly. A separate connexion should be taken direct from the main to the storage tank so that if there is inadequate supply from the cooler the storage tank can be filled up direct from the main by opening a stop valve.

DRAINAGE

Figures 19 and 20

201. Any system of drainage must comply with the requirements of the Local Sanitary Authority. All gulleys must be placed outside the cowhouse. Arrangements should also be made for conserving liquid manure.

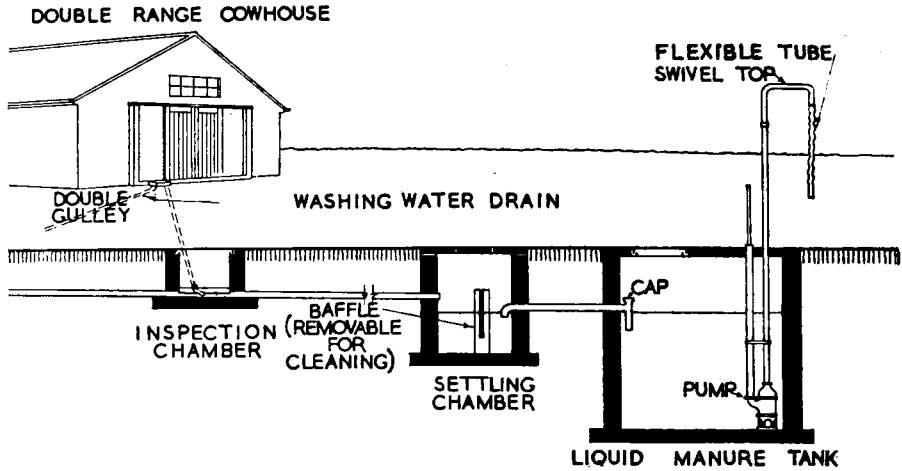
202. *Internal.* If the dung channels do not discharge at the end of the cowhouse, cross channels should be used to convey liquid manure and washing-down water to discharge outside the building. If covers for the cross channels are necessary they should be impervious and easily removable; cast-iron gratings are probably the most suitable.

203. *External.* The gulleys should be trapped and of the street type, provided with a strainer to intercept litter, and a bucket for removing sediment. An alternative to a gully is a small brick-built catchpit about 1 ft. 6 in. by 2 ft. 3 in. inside, covered with an iron grating from which sediment can be removed. The catchpit should be provided with a trapped outlet. The gully or catchpit should be connected to suitable drains for conveying liquid to the cesspool or ultimate outflow which, in the interests of the health of the herd, must not be near any ditch or stream to which farm stock have access.

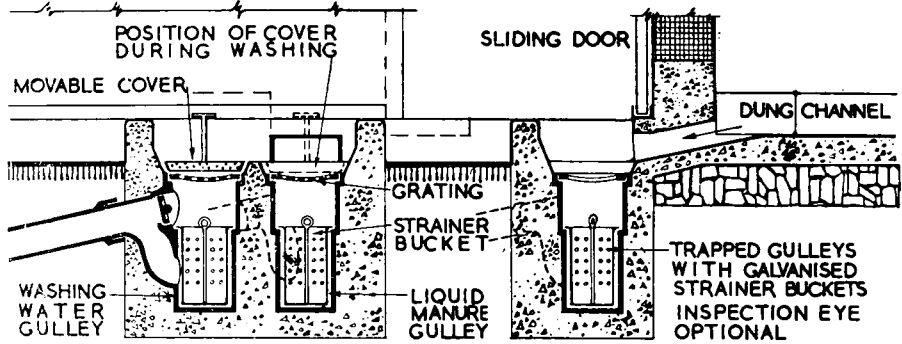
204. *Liquid Manure.* Where it is intended to use liquid manure on the farm—a course which is highly recommended—it will be necessary to make arrangements for collecting the liquid. The usual arrangement is to lead the liquid through a settling chamber to a storage tank. If the nature of the soil and the lie of the land favour direct application to the land, the tank can be emptied into irrigation channels. Otherwise the liquid manure from the tank can be pumped into a distributing cart or on to a compost heap. Whatever method is used, proper control must be exercised to protect the health of the herd.

Details of the construction of storage tanks are given in the Ministry of Agriculture and Fisheries' Advisory Leaflet 232, *Liquid Manure Tanks*, to which reference should be made for information to supplement the following notes:

a. *Dual System* (see Figs. 19 and 20). If liquid manure is to be conserved, it is advisable to avoid undue dilution of the urine. For this purpose two systems of drainage are required, one to carry washing water and rainwater to a convenient outfall and the other to take the urine to a storage tank. A second gully trap is

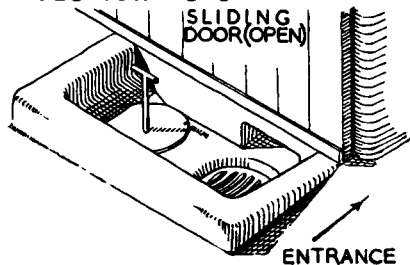
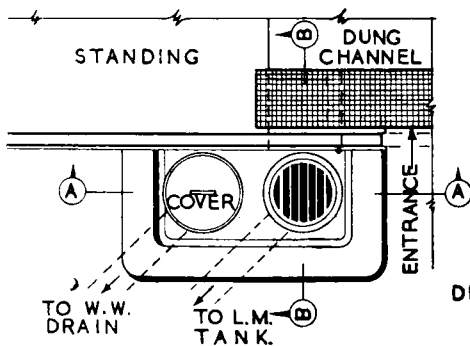


SECTIONAL VIEW OF INSTALLATION



SECTION - A - A

SECTION - B - B



DETAILS OF DOUBLE GULLEY

FIG. 19. DRAINAGE OF COWHOUSE, DUAL SYSTEM

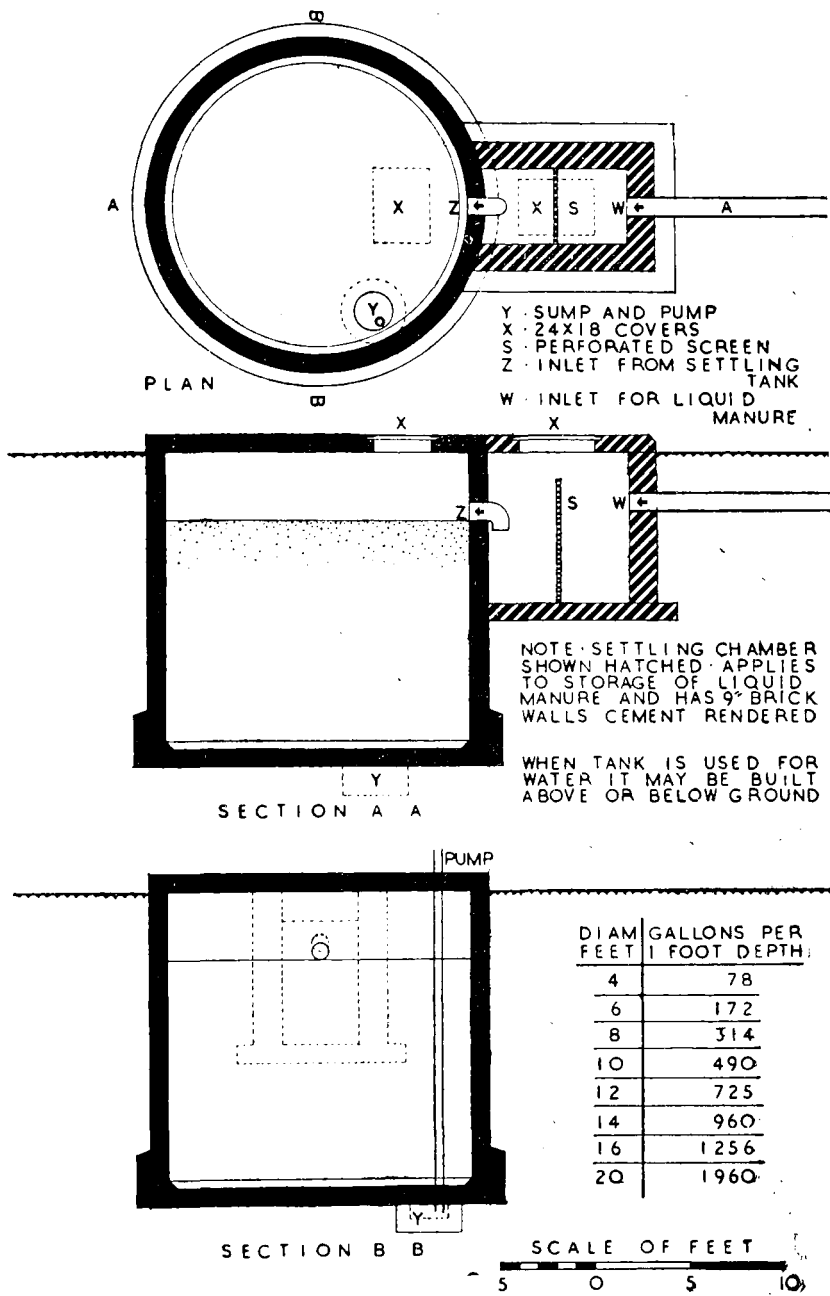


FIG. 20. STORAGE TANK FOR WATER OR LIQUID MANURE

FARM BUILDINGS

required at the outlet from the cowhouse so that, by the adjustment of a plug, the drainage can be diverted while the building is being washed down. The liquid manure is taken from the gully trap through glazed stoneware pipes to a baffled settling chamber and thence to a liquid manure tank. The pipe between the settling chamber and tank should be trapped by the insertion of a stoneware bend at each end to preserve the sealing surface which forms upon the liquid. The settling chamber and liquid manure tank should be built in brickwork or concrete and rendered internally. It is important that these compartments should be water-tight and air-tight, since it is essential that the air space over the liquid in the tank should be sealed. Access can be provided by means of air-tight man-hole covers. Unless the lie of the land enables the tank to be emptied without pumping, a specially designed pump should be fitted in the tank and the joint where it passes through the top of the tank should be made air-tight.

The capacity of the storage tank will depend on the size of the herd, the time the cows spend in the cowhouse and the period of storage. If the cows are housed day and night and the tank is to be emptied once a week, about $3\frac{1}{2}$ cubic feet of tank capacity (below invert) for each cow will probably be adequate.

b. *Single System.* For small herds or where the dual drainage system is not possible, some use can be made of liquid manure by providing a system in which both liquid manure and washing water are run into a settling chamber and liquid manure tank. The liquid obtained, however, is too much diluted to be of high manurial value. Care must be taken to prevent the tank overflowing, and unless some system of overflow or irrigation can be arranged the storage tank will need to be much larger than is required for the dual system. The Local Sanitary Authority should be consulted before such a system is installed.

MANURE DISPOSAL

Figure 21

205. An overhead carrier is a convenient and labour-saving means of removing manure from the cowhouse. If the gangway is wide enough, another method is to use a dung cart; where the layout of the building allows it is an advantage to have doors at both ends of the gangway so that the cart can be driven straight through.

It is preferable that manure should be carted away each day and not left near the cowhouse or dairy. For this purpose a loading ramp is a great convenience if a barrow has to be used for removing manure from the cowhouse. It is a common practice to take the manure to a fold yard for trampling by other stock, but if the fold yard is near to the cowhouse or dairy, ample litter must be added and great care taken to avoid the risk of contamination. If manure must be stacked in a dump in the yard then a concrete paved pit should be used. This should be placed well away from the buildings; save in exceptional circumstances where the risk of contamination is negligible, any manure heap should be at least 60 feet away from the cowhouse and dairy. Even so, the manure heap ought to be cleared at regular intervals. Therefore the pit should not be made too large; the size should be so adjusted to the size of the herd as to ensure that it must be cleared out not less frequently than every 6 to 8 weeks. The pit should be sloped and drained to the back and it should have a low retaining wall to prevent access by cattle.

APPROACHES TO COWHOUSES AND DAIRIES

206. Approaches to cowhouses should always be paved, preferably with concrete finished with a roughened surface, and sloped to an adjacent drain. It is desirable that adjoining yard surfaces should be suitably paved and kept free of mud and manure. Similarly it is important that the approaches to farm dairies and the

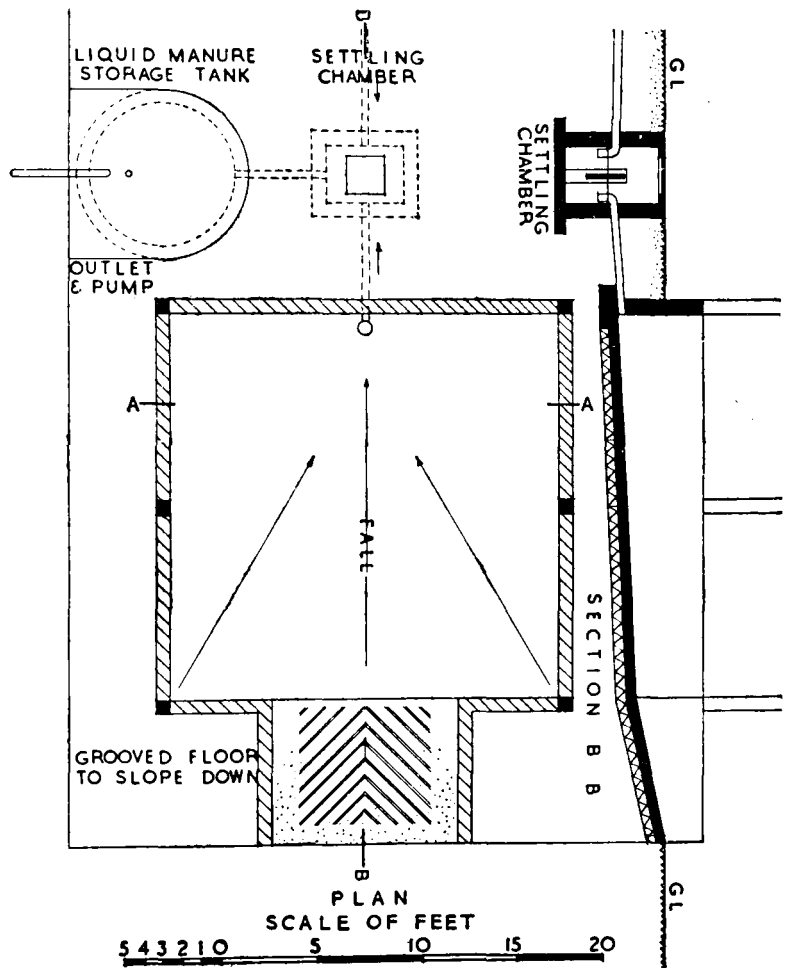
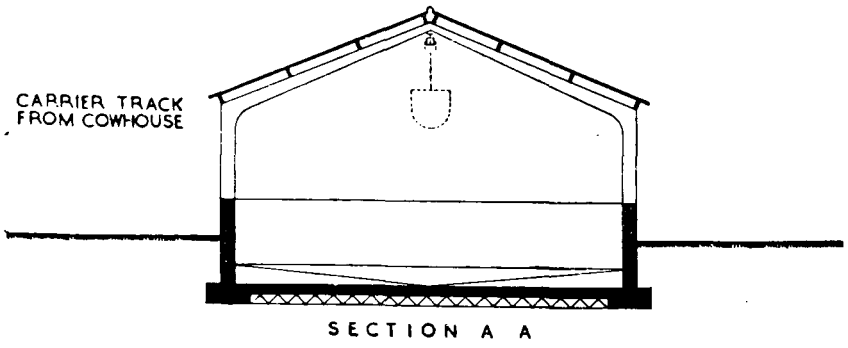


FIG. 21. COVERED MANURE PIT

FARM BUILDINGS

general surroundings should be capable of easy cleansing and be kept free of contaminating materials.

BOXES FOR ISOLATION, ETC.

207. On all dairy farms there should be adequate accommodation for calving, calf rearing, housing cows with minor ailments or otherwise in need of special attention, and for isolating diseased cows or new stock before introduction into the herd. Loose boxes are suitable for these purposes. It is desirable that boxes to be used for isolation should be some distance from the cowhouse, be without communication with neighbouring boxes, have separate connexion to the drainage system, and be constructed so that they can be easily cleansed and disinfected. Light, ventilation, and water are also necessary. Further details of the construction of isolation boxes are given in Chapter 12, paragraphs 351 to 356.

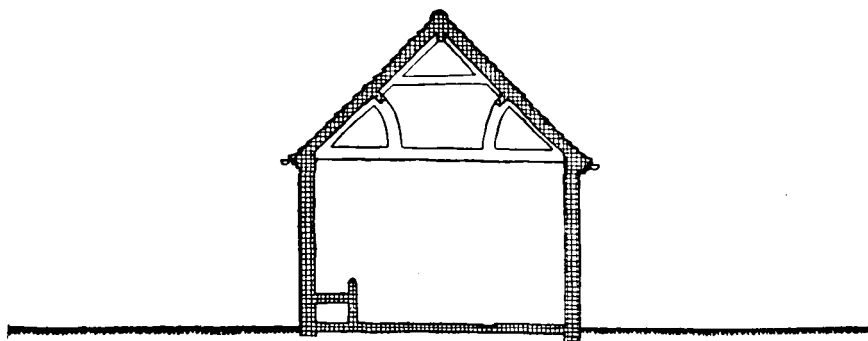
ADAPTATIONS

Figures 22 to 24 and Plates 5 and 6

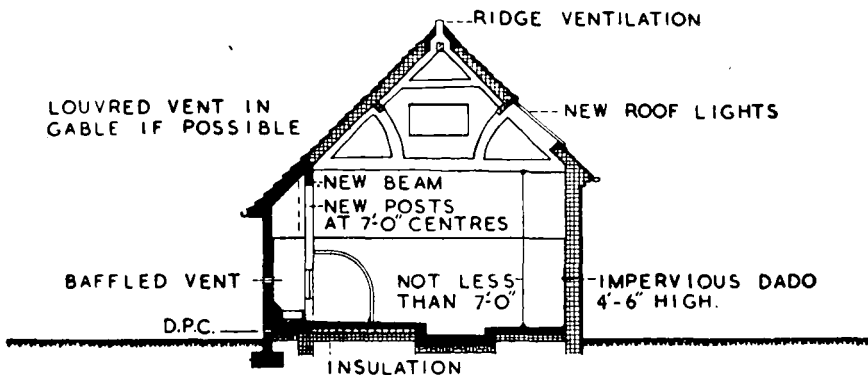
208. While the plan of an entirely new building may be designed to embody all desirable features with comparative ease, the adaptation of old buildings is often more complicated and provides more scope for ingenuity. The problem is not always so difficult and expensive as might appear at first sight, and if successfully dealt with, the cost of the operations will be more than offset by increased efficiency and saving in labour. When a farmer is proposing to recondition a cowhouse he should not think only of the existing cowhouse; he should consider also his other accommodation and obtain advice on the best use of his farm buildings as a whole. It may well be that the cowhouse is so situated that it is more suitable for a different use, whilst some other building could more readily be converted into a satisfactory cowhouse. One of the most common defects of old cowhouses is that they are too narrow and too low.

209. It is not possible to deal with the great variety of plans and constructions that may be met with, but a few typical examples of existing buildings are given, and suggestions are made for dealing with them in such a way as will satisfy statutory requirements. It should be remembered, however, that the general principles and many of the details of construction recommended for new buildings should apply to the adaptation of existing buildings. The main objective in any reconstruction is to obtain a cowhouse with good light and ventilation, an easy and clean approach, an impervious floor of correct layout, and fixtures which may be easily kept clean; the comfort of both the cows and staff must also be borne in mind.

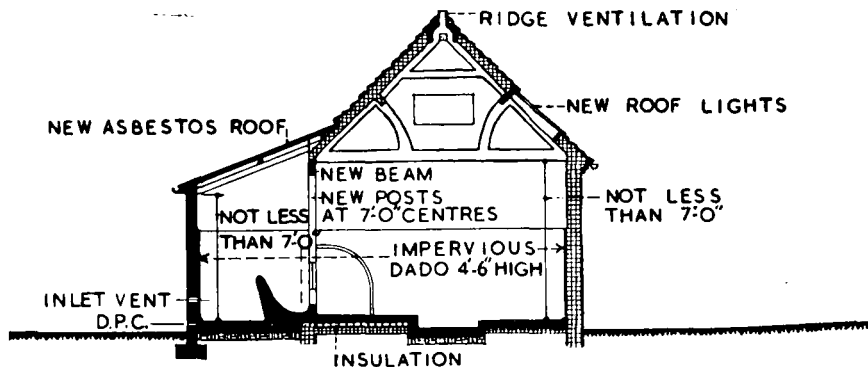
210. A common form of building 12 ft. 6 in. wide, obviously too narrow as it stands, and faulty as regards its manger, standing and channel is shown in Fig. 22. The easiest extension is on the manger side, with or without a feeding passage. It is necessary to see that the roof is tied and the bearing plate sound and continuous. Portions of the old wall are removed and new posts inserted at 7 ft. centres, and then the whole wall is removed and the new portion built. If a suitable old floor exists it can be used. Windows, ventilation, finish of floors, mangers, and other details will be improved or altered if necessary to follow the usual requirements. The system is applicable to plain buildings of almost any construction, and the drawings are intended to serve merely as suggestions. In the smaller extension shown, reaching only over the manger, slates or tiles can be run down in continuation of the old roof, but the wider extension involves the use of material that can be laid nearly flat. An extension on the gangway side is a little more elaborate inasmuch as the new wall must be built and new beams inserted to carry the existing roof, before the old wall can be removed, but this should not prove difficult.



(A) SECTION THROUGH EXISTING BUILDING



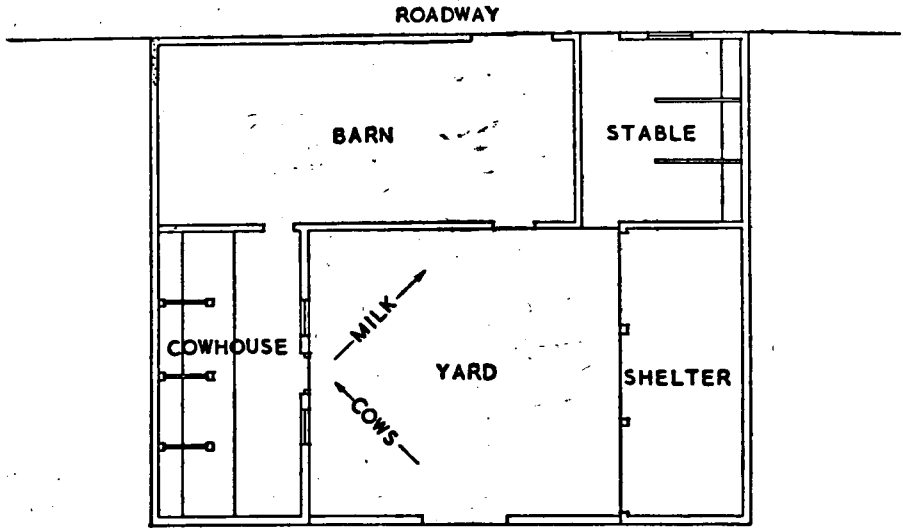
(B) EXTENSION ON MANGER SIDE WITHOUT FEEDING PASSAGE



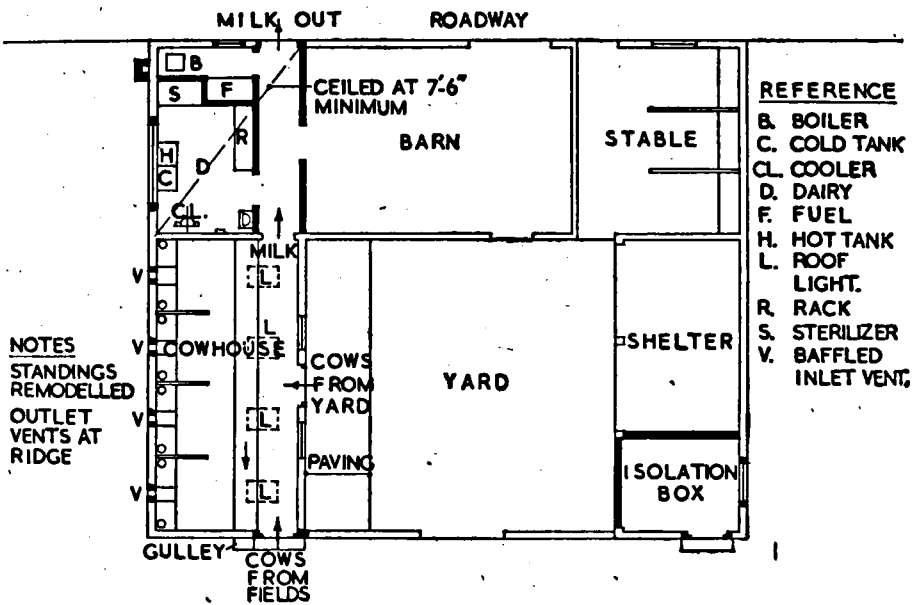
(C) EXTENSION ON MANGER SIDE WITH FEEDING PASSAGE



FIG. 22. ADAPTATIONS
NARROW BUILDING INTO COWHOUSE



(A) PLAN OF EXISTING BUILDINGS



(B) SUGGESTED ADAPTATION

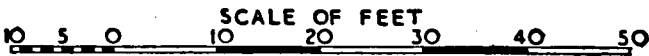
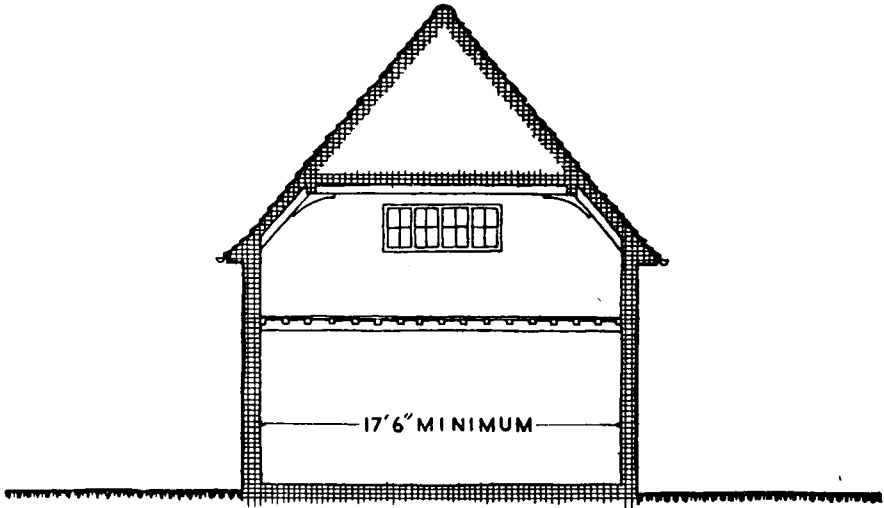
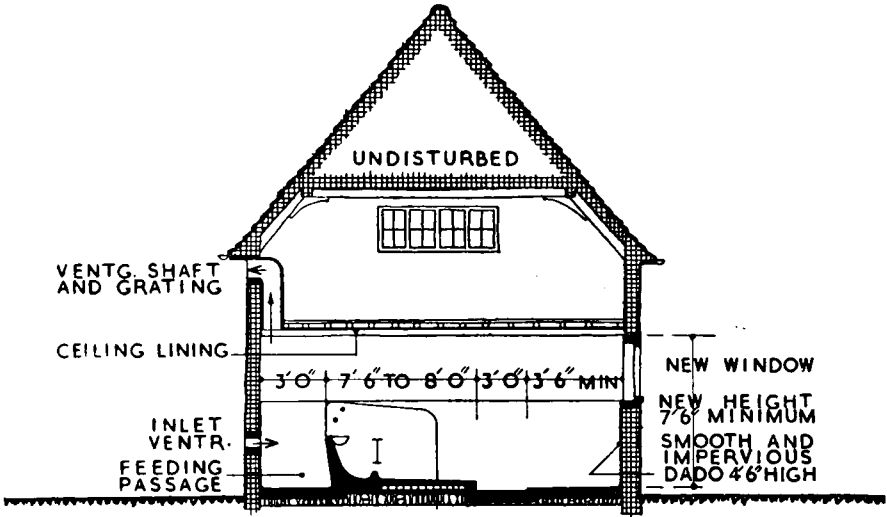


FIG. 23. ADAPTATIONS
PROVISION OF DAIRY IN EXISTING BUILDINGS



SECTION AS EXISTING



SECTION AS ADAPTED



FIG. 24. ADAPTATIONS
TWO-STORY BUILDING INTO COWHOUSE

FARM BUILDINGS

211. A set of buildings of traditional plan, illustrated in Fig. 23, shows a fold-yard open to the south, barns or food stores across the north side, one wing contains boxes, stables or shelters, and the other a cowhouse, while the centre is used as a stock yard. The only means of access for the cows is through the yard and in many instances milk is carried through this yard, or through buildings where it is exposed to dirt and contamination. The suggested plan shows a simple method of improving this unsatisfactory arrangement.

212. Where, by reason of a loft above, sufficient light and ventilation cannot be obtained in an existing cowhouse, the loft floor should be removed. If this is not possible, a wooden or metal ventilation shaft may be carried through the loft to the roof (see Fig. 24). In all cases the ceiling should be made dustproof. In dealing with old timber buildings, difficulty often arises in obtaining hygienic surfaces on those parts requiring frequent cleansing. A dado to the height of 4 ft. 6 in. with a smooth impervious surface is essential. This can be provided by expanded metal with cement rendering or by flat galvanized sheets.

213. Corrugated iron should not be used anywhere in adaptations; it has a short life, is difficult to clean and is little protection against extremes of temperature.

B. THE MILKING HOUSE SYSTEM

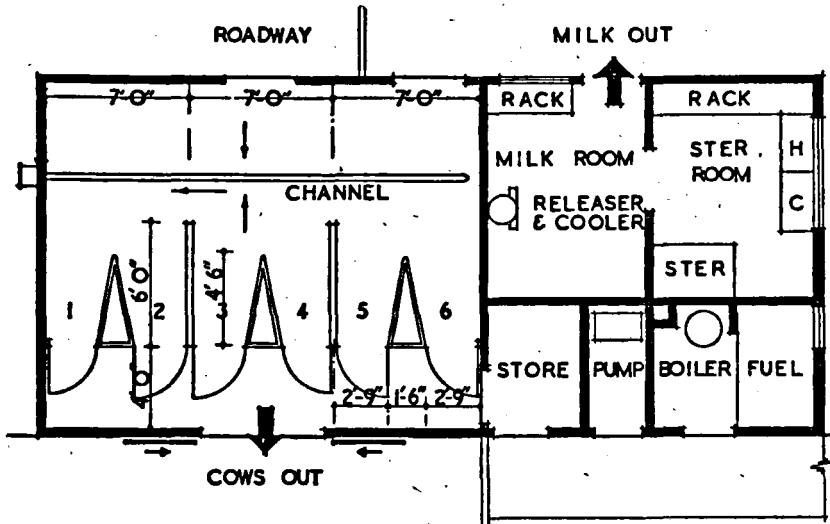
Figures 25 to 27

214. The history of dairy farming in this country has been one of constant development and adaptation to meet the changing economics and labour conditions of milk production. In recent years the ever-increasing demand for liquid milk for human consumption has involved more winter milk from the traditional dairying districts, and a widespread extension of milk production in other parts of the country, where cowhouses, as such, did not exist. Much greater emphasis has been placed on cleanly methods of production, labour-saving equipment, including mechanical milking, and the general health of the dairy herd.

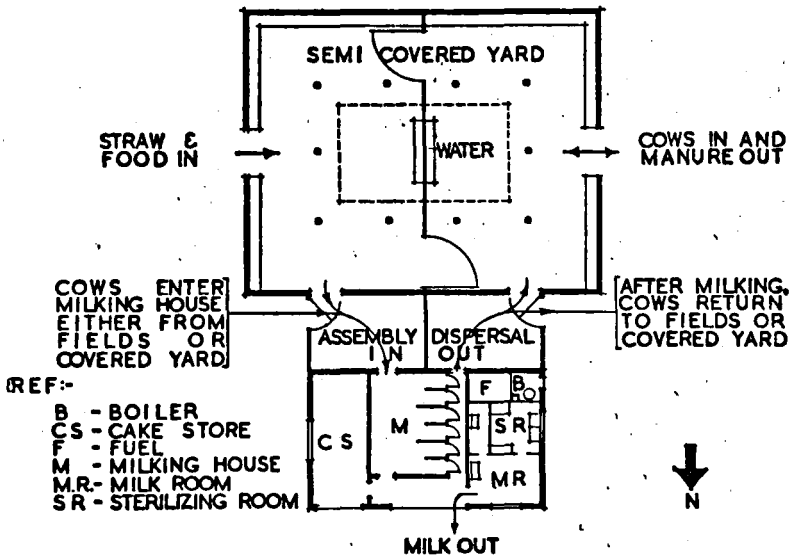
215. In some cases existing cowhouses have been improved and extended to provide for the desired expansion, a suitable farm dairy with a good water supply completing the scheme. Frequently, however, the existing buildings were unsuitable or too scattered for modern milk production, although capable, with slight adjustments, of housing the cows during the winter months. On mainly arable farms, covered or partly covered yards and fattening sheds prevailed; in some areas buildings were entirely absent. In the drier districts, with a mild winter and light soils, it has long been the practice to house the cows at milking times only, whilst even in less favourable districts they remained at pasture for the greater part of the year.

216. In these circumstances the milk producer usually desired to make the best use of existing buildings for housing the cows, at the same time taking full advantage of modern methods of production and labour-saving devices. The method in many cases was to provide a special milking house, adjoining a farm dairy, in which the cows could be cleaned and milked efficiently in batches, and receive their required ration of concentrates. By this means the available buildings or yards on arable and mixed farms could be used without extensive alterations or the expense of providing a cowhouse large enough to house the entire herd.

It must be understood, however, that this system of housing in yards has been very frequently adopted, not because the usual type of cowhouse could not be provided, but through confidence in the merits of the system itself.



PLAN SHOWING WALK-THROUGH SYSTEM WITH RELEASER MILKING UNIT.



COVERED YARD WITH WALK-THROUGH SYSTEM.

SCALE 0 10 20 30 40 50 60 FEET

FIG. 25. THE MILKING HOUSE SYSTEM

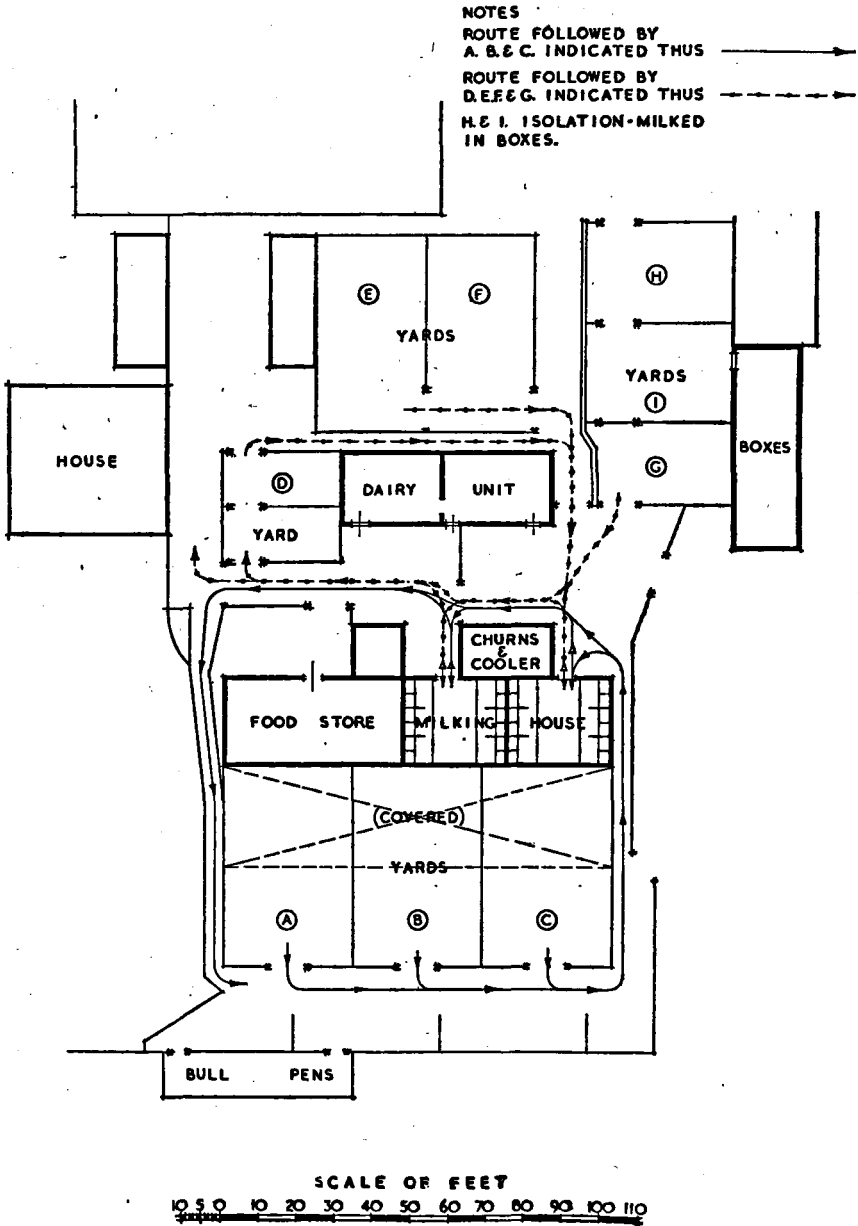


FIG. 26. THE MILKING HOUSE SYSTEM, EXAMPLE A

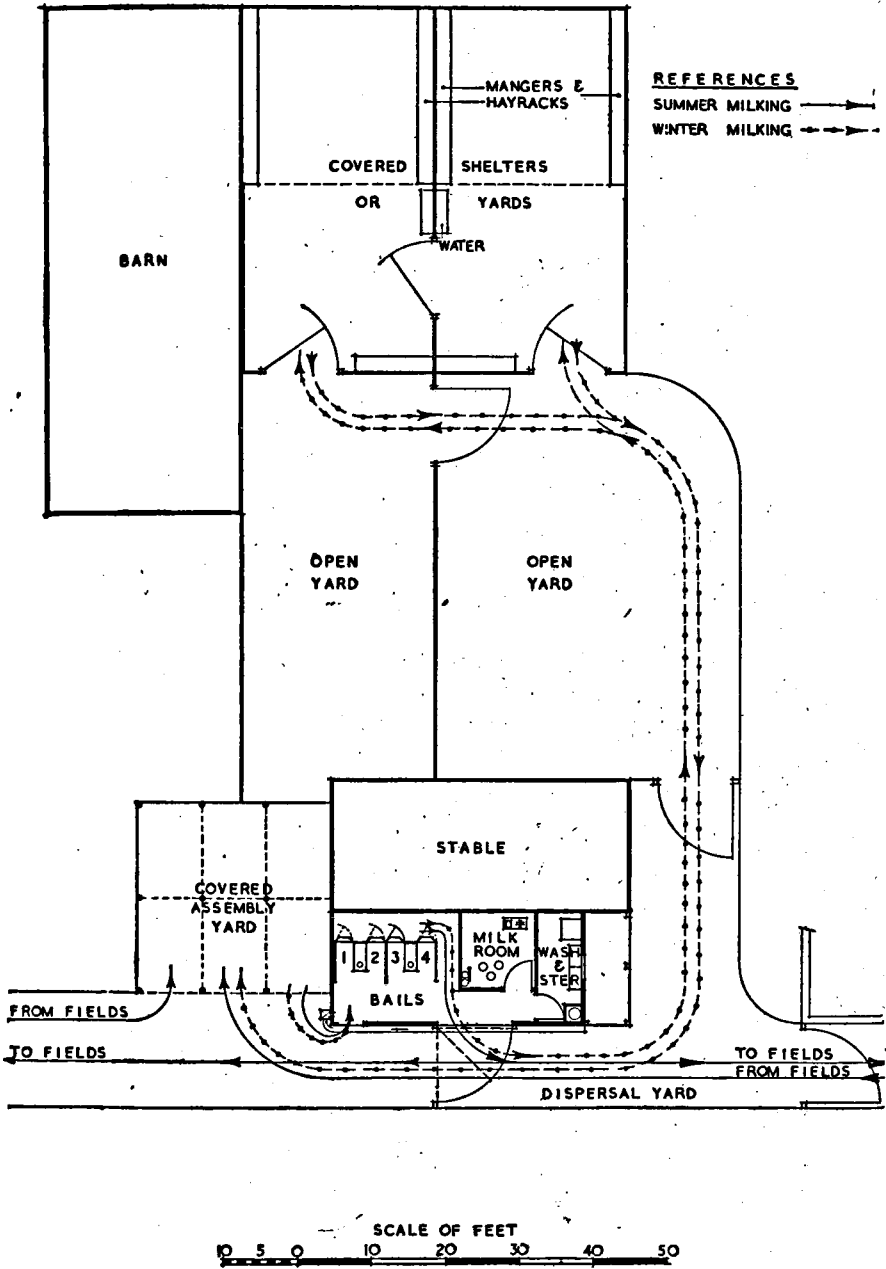


FIG. 27. THE MILKING HOUSE SYSTEM, EXAMPLE B

FARM BUILDINGS

217. The system is closely associated with mechanical milking by "releaser" or "releaser-recorder" milking machines, although hand milking or the "bucket" type of machine can equally well be used. It is doubtful, in fact, whether the milking-house system has yet reached its ultimate development with the necessary variations for herds of different sizes and farms of different types. There are, however, already a number of farms on which a completely new set of buildings has been erected on these lines.

The advantages claimed for this system are:

- a. Lower building costs compared with the cowhouse system—comparative estimates should always be obtained.
- b. Better health of cows and freedom from troubles in knees and hocks.
- c. Milk of high quality can be produced with less labour and trouble.
- d. The daily cleansing of a large cowhouse is avoided.
- e. Less water is required and there is less effluent.
- f. Dung and urine are conserved and may be removed from the yards at convenient intervals, an ideal arrangement for mixed or arable farms, whether large or small.
- g. The facilities and equipment for producing and handling the milk are concentrated, making supervision easier.
- h. In the summer months a collecting yard and a milking house are the only accommodation used by the herd.
- i. Where the open-air system is adopted during the summer months only, the bail can be transferred to a prepared site at the farm buildings to serve as a milking house during the winter.
- j. The buildings can be easily adapted for purposes other than milk production should a change in the system of farming render this necessary.

The alleged disadvantages are:

- a. Difficulty of isolation or segregation for disease control.
- b. Danger of bullying unless the master cows are separately housed or de-horning is practised.
- c. Difficulty of controlling individual rationing; heavy yielding cows require more careful handling and individual attention than is possible under this system.
- d. Frequent moves during milking time may adversely affect the milk yield.
- e. Unless ample straw is available the yards housing the cows become fouled.

218. Variations of form and complexity in the system are possible with considerable variation in the buildings required. The chief points are discussed in the sections which follow, and two examples are given of the system in actual practice for purposes of illustration only.

219. Apart from hand milking, there are two main types of milking machines associated with this system:

- i. The "releaser" type, in which the milk from each milking machine unit (*i.e.* each set of teat cups) is carried by a common pipe to the adjoining milk room for cooling, etc. An auto-recording device may be fitted to the milk pipe from each milking unit, the milk given by each cow being separately weighed by this device.
- ii. The "bucket" type in which milk from each milking unit flows into a closed "bucket" of special design, thus enabling the milk from each cow to be weighed directly.

THE MILKING HOUSE SYSTEM

The milk producer must, of course, choose his own type of machine, but in either case the number of milking units on the machine, and therefore the number of cows which can be milked at the same time, may be one, two, three or more up to the capacity of the engine and pump. The number of units will largely determine the total time required to milk the herd.

220. Gates and passages must be suitable for moving cows from the buildings to the milking house and back again. The arrangement may be very simple as in some adapted old buildings, or elaborate as in some new buildings (see Figs. 25 to 27). In some arrangements cows, after being milked, leave the milking house by moving forward through the stalls; in others they turn and pass out along the route by which they enter. Choice between these two ways of egress is dependent on general layout, and does not affect the general procedure described below.

221. Cows may be washed before milking, preferably in the milking stalls themselves. Separate washing stalls require a larger building with more fixed equipment, and the time available for feeding concentrates is reduced, since no food is supplied while the cows are being washed. The additional movement is in itself a disadvantage, and critics of the system state that the cows are moved too often and too quickly to allow of their giving their optimum yield of milk.

There is no fixed proportion between the number of stalls in the milking house and the average number of cows to be milked on the farm, and considerable variations are found in practice. The more stalls, the longer the time which can be allowed for feeding without unduly lengthening the time required for milking the whole herd, but against this must be set the cost of a larger building with its fittings. The number of cows which can be milked at any one time, *i.e.* the number of units on the machine, may be one, two or more, up to the total number of stalls or the engine capacity. It is usually half the number of milking stalls, one unit being placed between each pair of stalls. The greater the number of milking units on the machine, the greater the initial cost, but the less time required to milk the herd; an important aspect where rail or road transport is involved.

222. In the milking-house system, hay, roots, and other bulky foods are given in the fields or in the buildings or yards housing the cows, the concentrates being fed in the milking stalls while the cows are being milked. The amount of time available for eating concentrates is a matter of great importance, particularly with high yielding cows. With yields of the order of 500-600 gallons per annum, the cows can quickly be put through with twice daily milking. Where cows yielding 1,200 gallons or more are concerned, experience would appear to indicate that any form of batch milking is unsuitable; close individual attention as well as ample time for feeding being indispensable.

Although cows vary individually it can be reckoned that about two minutes are required to consume 1 lb. of concentrates. This may involve a period of 10-15 minutes or even longer in the milking stall, according to the amount of milk produced at the time. If this period is unduly limited, both the cow and her yield will suffer. It would facilitate smooth working, therefore, so to group the cows that those in the same batch are receiving about the same amount of concentrates.

GENERAL HOUSING

223. Buildings or yards used for general housing must provide conditions satisfactory for the health of the herd with adequate light, ventilation, and general sanitation. Facilities must also be available for segregation and isolation in the interests of disease control, for the prevention of bullying and the management of exceptionally heavy yielders. The cows will normally be housed during the winter months in existing buildings, or in covered or partly covered yards which are dependent on the liberal use of straw to ensure reasonable conditions of cleanliness. Where covered yards are used, small herds may be housed in a single yard, but for

FARM BUILDINGS

larger herds it is considered desirable to use separate yards for every 10 to 15 cows grouped according to yield and general convenience of management. A yard area of 100 sq. ft. per cow is desirable for the smaller breeds or polled cattle, and about 150 sq. ft. for the larger breeds. The construction of covered yards is dealt with in Chapter 13.

224. To secure an orderly procession of cows through the milking house it is necessary to plan an easy circuit to and from the living quarters and to provide sufficient gates for separating batches of cows. The milking house should, therefore, have easy access to the living quarters and to pastures. A concreted yard for collecting the cows either before, or preferably after, they are milked may assist smooth working; this applies particularly with larger herds where it might be possible for a cow to be missed or to return for a second helping of concentrates.

MILKING HOUSES

225. There are two main types of milking houses:

- i. The "walk-through" type usually associated with "releaser" or "releaser-recorder" milking machines.
- ii. The "cowhouse" type usually associated with hand milking or "bucket" machines.

226. The "walk-through" type may be a new or adapted building or part of an existing building suitably modified for the purpose. It should be at least 16 ft. wide so as to allow not less than 3 ft. for an exit passage in front of the cows and at least 5 ft. for a gangway behind them. The floor may consist of a foundation of hardcore covered with about 3 in. of concrete with a slightly roughened surface, and set sloping towards a shallow dished channel about 3 ft. behind the cows. The channel should run to an outside gully and thence to the farm drainage system. The walls should be rendered smooth for easy cleansing. Milking stalls for four, six, or eight cows with half the number of milking units are provided, according to the number of cows and the time allowed for milking the herd. They should be not less than 2 ft. 6 in. wide, and may be made of metal tubing or suitable hard timber with a light gate in front of each cow to which may be attached a receptacle for the concentrate ration. The gate, operated by a lever, should open upwards or outwards into the exit passage. Special washing stalls may be provided if so desired, but extra width of building will be necessary. Lighting and ventilation must be adequate. Piping for conveying milk to the milk room should be reduced to a minimum.

Where a movable bail is transferred from the fields to the farm buildings during the winter months, it should be housed on a suitably prepared fixed site. There should be sufficient floor space for the bail, in addition to an exit passage not less than 3 ft. wide and an entrance gangway at least 5 ft. wide. The floor should be of concrete, and shelter from the weather can be provided by a light structure such as an asbestos sheeting roof on metal, wood, or reinforced concrete supports and with smooth metal sheeting around the sides.

227. The "cowhouse" type may actually be an existing cowhouse, or part of it, if suitably constructed for easy cleansing. Either single-range or double-range cowhouses are suitable. If some other building is used for this purpose, the internal design should be simple but on lines similar to the normal type of cowhouse. It should be constructed for easy cleansing and should provide ample light and ventilation, a concrete floor, standings raised 3 or 4 in. above the gangway, solid or tubular divisions, double stalls and facilities for feeding the concentrate ration. A dung channel, 2-3 in. lower than the gangway and wide enough to take a broom and shovel, should discharge outside the building. An alternative is the shallow

THE MILKING HOUSE SYSTEM

dished channel as recommended for the "walk-through" type of milking house. Easy access to the milk room should be provided. The size of the unit will depend on the time and labour available to complete the milking operations, but it is usually desirable to provide stalls for not less than a quarter of the herd.

228. In all cases water must be laid on to the housing section for stock drinking, to the milking house for cleansing and for washing the cows, and to the dairy for cooling the milk and cleansing the utensils. Where a milking machine is installed, the farm dairy should include a boiler of sufficient capacity to ensure efficient sterilization of the equipment and utensils.

THE SYSTEM IN PRACTICE

229. Example A consists of a set of old farm buildings which have been converted to house a herd of 60 cows. Fig. 26 shows the general layout which, although not ideal, is considered the best possible means of making use of the existing buildings.

The cows can be milked in two batches. Those from yards A, B, and C are drafted into the milking house as indicated by the arrows and, after milking, back to the yards again. The second batch are kept in yards D, E, F, and G and can be drafted to the milking house and back again as indicated. Yards H and I are kept for dry cows. The milking house will accommodate 24 cows and is divided into two sections with twelve standings in each. The milking machine is of the "bucket" type, and there are four milking units. Concentrates are weighed and ready for the cows when they enter the milking house. Cows in excess of the number required in the two sections of the milking house are retained in the concrete yard outside until required in the milking house.

Twelve cows are washed at a time, the first twelve being dealt with by three men and a girl, the time taken being twelve minutes. Thereafter two men continue milking operations and the remaining staff carry out other duties, including calf feeding, returning to the milking house to wash cows as and when required.

Immediately the first twelve cows are washed the head stockman examines the fore milk, the second man following with the milking units. The time taken for actual milking is 3 to 5 minutes per cow.

Before each batch of twelve cows enters the milking house the concentrates plus roots are placed in each manger. The largest quantity of concentrates fed to any cow milked twice daily is about 8 lb. at each milking, and this is consumed at the rate of 1 lb. in two minutes. As each batch of twelve cows is in the milking house about 30 minutes, they have ample feeding time, and the batches are so arranged that the heavy yielders are milked first in the morning and last at night. In theory, it should be possible to complete milking in less than two hours, but in actual practice two and a half hours are allowed to ensure efficient production and the maximum yield.

The ties in the stalls are of the single chain quick release type, giving reasonable freedom of movement to the animal. Each manger is partitioned off to ensure individual rationing and milk yields have been well maintained.

230. Example B, illustrated in Fig. 27, consists of yards for 36 cows and a milking house. The milking machine is of the "releaser-recorder" type, consisting of four milking stalls with two milking units. Two cows are milked whilst two others are washed in the adjoining stalls, which are of the "walk-through" type.

The total time occupied by each cow in the milking stall, where the concentrates are fed, is about ten minutes, but additional time is allowed for heavy yielders. Up to 8 to 10 lb. of concentrates are sometimes given to an individual cow in heavy yield at the time. The herd average over the last eight years has been about 700 gallons per cow per annum.

FARM BUILDINGS

There are two yards, each 50 ft.×25 ft., accommodating eight horned cattle, or sixteen dehorned cattle. In summer two men are employed and are able to give some assistance in other farm work; in winter they are fully occupied with the dairy herd. Each man manages two stalls, washing one cow while the other is being milked, and doing all the cleaning, feeding and other work connected with the milking house.

C. THE OPEN-AIR SYSTEM

231. Open-air dairy farming is a system adopted in certain districts where climatic and soil conditions permit the dairy herd to live in the open and be milked in the fields throughout the year, or during the summer months. Milking in the fields, especially by hand, is open to serious objections, unless special precautions are taken to maintain cleanliness, but it can be carried out satisfactorily in a movable milking plant commonly known as a bail. In mild climates with low or medium rainfall, this system is suitable for light, well-drained soils, and has in many cases been adopted on land distant from buildings, or where buildings are too small or otherwise unsuitable either for milk production or the maintenance of the health of the herd. Mechanization leads to economy and concentration of labour, whilst the daily moving of the bail reduces the soiling of cows and of equipment to a minimum, and solves the problem of drainage and manure disposal. The system ensures the maximum use of manurial values and is in keeping with arable farming and alternate husbandry. It does, however, require an adequate water supply for stock drinking, cooling the milk and cleansing utensils, and a high standard of management is essential, particularly during hot weather.

232. A convenient herd unit is 50 to 60 cows, usually milked in batches of six or eight by not more than three workers. The usual practice is to make a large collecting pen, by means of movable light wooden fencing or an electric wire fence. At milking times the cows are driven into the pen and then passed in rotation through the milking plant. The bail is moved each day and the pen every third or fourth day. To facilitate clean milk production the bail should be worked on dry land, reserving the driest sites for use in periods of bad weather. On dry turf the collecting pen will remain reasonably clean and suitable for at least one day and the turf in the bail will not be broken in normal weather. To avoid two moves per day during very wet weather it may be necessary to use a thin layer of straw in the bail. Clean straw should be used for each milking, but the use of litter to avoid daily moves is a practice to be discouraged since many of the advantages of the bail system are lost unless daily moves of the bail and frequent moves of the collection pen are made. Contamination by mud in winter and by dung all the year round is much reduced by frequent moves. In winter, advantage should be taken of any natural shelter from prevailing winds, but in summer the bail should be kept on open sites to take full advantages of breezes to reduce trouble from flies.

233. The bail itself is designed to accommodate the herd in small batches of 6 or 8 cows for cleansing, milking, and feeding the concentrate ration. It has no floor but is mounted on wheels or skids to assist moving by horses or tractor. Cover from rain is provided by means of a light roof and all parts liable to contamination by manure or milk splashings should be made or covered with metal to assist easy cleansing. The bail usually includes 6 or 8 stalls of the "walk-through" type, with half the number of milking units of the releaser or releaser-recorder machine type, a device for feeding concentrates to each cow, a milk cooler and accessories for cleansing, sterilizing, and storing the equipment. It is essential that the machine and all utensils which come in contact with milk should be cleansed and stored as efficiently as under the more normal systems of production. To ensure that this will be done under reasonable conditions for the employees,

THE OPEN-AIR SYSTEM

the provision of a portable hut is desirable. This hut should be divided into two compartments in one of which the boiler and engine are housed; the other and larger compartment should be provided with a perforated metal floor, and used as a combined milk cooling and washing room. Alternatively the cooling of the milk, and the cleansing and sterilization of the utensils can be carried out at a farm dairy, provided they are protected from contamination during their return to the bail. A piped water supply to the fields, with service points for the bail and for stock drinking, is a great asset; it ensures an adequate supply and avoids the daily cartage of a relatively large volume of water from a distant source.

234. A study of this system in various localities, with particulars of labour, costs and output, has been published by the Agricultural Economics Research Institute, Oxford (*Open Air Dairy Farming*—by R. N. Dixey).

THE FARM DAIRY

Figures 28 to 30

SITE

235. Hygienic conditions are of first importance in selecting the site for the farm dairy. The site should be well drained and, save in exceptional circumstances where the risk of contamination is negligible, the dairy should be at least 60 ft. away from any cesspool, dung heap, liquid manure tank or other possible source of contamination. The dairy should be near the cowhouse but should have no direct opening into it or into any other building from which contamination may arise. A covered way between the cowhouse and the dairy is a great advantage. The approaches from the cowhouse and the roadway should be so constructed as to ensure cleanliness in the dairy. Easy access for milk loading should also be considered and advantage taken of any natural fall on the site. In planning the dairy, the milk room should be so placed that it is sheltered from the sun and faces north or east wherever this can be arranged.

ESSENTIAL REQUIREMENTS

236. Whether the farm dairy is provided by a specially built self-contained unit or by the adaptation of existing premises, the essential requirements are:

- a. A milk room for cooling the milk, filling the churns or bottles and storing the milk before despatch from the farm.
- b. A washing and sterilizing room for cleansing and storing all milk utensils.
- c. A boiler house for the boiler and fuel (unless a gas or electric sterilizer is used).

237. On farms where a number of milkers are employed, the boiler house could with advantage be large enough to serve also as a warm mess-room for the staff. A desirable, though not essential, addition to the milk room is a separate milk receiving room where the milk can be weighed, poured into a receiving pan and, by means of a detachable pipe, passed through the wall to the cooler in the milk room. If the receiving room is omitted the receiving pan can be placed in the washing and sterilizing room.

238. For small herds of not more than 15 to 20 cows, where the milk is sold under a wholesale contract only, and is not stored on the farm after production, the dairy may be reduced to a single room large enough for cooling the milk, and washing, sterilizing, and storing the utensils. The boiler should, however, be capable of fuelling from the outside of the dairy or, alternatively, be separately housed unless electricity or gas is the source of heat.

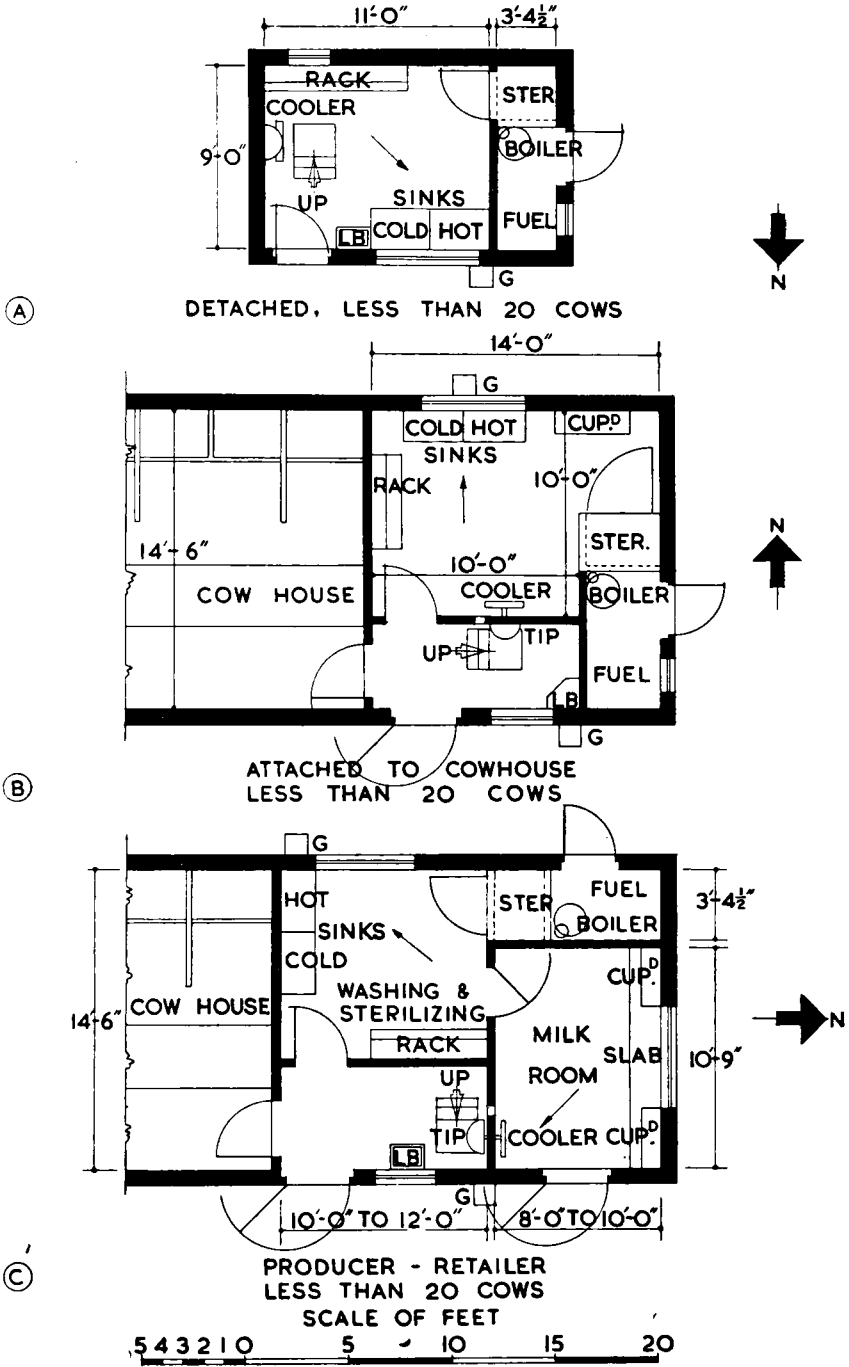


FIG. 28. FARM DAIRIES FOR SMALL HERDS

THE FARM DAIRY

DIMENSIONS

239. In designing a new farm dairy, the size and shape of each room will depend mainly on the size of herd, the available site and the shape of the building as a whole. Necessity for milk storage and the retail sale of milk in bottles will involve relatively larger milk and washing rooms than on farms where milk is despatched in churns on a wholesale contract only. Square buildings with adjacent rooms are usually cheaper than long narrow buildings of a single room width.

240. Convenient minimum sizes in square feet for each room are as follows:

SIZE OF HERD	MILK RECEIVING ROOM	MILK ROOM		WASHING AND STERILIZING ROOM		BOILER HOUSE
		W	R	W	R	
Less than 20 cows	sq. ft. —	sq. ft. —	80	100	100	30
20-40 cows	40	60	120	120	150	40
Over 40 cows	40	100	150	150	200	50

W=Wholesale contract only.
R=Producer-retailer.

241. The inclusion of a boiler house, even for the smaller units, is usually an asset although not essential in many cases. Typical plans are given in Figs. 28 to 30. There should be direct access between the milk room and the washing and sterilizing room, but not between the receiving and milk rooms nor between the washing room and boiler house. Economy in space and heating is achieved if the sterilizing chest is placed mainly in the boiler house adjacent to the boiler itself, the front opening into the washing room through the dividing wall.

CONSTRUCTION

242. The choice of materials for the construction of a farm dairy are determined partly by locality and partly by the degree of economy desired. The ideal dairy for a large herd would probably consist of brick or concrete walls lined on the inside with smooth cement, specially constructed concrete floors, sound roof with a suitable ceiling, north lighting, and efficient ventilation. There would be four complete sections, viz. milk receiving room, milk room, washing and sterilizing room, and boiler house. The receiving room would be approached from the cowhouse by means of a covered way.

On the majority of farms, however, it will be necessary to adapt existing buildings.

243. *Walls.* Interior partition walls may be of local materials, or cement breeze blocks or hollow building blocks rendered smooth with cement. A smooth cement dado should reach to a height of at least 4 ft. 6 in. around the walls, extending to the top of the wall behind the cooler. In all cases the wall surface above the dado should be capable of easy cleansing. To this end brick walls should be pointed and rough surfaces rendered with smooth, hard cement. If a liquid covering is desired, flat washable paint should be used. Whitewash and distemper are unsuitable because of their tendency to flake. All internal angles should be coved and window ledges, etc. sloped to avoid the collection of dust.

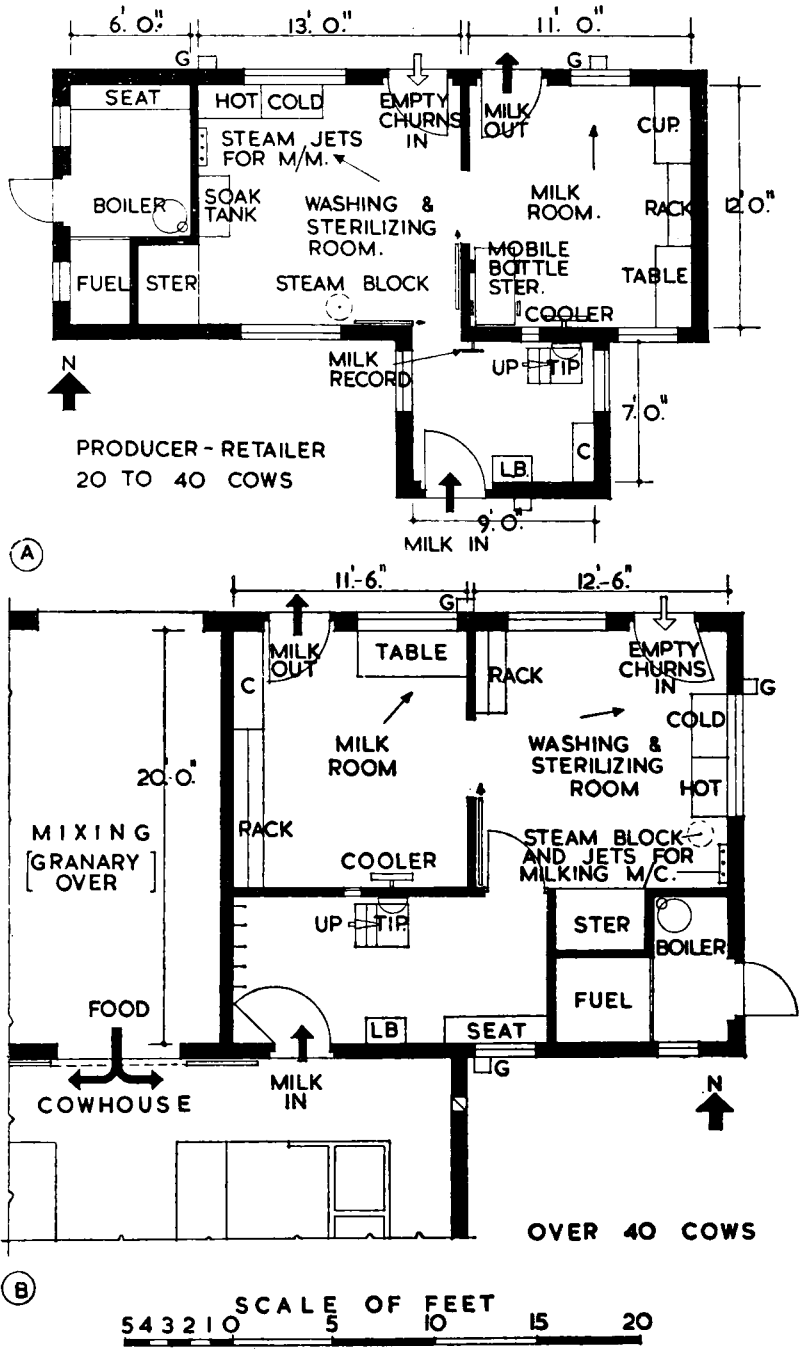


FIG. 29. FARM DAIRIES, FOR MEDIUM AND LARGE HERDS

THE FARM DAIRY

244. *Floors.* The floors should be acid-proof and of non-absorbent material and have a sufficient fall (1 in 50) for drainage to an open shallow channel leading through the wall to a trapped external gully. Floors are usually made of impervious concrete, but Staffordshire blue brick, or hard stone paving, set in cement and well grouted, may be used. In the milk room excessive wear may be reduced by embedding perforated cast iron gratings in the concrete where traffic is heaviest. In all rooms the surface should have a smooth finish and be made more resistant to wear and corrosion by the use of a topping containing granite chippings, steel grit or carborundum powder and a special waterproof hardener.

245. *Roof.* The roof covering may be tiles, slates, wood shingles, or asbestos-cement sheeting. When tiles or slates are used, the roof should be ceiled by plastering or by underlining with a smooth impervious material. A flat ceiling with a suitable ventilation shaft in the centre is the ideal to be aimed at in the milk room itself.

246. *Lighting.* Ample north lighting should be provided by sash or hopper windows in the walls and fixed glazed lights in the roof. The window openings should be covered with perforated zinc or wire gauze to exclude flies.

247. *Doors.* Separate external doors should be provided for each section of the dairy; a sliding door could be used to connect the milk room with the washing and sterilizing room. Both the door and surrounding fittings should be as free as possible from crevices and ledges which tend to collect dirt.

THE MILK ROOM

248. The use of this room should be reserved for the cooling, handling, and storage of milk and possibly for the storage of small utensils. The cooler is usually suspended by metal brackets fixed to the wall at a height convenient for filling bottles or churns direct from the cooler. If churns and small utensils cannot be stored in the sterilizer, metal racks consisting of two or three lengths of galvanized iron tubing should be provided at a sufficient height (usually 2 ft. 6 in. to 3 ft.) to permit of easy cleansing beneath. A stone or slate bench is an advantage if milk is bottled. A portable washable table is also a convenience and portable metal stands for the cooler are now available.

THE WASHING AND STERILIZING ROOM

249. This room should be larger than the milk room, particularly if bottles and milking machine equipment have to be dealt with. It should contain the necessary sterilizing equipment and an adequate supply of hot and cold water piped to a portable two-sectioned metal trough fitted with drainage plugs. Where a milking machine is used the equipment should include steam jets at least 6 feet from the boiler, which must be of sufficient capacity to ensure efficient sterilization of all parts of the machine. Churns can be sterilized singly by inverting them over a steam jet projecting through a block or pedestal about 6 in. above the floor. In practice, however, greater efficiency and economy are usually obtained by sterilizing the churns in the sterilizing chest than by the use of a steaming block. The sterilizing equipment should be in that part of the room nearest to the boiler in order to avoid undue loss of heat. Unless there is danger of contamination from a boiler, the milk receiving tank, fitted with a suitable detachable lid, may be placed in this room and reached by means of portable steps constructed of wood or metal which can be easily cleansed. The layout should be so planned as to ensure the maximum economy in labour.

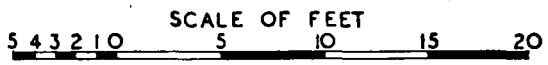
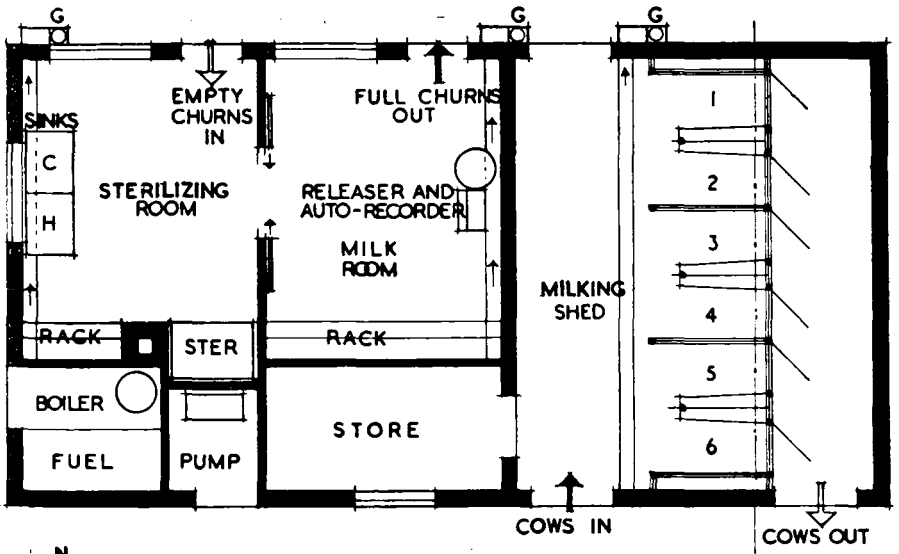
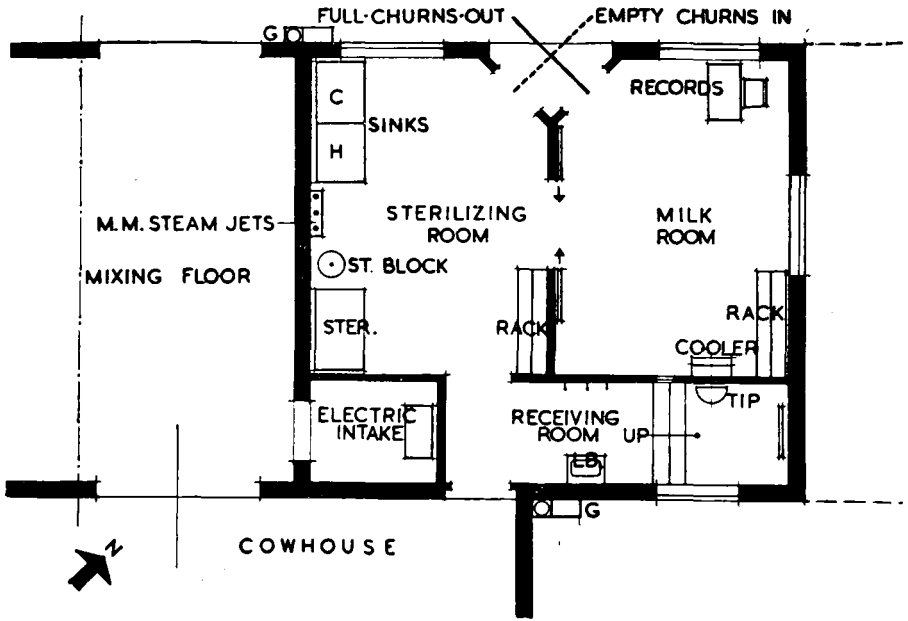


FIG. 30. FARM DAIRIES, FOR LARGE HERDS

THE FARM DAIRY

250. If a pressure boiler is used it is more economical to heat water by blowing steam through a flexible pipe into cold water in the washing tank, or into a special tank provided for the purpose. Otherwise hot water may be obtained from an open copper used solely for dairy purposes, or direct from a low pressure boiler. It should be realized, however, that a farm copper is only suitable for very small herds where the milk is sold wholesale.

251. For producer-retailers and producers possessing large herds, a special boiler and sterilizing chest are essential. The chest should be of sufficient capacity to permit sterilization of all the necessary equipment in one operation, except in the case of producer-retailers where separate sterilization of bottles may be carried out as an alternative to the provision of a special type of sterilizing chest for bottles. Sterilization is more efficient if the chest is not filled to capacity and it is desirable to have a chest large enough to allow 25 to 30 per cent. clear space. For a unit of 30-40 cows where milk is sold wholesale, the chest should have a capacity of 36-48 cu. ft. and for larger herds, 48-64 cu. ft. It is important, however, that the boiler capacity should be in relation to chest capacity, the essential features being the provision of an adequate supply of hot water and the ability to maintain a temperature of at least 210 degrees Fahrenheit for not less than 10 minutes during the sterilizing process.

252. Chests are usually constructed of metal from which heat losses by radiation can be reduced by adequate insulation, or by placing as near the boiler as possible. Efficient drainage should be provided by means of a metal rack and a suitable hole in the base of the chest. An accurate thermometer, suitably protected, should be fitted in a position away from the direct current of steam. The steam should enter at the base and be distributed evenly throughout the chest; this can be done by the provision of a pipe with lateral perforations placed beneath the drainage rack. The doors should be as steam-tight as possible and easy to operate. Provision should be made to allow for wear in hinges and catches, or screw fasteners should be fitted. When sterilization is completed the door of the chest should be opened to allow the steam to escape. This prevents condensation, aids drying and avoids excessive rusting of utensils. The door should then be closed again until the equipment is taken out for immediate use without further treatment or unnecessary handling.

THE BOILER HOUSE

253. Where solid fuel is to be used space should be provided for a suitable boiler and for storage of fuel. The boiler house may also serve as a drying and mess room. The boiler should be capable of raising the necessary steam for sterilization and of heating water for washing. Some reserve capacity is desirable, sufficient to allow for the possibility of inefficient stoking and for any increased demand for steam and hot water which may arise if business expands or additional appliances are purchased.

254. There are many types of both low-pressure and high-pressure boilers on the market, including a number heated by gas, oil, or electricity. Official tests and the practical experience of many milk producers have shown that the efficiency of sterilizing equipment varies considerably, depending mainly on steam output. It would seem desirable, therefore, before purchasing sterilizing equipment to seek the advice of the County Agricultural Organizer or to make use of the information contained in the reports on certain sterilizing outfits which have been tested under the Agricultural Machinery Testing Scheme of the Ministry of Agriculture and Fisheries. By such means it should usually be possible to obtain a boiler, reasonable in price, strongly and suitably constructed, and capable of giving the service necessary to ensure efficient cleansing and sterilization under normal working conditions, without involving excessive running costs or depreciation.

FARM BUILDINGS

255. Low-pressure boilers and comparable heaters using oil, electricity or gas, are suitable for small and medium herds, but where a substantial gallonage is sold retail or where milking machines of the bucket, releaser, or releaser-recorder types are installed, a boiler with high steam output is essential. When purchasing a boiler consideration should be given to the type of fuel most readily available. Where the rates for gas and electricity are sufficiently low, the advantages of these clean and immediate sources of heat should be duly considered: a separate boiler house would be unnecessary.

256. It is strongly recommended that milk producers should take out a boiler insurance policy. The Insurance Companies carry out automatically an inspection of the boilers as laid down in the Factories Act, 1937, the fee being included in the premium. By such means the risk of fire or explosion due to faulty construction or condition is reduced to a minimum.

ACCOMMODATION FOR CALVES

Figures 31 and 32

257. On most milk-producing farms, large or small, some calves are reared to provide replacements for the herd. Arrangements for the housing of calves are therefore of wide interest, and certain possible developments may give them an added importance. First, a programme of expansion of our dairy herds will confer greater importance on calf rearing. Second, the Ministry of Agriculture and Fisheries' campaign for an improvement in the quality (that is to say: the efficiency) of cows will require, among other things, greater attention to the environment, nutrition, and management of heifer calves; moreover, the value of calves bred for higher production is greater, and therefore justifies the expenditure of more time and money. Third, if the foregoing conditions are fulfilled, the practice of home-rearing can be expected to be more widely adopted.

258. The building accommodation for calves depends on whether they are to be suckled or hand-fed. In every dairy herd cows must be culled from time to time through disappointing milk yield or for lameness or other simple physical disability, and each such beast will rear four calves at a time, suckling them in 10 to 12 weeks, the calves thereafter going on dry food. Advocates of this system find it safe and simple and claim that it gives heifer calves a particularly good start in life. The only buildings the system needs are a few roomy boxes, preferably facing south, with a yard for the cows. The weaned calves can be kept in boxes or well-sheltered sunny yards.

259. Buildings for hand-reared calves vary considerably. Thus while it is widely believed that calves up to three months should be kept in single pens, some highly successful breeders run calves in groups of three or four; and among the believers in single pens there is a wide diversity of view on the construction of the pen. Again, while there is a general consensus of opinion that buildings in which calves are housed should be light and airy, examples can be found of calves doing well in buildings without these features. In reaching its conclusions, therefore, the Committee has taken into account what appears to be the best modern practice, but in this as in many other questions affecting the housing of livestock it is clear that further research is required before decisive answers can be given.

SYSTEMS OF MANAGEMENT

260. It is now generally considered that calves should be kept in separate single pens until they are three months old, and in groups of three to six for the next two or three months. Separate pens are much preferred to the alternative of tethering the calves to keep them apart. The main advantages claimed for this individual

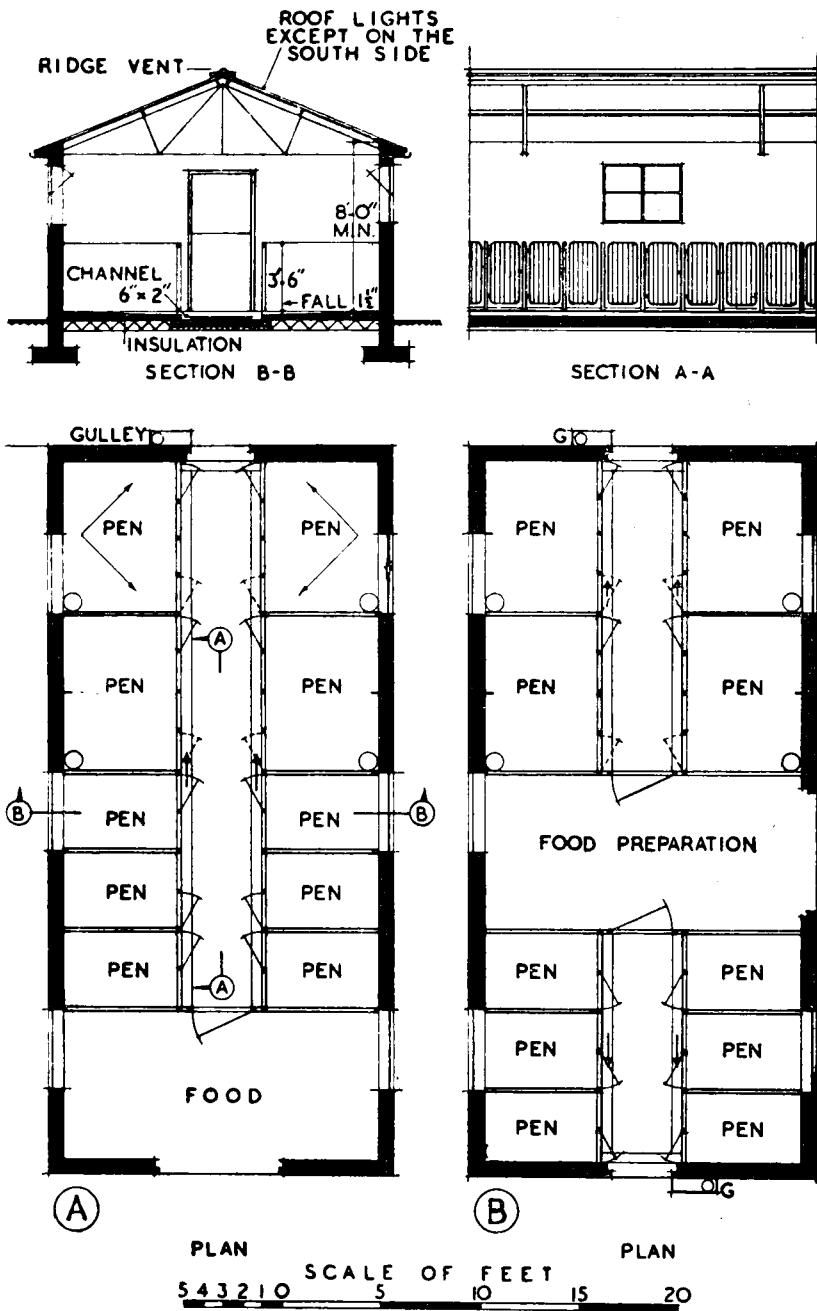


FIG. 31. CALF HOUSE

FARM BUILDINGS

treatment are: the calves cannot suck each other; and disease does not spread so easily. The building requirements of this system of management depend on the number of calves reared annually, and on the management of the dairy herd. Thus, if there are at most times of the year some six or more calves under six months it is best to set aside a special building or part of a building as a calf-rearing unit; with smaller numbers one or more loose boxes may be used, suitably supplied with movable partitions and other fittings. Moreover, a farm which concentrates on winter milk production will need more accommodation for calves during the winter and spring, and less in the summer, than a farm on which calving is more or less evenly spread over the whole year. The farmer must therefore arrange his buildings so that he can provide suitable accommodation when required, avoiding so far as possible the erection of a special building which cannot easily be put to other uses if not required for calves. Generally, this will mean that for large and medium herds, rearing all or most of their own replacements, special building provision should be made; for small herds loose boxes, properly fitted and equipped will be adequate.

261. An alternative system followed in some countries, notably New Zealand, is to keep the calves in groups at all ages, but to separate them for feeding. Calves are fed in a bail and it is claimed that, especially if they are given a little dry food when they have finished the milk or gruel and they are left in the bail for a little while after feeding, the habit of udder-sucking is largely overcome. Such a bail system of management should be investigated by the proposed Advisory Service. In the past, various forms of the system have been tried in Great Britain: none has been widely adopted.

THE CALF-REARING UNIT

262. *Siting of the Calf House.* Twice a day milk must be taken from dairy to calf house; the two buildings should therefore be close together, with a passage under cover. It will often be convenient to include the calf house in a building the rest of which consists of a range of loose boxes.

263. *Design.* A pen to take one calf up to three months old should have a floor area of from 20 to 30 sq. ft.; about 6 ft. by 4 ft. are suitable dimensions. From three to five or six months, the calves will be run in small groups and will need less floor space per calf. A pen about 6 ft. by 8 ft. will take three calves of this age.

264. The calf-rearing unit should consist therefore of a range of single pens and a smaller number of larger pens; or partitions between pairs of single pens should be removable. The choice will depend on the number of calves reared. A suitable arrangement, illustrated in Fig. 31, is to form the pens on both sides of a central passage. Five feet is thought to be the best width for the passage, in order to allow a wide barrow to be pushed along it; 4 feet is the minimum. It will be seen that a building of about 16 ft. span, discussed in Chapter 3, could accommodate two rows of pens and a 4-foot passage; if the pens are turned round so that they are only 4 ft. deep, a building only 12 ft. wide would do, but so narrow a building is likely to be unsatisfactory in other respects. An existing building 14 ft. wide could be used for the purpose, by arranging the long axes of the pens parallel to the wall on one side of the passage and at right angles on the other. The Committee considers therefore that new buildings for calf-rearing units should be not less than 16 ft. wide; while a building, satisfactory in other respects, can be satisfactorily converted if it is not less than 14 ft. wide.

265. *Preparation of Food.* With small numbers of calves, food will usually be prepared in the washing-up room of the dairy. With large numbers it may be economical to prepare the food in the calf house. In either case space will be required for bins containing dry food and for the attendant to set down his buckets

ACCOMMODATION FOR CALVES

and so on. If food is mixed in the calf house it will be necessary to provide a means of heating it; or hot water can be laid on. Cold water should be laid on to the building.

Fig. 31 shows two ways in which the food space can be provided. The second (B) is preferable where food is to be mixed in the building.

266. *Construction and Materials.* The building should conform to the standards set out in other Chapters for housing other livestock. Walls and roof should be of the high thermal insulation type in order to avoid excessive changes in temperature; the floor must be insulated.

267. *Ventilation.* It is generally agreed that ridge ventilation as an outlet for stale air is best, but there is a divergence of opinion on the best method of admitting fresh air. The amount of air-space per unit of live weight is of course much greater than in a Scandinavian type pighouse, and accordingly the problem of ventilation is not so difficult. The Committee considers that, on present information, hopper-type windows are sufficient in ordinary circumstances. Alternative methods are to provide an inlet in each pen, by means of a baffled air-brick or sanitary bend. One hopper type window should be allowed for three single pens, and *pro rata* for the larger pens. It must be remembered that ventilation is affected by the construction of the pens; for example, that the type of pen division (solid or open rail) affects the flow of air. At present, knowledge of air volume needs of calves is incomplete. It is, however, certain that draughts must be avoided; and it is recommended that if there is a risk of draughts, as in narrow buildings or in exposed sites, solid pen divisions should be used (see paragraph 270 below).

268. *Heating.* Intimately connected with ventilation is the artificial warming of calf houses. The Committee's conclusion in this matter is that, in our present state of knowledge, there is no evidence that artificial heating is desirable, or that on ordinary farms it justifies the expense.

269. *Lighting.* In the amount of light provided there is again a wide variety of successful practice. On the one hand there is the modern view, consistent with general biological thought, that ample light is beneficial and its absence harmful; on the other, healthy calves are reared in buildings which are dark and indeed apparently dismal. The Committee holds the former view; and recommends accordingly the provision of a 4 ft. by 3 ft. window (the upper half to open—see above) to each three pens, and roof lighting, as described in Chapter 11, in addition. Roof lighting, however, should not be provided if it is southerly in aspect, because it is liable to make the building too hot on warm sunny days.

270. *Pen Divisions.* Partitions between pens may be either solid or railed. Rails have the advantages that calves can see each other, thus having the benefit of "company" without its dangers; and that the free flow of air is not prevented. For solid partitions it is claimed that transmission of disease from calf to calf is more difficult; and draughts are avoided. The recommendation of the Committee is that if ventilation is satisfactory (a condition which will itself reduce the danger of disease) rails are suitable; if there is any risk of draughts which cannot easily be obviated, solid partitions are preferred.

271. It is usually desirable that at least some of the partitions between single pens should be removable in order that pairs of pens can be thrown together to take three calves from three to five months old. This precaution may not be necessary in large calf houses with an adequate number of larger pens, but it is a useful economy measure for the smaller unit. Furthermore, if at any time it is desired to use the calf house for an entirely different purpose, readily movable partitions are a great advantage.

FARM BUILDINGS

272. Materials suitable for partitions include concrete (2 in. slab if fixed, 2 in. planks in grooved posts if movable), brick (4½ in. fixed), timber (boarded if solid, rails alone or rails and vertical battens if open; spaces between rails or battens not more than 3 in.), tubular steel rails (fixed or movable not more than 3 in. apart); and various kinds of sheeting not liable to fracture. Details of some types of partition are shown in Fig. 32.

It should be noted that even if solid fixed partitions are provided in brickwork or concrete, they need not be so heavy that conversion of the building to another use presents difficulty.

273. The considerations mentioned above apply also to a choice of solid or railed front walls to the pens, fronting on to the central passage. It is believed, however, that there is here less risk of communication of disease, and hence a stronger preference for rails or open fences. A gate 2 feet wide should be provided, opening outwards flat against the wall.

274. All partitions should be 3 ft. 6 in. high; high enough to keep the calf in, low enough to allow the attendant to feed from the passage.

275. *Floors and Drainage.* The floor should be impervious, and either surfaced with material of low conductivity, or properly insulated. 2½ to 3 inches of concrete laid on a bed of hardcore, and covered with ¾ inch of asphalt, or 3 inches of concrete with hollow tile insulation, the whole laid on a bed of hardcore, are suitable. Wood-paving blocks creosoted under pressure or similarly treated have also been suggested. It is of first importance that calf pens are provided with "warm" floors.

276. To facilitate cleansing, the floor of the pen should slope from the external wall to the central passage; a fall of 1½ inches in 6 feet is suitable. If the front partition is solid, the floor should slope to the gate, otherwise to the whole of the front of the pen. This arrangement will also be sufficient to allow urine to drain away if it is not absorbed by straw, peat-moss or other material.

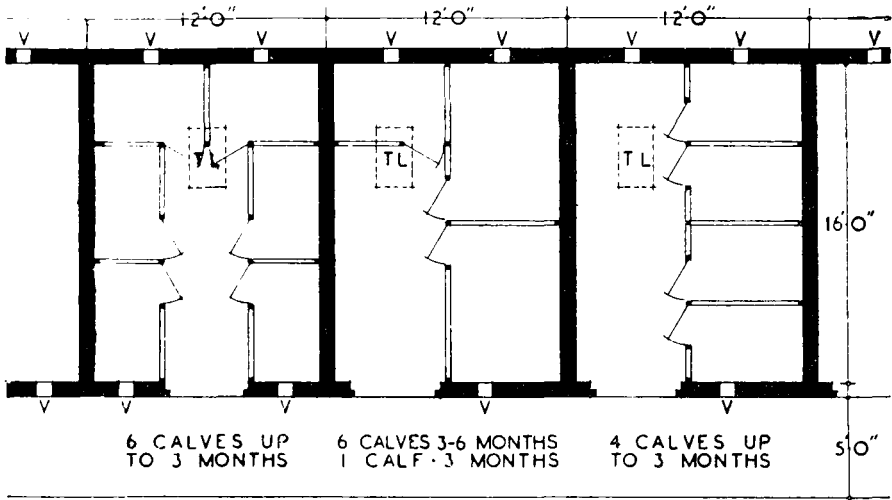
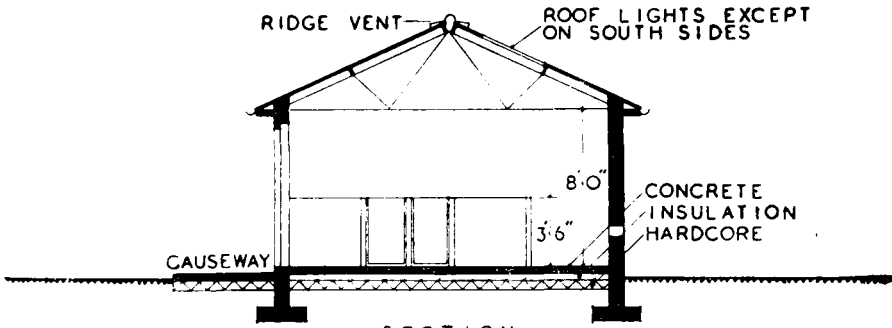
277. Gutters 6 inches wide and 2 inches deep should be formed on each side of the passage, against the fronts of the pens, to take drainage or washing water, and leading to a trapped gully outside the building.

278. *Water Supply.* Large pens for groups of calves should be provided with automatic drinking bowls; this provision is not so desirable with younger calves in single pens. A tap inside the building is very convenient, and saves labour.

279. *Other Fittings.* A continuous hayrack along the external wall is found to be suitable and is preferred to netting; the space between slats in the rack should not exceed 2 inches. In addition each single pen requires a bowl for dry food, and a bucket-holder to prevent spilling of liquid food. Bowls of size and shape to hold a bucket, make a special fitting for the bucket unnecessary. For larger pens a manger of wood or cast iron is suitable, allowing 1 ft. 6 in. of length for each calf.

THE LOOSE BOX ADAPTED FOR CALF REARING

280. For temporary or emergency use, loose boxes can be divided into pens by hurdles or other improvised means. If, however, a box is likely to be used mainly for calves it is worth while making more permanent, though movable partitions. The partitions can consist of rails and upright fence battens. They can be hung and secured on the walls of the box and on posts inserted in sockets provided in the floor. Fig. 32 illustrates the use and division of loose boxes.



TYPES OF PEN DIVISIONS

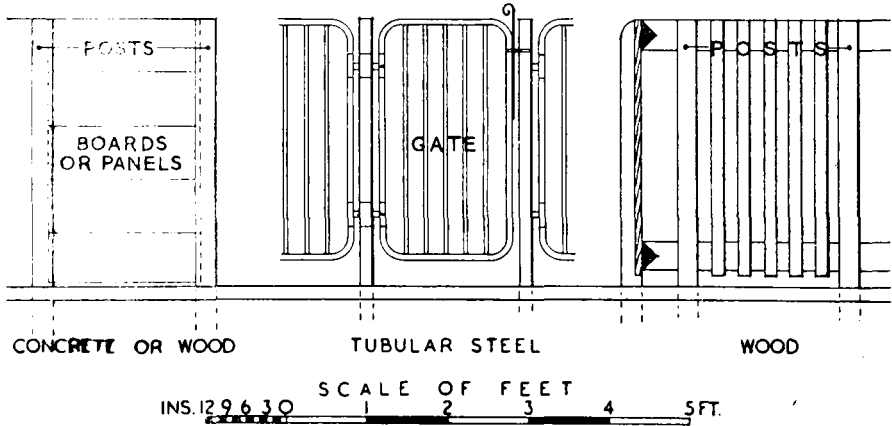


FIG. 32. HOUSING CALVES IN LOOSE BOXES

FARM BUILDINGS

ACCOMMODATION FOR THE BULL

281. Accommodation for the bull is very unsatisfactory on many farms. Common faults are lack of light, air, and space and the complete shutting out of the outside view. Good accommodation, ensuring easy control and proper management, is not, however, costly to provide. The essentials of accommodation are dictated by the requirements of good management, and it is from this point of view that the suggestions for bull accommodation in the paragraphs which follow are made.

282. The ideal arrangement for keeping a valuable stock bull is a paddock of from one acre up to two or three acres with a good-sized loose box. If the paddock is surrounded by a good strong hedge, all that is necessary with regard to fencing would be a barbed-wire fence on the paddock side of the hedge to prevent the bull forcing a way out. By having the paddock two or three acres in size, at most times of the year one or two dry in-calf cows can be kept in the paddock with the bull. This arrangement will keep the bull much more settled than if he is kept in a paddock entirely alone. If a loose box and open exercising pen is used or an open-fronted shelter with an exercising pen in front of it, then the box or open shed should face south, and the pen should be well sheltered from prevailing winds. A portion of the fencing should be so constructed that the bull may enjoy an open view. The covered shelter should have an area of 150 to 200 sq. ft. and the exercise yard of at least 400 sq. ft.

283. Where the bull is to be kept in a box and small exercising yard it is essential that the box and yard should have a concrete floor as this ensures the bull's feet being kept in good order. The surface of the concrete should be left rough to avoid slipping. Whatever system is adopted a simple arrangement for feeding and watering the bull from outside should be made, and if a short length of chain is attached around the bull's horns and through his ring, hanging two or three feet below the ring, there will be no difficulty in catching him when he comes up for food or water. If the loose box has no feeding passage there should be a hinged opening in the wall above the manger so that the bull can be fed from the outside. If it is difficult to provide such an opening in the loose box itself, part of the yard can be roofed to a depth of 8 ft., the manger being firmly fixed on the fence under cover. In this case similar provision should be made for feeding from the outside. An automatic drinking bowl should be provided. A strong ring should be fixed in a suitable position for tying the bull from outside. He can then be caught when feeding and tied up until his box and yard have been cleared. Tying up the bull regularly for a short time each day will tend to keep him quiet and tractable.

284. A service crate that can be used without the attendant having to enter the yard is a great advantage in handling a difficult bull. Suitable dimensions are: 12 ft. long, 4 ft. wide and 6 ft. high. To avoid risk of damage to the animal's legs the crate should have smooth, solid or sheeted sides.

All fastenings and fencing must be strong and the fencing such as to preclude risk of the bull getting its horns or feet caught in it.

CHAPTER 10

ACCOMMODATION FOR HEAVY DRAUGHT HORSES

285. Horses are usually housed in stables, though in some districts, notably the Eastern counties, it is customary to keep them in open yards with shelters. In the milder parts of the country an increasing number of farmers do not provide even this reduced protection; horses run in paddocks throughout the year. Those who follow the open-air systems (that is, open yards or paddocks) are satisfied that the horses enjoy better health and that there is a saving of labour. The paddock system has the additional advantage that no buildings are required; on the other hand muck is made in the open yard. The paramount consideration is the health of horses, and the Committee believes that this is best served by avoiding stables unless the climate dictates their use.

THE OPEN YARD WITH SHELTER

Plates 7 and 8

286. The design and construction of the open yard with shelter are described in Chapter 13.

THE STABLES

Figures 33 and 34

OBJECT

287. The main objects should be the health and comfort of the horses, with their easy and safe control, and economy of working.

SITING

288. Stables should be:

- a. placed with access directly off a hard road or paved space;
- b. handy to fodder storage, which may in some districts include a chaff-house where chopped straw is stored;
- c. handy to cart and implement sheds.

DESIGN

289. The stable should be a single-storey building with a pitched roof; a loft is not liked because it is liable to make the stables dusty and noisy, to harbour vermin and to make ventilation more difficult (see Chapter 3, paragraph 29). If there is a loft care should be taken to see that the stable is properly ceiled, and that adequate head room is provided both in stable and loft.

290. A stable should have the following dimensions:

Depth. A suitable depth is 18 feet, with an absolute minimum of 16 feet where more than two horses are housed. This is important, particularly when it is necessary to pass behind tethered horses.

Stall divisions should be spaced at 6 ft. 6 in. centres.

Height. Wall plate height should generally be not less than 8 feet above the floor

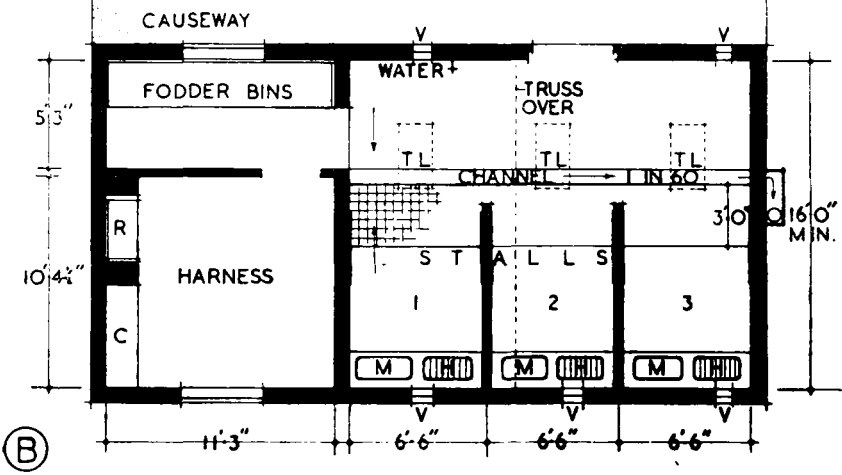
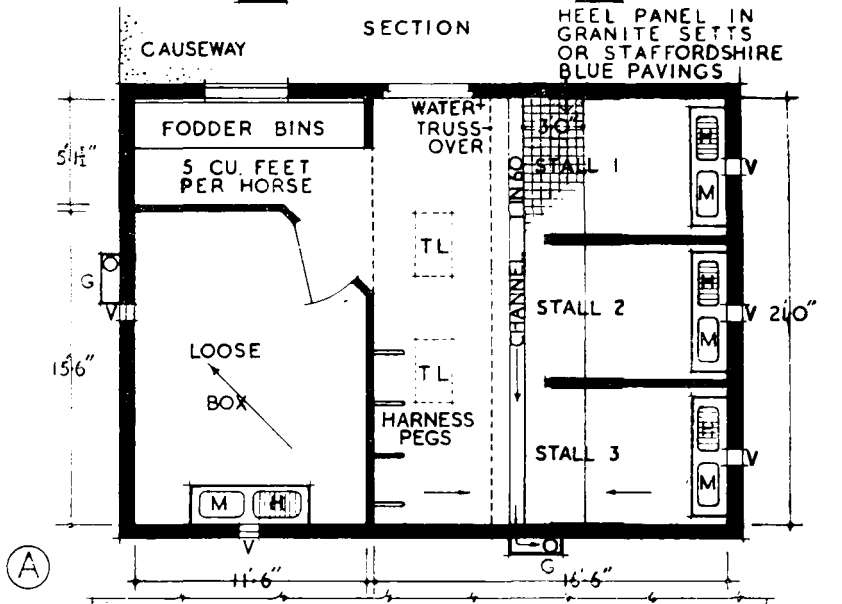
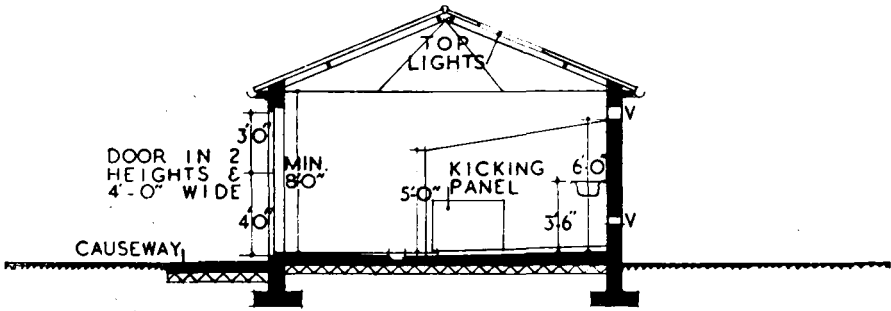


FIG. 33. STABLES

ACCOMMODATION FOR HEAVY DRAUGHT HORSES

CONSTRUCTION

291. Stabling should be of substantial construction since heavy draught horses can effect great damage if restive. The stabling should preferably form part of the permanent buildings of the homestead.

292. *Walls* should be strong enough to withstand kicking or rubbing by heavy horses, e.g. bricks 9 in. thick in gauged cement mortar (not lime mortar) or concrete 6 in. thick if in mass form or less if reinforced. External angles such as those at door openings or the corners of buildings should be bullnosed or rounded to a height of 6 feet.

If an outer wall forms part of a stall, the wall should be strengthened to provide a kicking panel. A steel plate can be bolted to the wall for this purpose; or blue bricks are suitable in brick buildings (see Fig. 33).

293. *Roof.* All the common roofing materials, except thatch, are suitable, but in fixing them iron nails should not be used because they are quickly attacked by moisture and ammonia fumes.

For further details as to roofs, reference should be made to Chapter 3.

294. *Floors* are subject to severe wear, especially from chafing under the hind feet of tied horses. Granite setts or Staffordshire blue brick, laid on 4 in. concrete, are ideal but rather expensive. Cement concrete at least 6 in. thick, topped by 2 in. granolithic finish roughened by bouncing with a broom, will make a good standing, and is cheaper, but the heel panel (the rear 3 ft. of the standing) should be made of the before-mentioned pavings to take the most severe wear. A floor of cement concrete alone will wear quickly, and is not advised, unless a hard aggregate is used.

The stall floor should fall 1 in. from each side to the centre, and 2 in. from head wall to 1 ft. behind heel posts, where a long shallow gutter falling 1 in 60 should conduct drains to a gully outside. The rear gangway should slope towards the gutter.

295. *Drainage.* Only surface drains should be permitted within the stable. The gutter or channel should be given a drop of 3 or 4 inches where it passes through the external wall, and thence it should turn and run close to and parallel with the wall for 2 feet before reaching a trapped gully, both channel and gully being surrounded by a low kerb (see Fig. 42). This device checks draughts conveying drain air, and reduces risk of the choking of the drain.

296. *Lighting.* Adequate lighting is essential and roof lighting is preferable, close to the ridge on the north or east aspect to avoid strong sunlight. Wall-lighting by windows (if used) should be behind horses and high in the wall; windows of the hopper type with side wings should be used. Artificial lights must be behind the horses.

There should be at least 4 sq. ft. of glass for roof lights, or 12 sq. ft. for windows for each pair of horses.

297. *Ventilation.* The evidence before us suggests that there should be a minimum air-space of 1000 cubic feet per horse. The dimensions given earlier and shown in Fig. 33 secure this result. Complete air change 5 to 8 times per hour without localized draughts is desirable. To ensure this, both inlets and outlets are needed and both high- and low-level placing must be devised. A suitable arrangement is airbricks with baffles, or built-in controllable ventilators having an area of 9 square inches not more than 2 feet above floor level and placed one beneath the manger and two in the rear wall. Two similar airbricks or ventilators should be built in immediately under the eaves over the head of each horse, and ridge ventilation either by raised ridge-tiles or extract cowls should be provided. The low-placed ventilators assist in maintaining a dry floor.

FARM BUILDINGS

FITTINGS

298. *Stalls.* There are many stables, holding 12 to 20 or more horses, in which there are no stall-divisions, the horses being merely tied, and farmers are recommended to consider this point carefully. Alternatively, if the horses are not excitable, double stalls, each accommodating a pair of horses accustomed to working together, may suffice. Single or double stalls may be provided by using either fixed or movable stall-divisions.

299. *Fixed stall-divisions.* Extremely firm fixing is of prime importance. Dimensions should be 9 ft. long from head wall to heel post, with a height at manger end of 6 ft. 6 in sloping to 5 ft. at heel post. Knobs or projections in the heel post are dangerous since a rearing horse getting a leg astride the division is nearly impossible to extricate. Reinforced concrete 3 in. thick is a suitable material. If timber is used it should be oak or elm, with the boarding at least 2 in. thick and horizontally laid for the kicking panel, the better to take a glancing blow.

Any woodwork should be raised from contact with the floor by at least 2 in. A concrete base and dowed fixing should be provided for posts. All edges should be rounded.

300. *Movable stall-divisions.* Many farmers prefer movable stall-divisions and when they are used there is the great advantage that conversion of the stable to other uses is easier and cheaper. Swinging bales hung on chains are satisfactory, and are often used.

301. *The manger* should occupy one half the width of the stall, the remainder being used for a hayrack. The manger should be, in order of preference:

- i. 18 in. salt glazed special section with lip turning over inwards.
- ii. 18 in. reinforced concrete, or cast iron special section.
- iii. 18 in. ordinary half round drain channels, supported on brickwork or concrete.

A cross bar fixed at 6 in. from each end of manger will reduce food wastage. The top of the manger should be 3 ft. 6 in. from the floor in front.

302. *Hayracks.* Raised hayracks cause dust to fall into the horses' eyes, and either an iron crib or slatted wooden rack at the same level as the manger is preferable.

303. *Water.* A drinking trough so placed that it may be used by horses returning from work before they enter the stable is essential. This should be fixed at the level of the horses' heads as lower placing results in loose gear slipping down while the animals drink. There should also be a standpipe with hose-tap inside the stable.

There is a considerable variety of opinion on the value of automatic drinking bowls. Some farmers have used them for many years and have found them satisfactory. On the other hand, we have received evidence from the National Veterinary Medical Association that it is highly desirable to control and to limit opportunities for horses to drink—and such control cannot be exercised if automatic drinking bowls are provided.

304. *Tying.* Iron stable fittings are usually provided with means of securing horses. Other forms of manger need stout ring-bolts for tying, usually fixed to the manger chin rail near the centre of the stall.

305. *Doors* should be 7 ft. high by 4 ft. wide in the clear, divided 4 ft. from the floor and so hung as to open back flat against the outside wall. The bottom half-door should be protected on the top edge by a strip of hoop-iron screwed on.

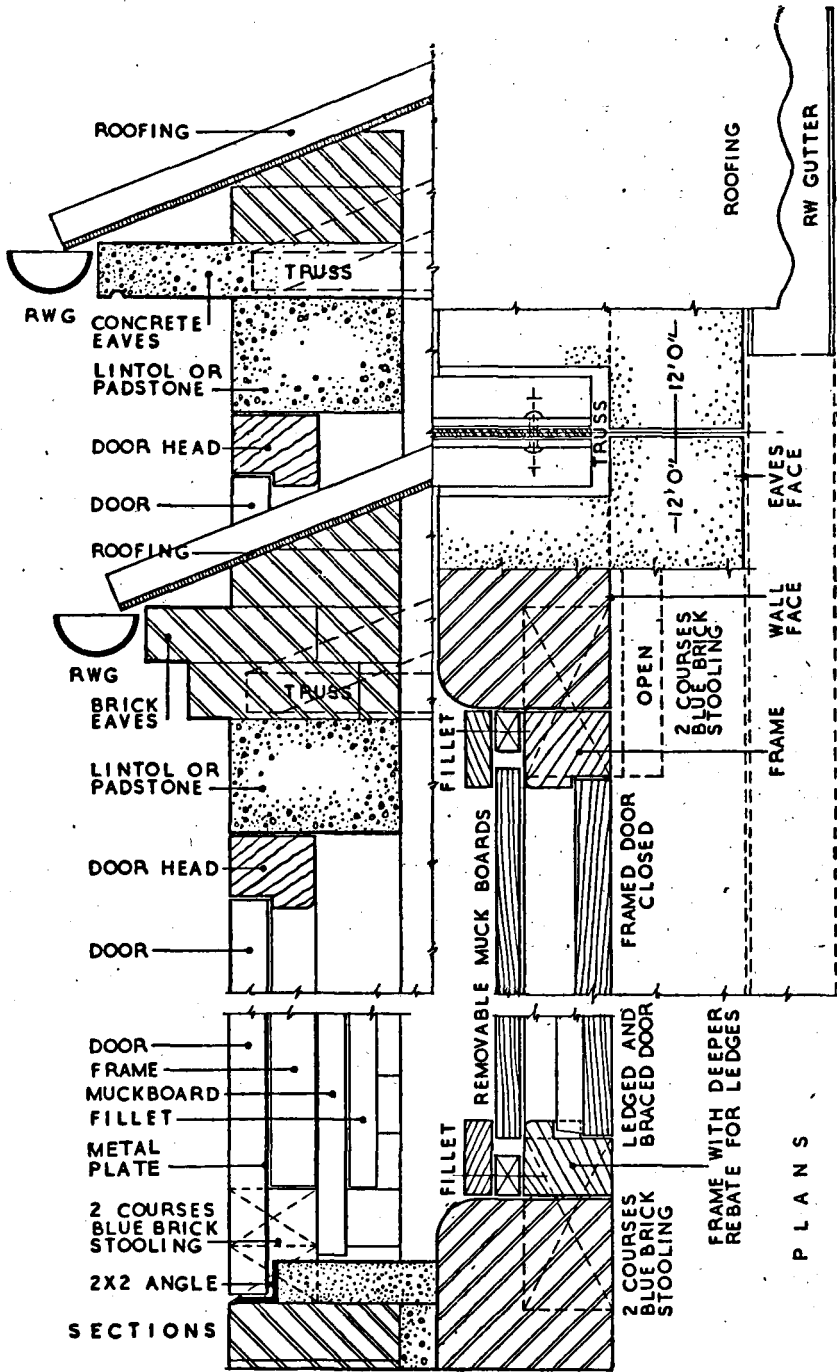


FIG. 34. STABLES, DETAILS OF EAVES AND DOORS

FARM BUILDINGS

The lower edges of both half-doors may have an iron strip so fixed as to drop 1 in. below the door as a protection against draughts and (in the bottom door) against rats. Alternatively it is a good practice to fix a strip of angle-iron projecting 1 in. to 1½ in. above the threshold, against which the door closes. There should be no step higher than this at the stable entry. Door frames should be stout (5 in. × 4 in. or 6 in. × 3 in.) and rebated. They should be well cramped to walls with iron cramps, and doweled to a 6 in. supporting block of cement. All arrises should be rounded. Doors may be framed, ledged, and braced not less than 2 in. thick, or ledged and braced with 1½ in. grooved tongued boards on 1½ in. ledges and braces. If the latter form is adopted the end board should be screwed to the ledges and the latter should extend full width to the edges of the doors with the frames checked out to receive them—as a precaution against damage by slamming. Stout smith-made hooks and bands are the best form of hanging. These should extend to allow a bolted fixing to the end board and shutting stile, and the top hook on each half-door should pass through the jamb and be secured with a nut to prevent sagging.

Fastenings should be stout wrought iron of a type without dangerous projections. A simple shutter-catch which can be operated by one hand should be provided to hold either half-door open.

306. *Harness and gears* may be kept in a separate room adjacent to and entered from the stable. Many users, however, prefer to keep the gears hung on brackets on the back wall of the stable behind the rear gangway and 18 ft. depth allows of this. Separate wood brackets for head-stall, collars and harness should be provided for each horse, and they must be stout and securely fixed either by building-in during erection, with dovetailed ends (plugging is useless) or by bolting through walls with a plate or large washer on the reverse side.

LOOSE BOX

307. Where a substantial number of horses is kept, the range of stabling should include one loose box primarily for horses. This will follow the width of the stable range, but should have a minimum size of 15 ft. 6 in. × 11 ft. 6 in. The general details will be similar to those of the stabling with the following variations:

- a. Wear on the floor being less concentrated, granolithic paving is generally satisfactory, and easier to clean.
- b. The floor should fall diagonally from the manger to a drain outlet in an external wall.
- c. The entrance door should be hung right-handed with the manger and hayrack on left immediately inside the box.
- d. A door to the adjacent stable should also be provided.
- e. A drinking bowl may be a convenience.
- f. Provision for ventilation should be equivalent to that required for two stalls in the stable.

HORSE YARDS

308. Where an abundance of straw is available it is often found convenient to provide, as an adjunct to the stable, a horse yard where horses may be run to assist in making muck. In such cases there should be a causeway alongside the buildings made of concrete or other paving, raised about a foot above yard level and with a width of at least 4 feet.

ADAPTABILITY

309. A stable of the dimensions illustrated may be adapted for other uses such as a single row cowhouse or a range of loose boxes, though this will be easier if permanent built-in mangers have not been provided.



PLATE 7. HORSE YARDS FACING SOUTH AND SHELTERED BY HIGH FENCE
Can be easily adapted for cattle. The centre section is a harness room, chaff house, and food store.



PLATE 8. INTERIOR OF HORSE YARD: HORSES BEING HARNESSSED



PLATE 9. MOVABLE FARROWING HUT SHOWING FEEDING TROUGH
AND ENTRANCE



PLATE 10. MOVABLE FARROWING HUT SHOWING TRAP-DOOR
FOR INSPECTION

CHAPTER 11. THE HOUSING OF PIGS

310. Veterinary opinion inclines strongly to open-air pig keeping for all except fattening pigs, wherever well-drained pasture is available and sufficient shelter can be provided. This applies to in-pig gilts and sows with litters, and store pigs up to 15 or 16 weeks, even in winter.

OUTDOOR PIG KEEPING

Figure 42 and Plates 9 and 10

OBJECT

311. The aim should be to provide protection against rain, cold, and strong sunshine. The structure should be either easily cleaned and moved or of materials which can be burnt when the pigs are moved to fresh ground.

DESIGN AND CONSTRUCTION

312. Suitable temporary shelters can usually be contrived from materials such as straw and bracken in conjunction with coppice poles, wire-netting, hurdles and galvanized iron, the bracken and straw being burnt and renewed as the shelter is remade with each change of pasture.

313. As an alternative to temporary shelters, sectional wooden buildings, movable pig-arks, or movable houses on wheels or runners are often employed, and several useful types are on the market. An example is illustrated (see Fig. 42).

The necessity of some protection for piglets when such buildings are used for sows with litters should not be overlooked. Arks, from their shape, give protection along the sloping side walls, but require a pig-rail along the rear wall.

The entry to a hut should be wide enough to prevent crushing should more than one pig attempt to enter at a time.

In arks and small huts it is essential that there should be access to the farrowing sow from the back of the structure.

314. A movable pig farrowing hut made to the specifications of Cambridge University Farm is illustrated in Plates 9 and 10. It is made by a local builder. The farrowing sow is tethered by means of a harness and chain, and the following notes may be useful.

- a. The sows are put on the chains about two weeks before they farrow to get them thoroughly accustomed to the equipment. Up to this time they will have been running in bunches in the field or in large pens.
- b. The harness should be reasonably tight, especially round the body, to prevent the sow wriggling out.
- c. Sows stay on the chains until the young pigs are weaned.
- d. A spring at one end of the chain is useful to lessen the shock from any wild movement by the animal. This is especially important with gilts.
- e. The length of chain is usually 20 to 30 feet, and the distance of the peg from the hut must be such as:
 - i. to allow the sow to enter so far into the hut that she can just touch the back with her nose; this will make sure that she can turn round if she wants to when farrowing;
 - ii. to prevent the sow walking round the end of the hut and coiling the chain round the hut, which would usually mean breaking either chain or harness.

FARM BUILDINGS

- f. A small door at the back of the hut enables the pigman to give assistance during farrowing when the sow will usually lie with her head towards the front door.
- g. The hut is moved by an amount equal to the length of the chain once a week in winter time and once every 10 days in summer.
- h. There should be a water trough attached to the hut, and it is a good plan to have a hinged flap to prevent any other stock, *e.g.* cows, that may be in the field from drinking the water.
- i. A few slats nailed lengthwise along the floor at about 6 in. apart are valuable to prevent the sow's feet slipping, and to assist the young pigs when sucking.
- j. The front doorway is ordinarily closed by a sack hanging over it nailed from the top. It is a good plan to have a slide at each side into which boards may be dropped. Sometimes in emergency it is desirable to shut in the pigs and the sow completely by dropping in these boards. During the first week of their lives the young pigs should be kept in the hut to avoid chills, and this can be done by dropping a couple of boards into the slots. After the first week the little pigs are usually let out when the chill of the morning has passed.

INDOOR PIG KEEPING

Figures 35 to 38 and Plates 11 to 13

OBJECTS

315. Indoor pig keeping involving permanent buildings should be carried out with the following aims, directed to the health of the pigs, and to the saving of labour:

- a. Avoidance of wet, cold, and foul surroundings, especially from pervious floors.
- b. Preservation of a uniform temperature, not subject to sudden changes.
- c. The control of humidity, which has an important influence on general well-being.
- d. Ease in management and in the cleansing and disinfection of the building.
- e. Provision of a dry, warm sleeping place free from draught and adequate in area for all the animals housed.
- f. Good feeding arrangements; adequate trough space and care of foods; suitable water supply; a food store in the house and a suitable food-boiling equipment.
- g. Protection against direct sunshine during hot weather.
- h. Convenient arrangement for periodic weighing.

METHODS

316. The position as to pig keeping accommodation on an average mixed farm is a variable one, but in the past generally one of three methods has been followed. Pigs have been kept either in:

- a. *The traditional small pigsty with run.* There is little to be said in favour of this type, except where pigs are kept by cottagers who are never likely to require to use the buildings for other purposes. Serious mistakes in design and construction of such minor buildings can be avoided by following directions given in Leaflet No. 4 issued by the Small Pig Keepers' Council.

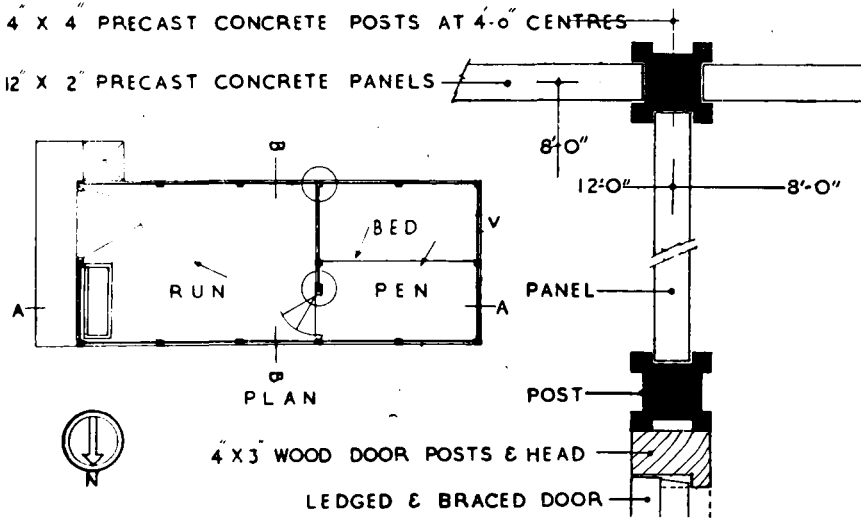
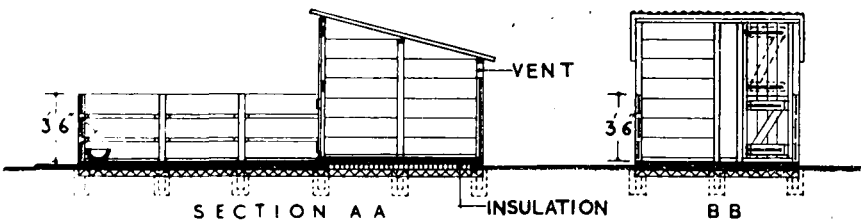
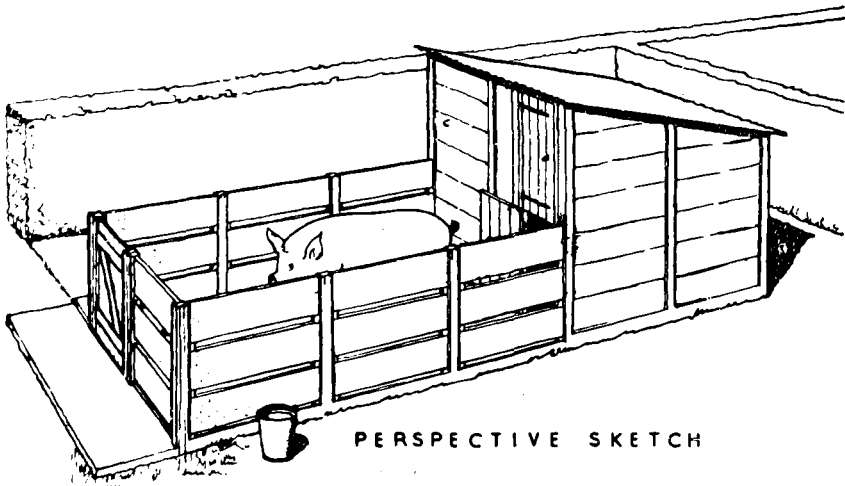


FIG. 35. COTTAGER'S PIGSTY

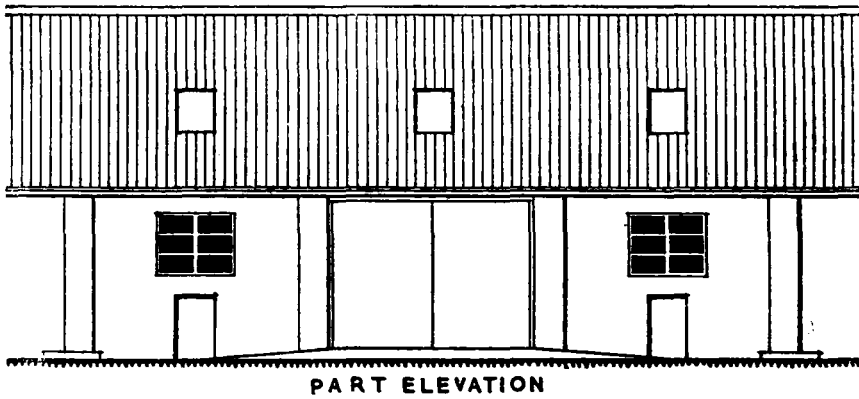
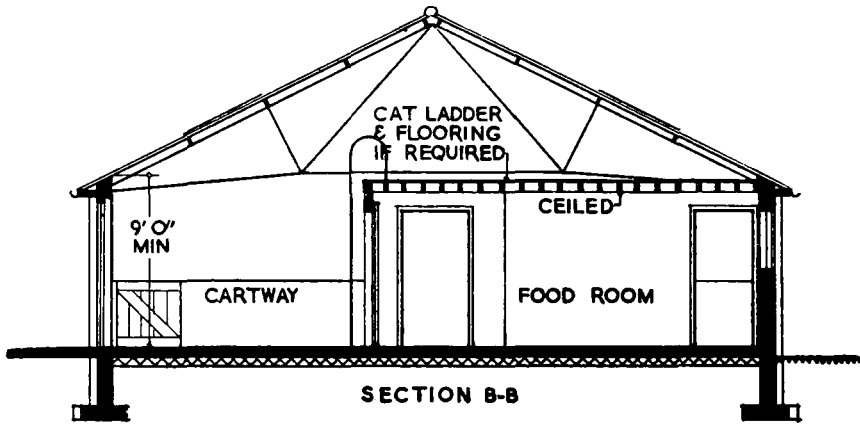
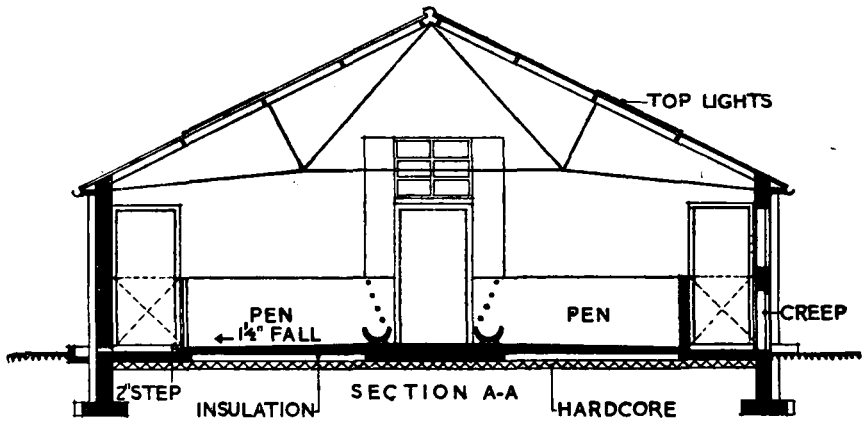


FIG. 36. PIGGERY

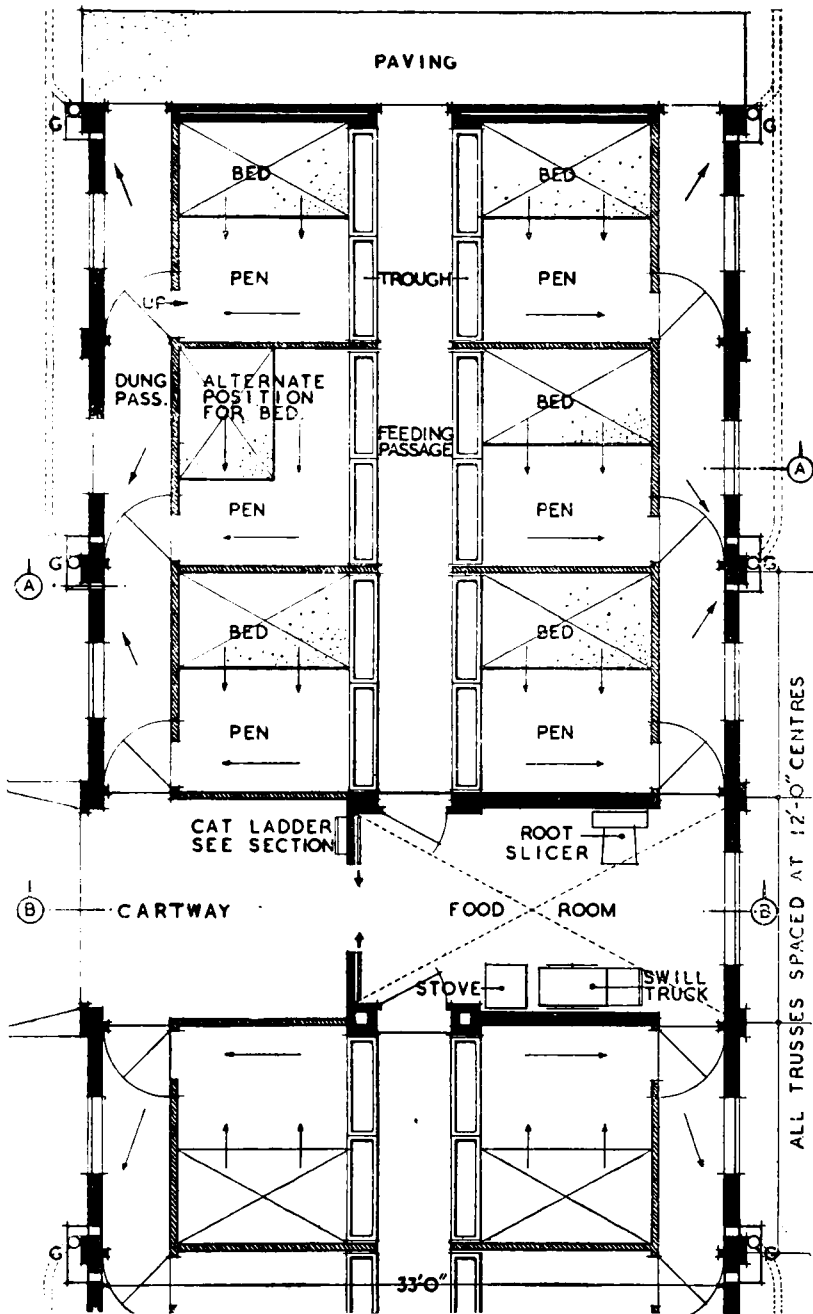


FIG. 37. PIGGERY

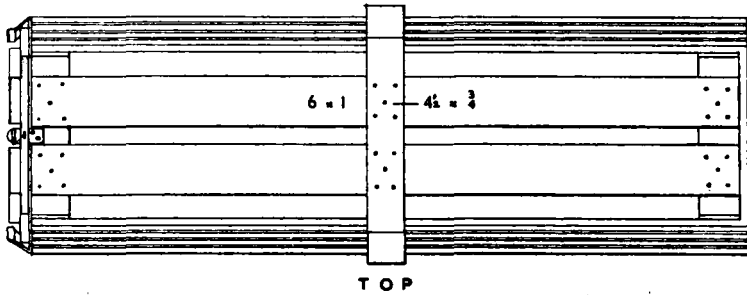
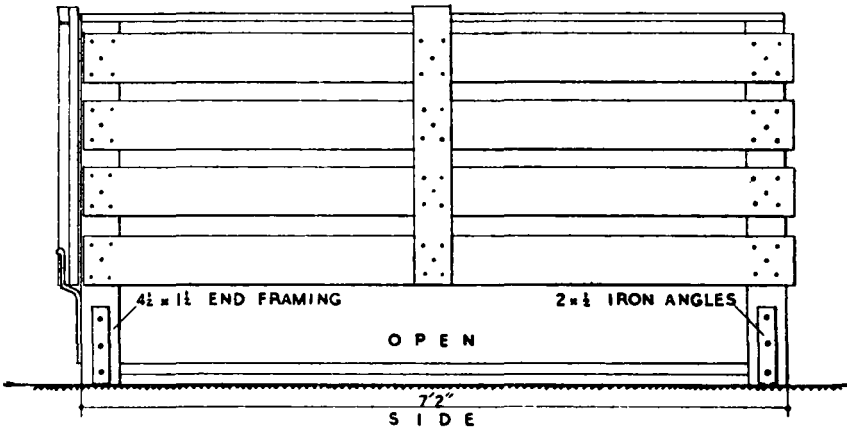
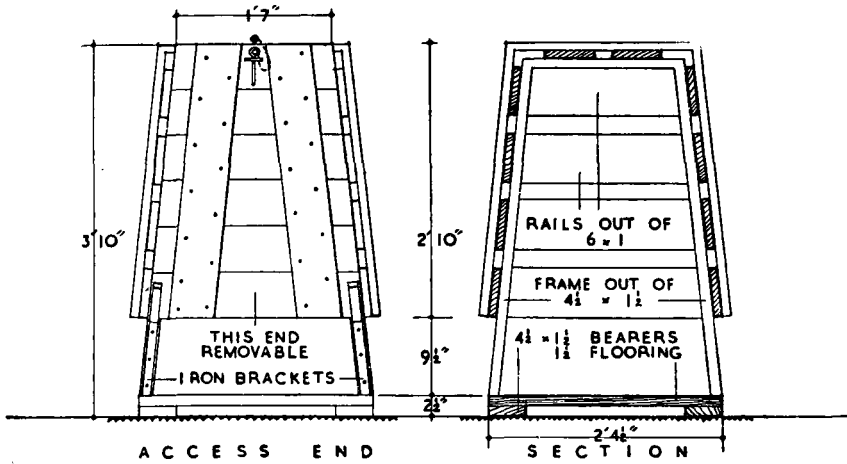


FIG. 38. REMOVABLE FARROWING CRATE

THE HOUSING OF PIGS

- b. *The Range of Piggeries.* The covered piggery, consisting of either a single or double range of pens, and having a boiling house and feeding passage, with properly organized arrangements under the same roof for the preparation and distribution of food is only justifiable when pig keeping (and particularly fattening) is followed as a specialized line. Though other types may be seen, the modified "Scandinavian" piggery appears to be the best yet devised for this purpose.
- c. *Ordinary loose boxes in conjunction with yards.* Great success has attended pig keeping in loose boxes and yards where adequate litter is available, and this applies both to the rearing and fattening of pigs in the ordinary course of farm economy. It should be unnecessary to emphasize the fact that this form of unspecialized accommodation permits absolute freedom as to change of farming method, and unless it is proposed to carry a substantial number of pigs the provision of a special building can be avoided. There is therefore much to be said for an ample supply of loose boxes on the general farm, without any special buildings for pigs.

Where ample straw is available the fattening of pigs in well sheltered yards has been found, in suitable localities, to give excellent results. The pigs are healthy and there is none of the daily cleaning which pens require. Manure is allowed to accumulate till required on the land, double-handling thus being avoided.

DESIGN

317. *The small pigsty with run.* Fig. 35 illustrates the cottager's type of pigsty with run.

318. *The Range of Piggeries* (see Figs. 36 and 37). The "Scandinavian" or "Danish" pig house was evolved under more rigorous climatic conditions than those of this country, and in the variants of it which have been attempted here it seems sometimes to have been assumed that certain of the provisions of the original could be dispensed with. The results have often been unsatisfactory. The full Scandinavian type, as illustrated by plan and section in various publications (including the Ministry of Agriculture and Fisheries' Journal and Bulletin 32) is a highly organized structure. It comprises not only the distinctive arrangement of central feeding-passage and outer dunging-passage (which has been seized upon in this country as its essence) but a large fodder-loft which is partly designed for insulation, a complex system of ventilation in combination with heating stoves, (in pursuance of the avowed aim that "it is cheaper to heat with coal than with corn"), direct exit from each pen to external exercise yards, and what may be called subtleties of internal design affecting sows with litters, weaning, and the progressive transference of piglets as they gain weight and size into larger pens until they are fully grown and ready for disposal. The buildings are also of very substantial construction.

319. The so-called "Scandinavian" pig house, as sometimes erected in this country, has often failed from one or more of the following causes, some of which might more properly come under the succeeding head of structural detail, but can more conveniently be grouped here:

- a. The use of unlined galvanized iron for outside walls and roofs owing to its poor insulating qualities.
- b. Liability to draughts.
- c. Badly located windows and poor (though by no means always simple) ventilation systems leading to excessive condensation.
- d. Communal internal drainage channels running down the centre of the dunging passage, and failure to isolate pen from pen by impervious and non-communicating divisions so facilitating the spread of disease.

FARM BUILDINGS

- e. Failure to provide insulation beneath concrete floors in the sleeping compartment.
- f. Excessive and wrongly placed roof-lighting which has caused "sun-scald" in brilliant summer weather.
- g. Massive concrete walls, especially enclosing the pens and which appear to result in a wet and cold atmosphere in the pen in winter.

320. With the foregoing facts in mind, it should be possible to design a pig house of Scandinavian type which will be satisfactory for the rearing of bacon pigs about 15 weeks of age when brought in, provided that they are then sound and healthy and that the general system of feeding and management is good. The provision of such a specialized building on the average 250-acre farm will not often be contemplated, but where such provision is required, the possibility of ready adaptation to other farm uses should not be overlooked. In the detailed design of such a house the following points should be observed:

a. Capacity should be governed by the number of pigs which with good management can be dealt with by one attendant (labour saving being one of the strongest advantages of this type of housing) and by disease factors. Veterinary opinion has pronounced 200 pigs as a suitable limit in one building.

b. Convenient dimensions are:

Central feeding passages (including portion of trough-width)—6 ft. 10 in.
Pens (including portion of trough-width)—8 ft. 6 in. depth with a width of 12 ft. along trough. Dunging passages not less than 3 ft. 6 in. to give pigs room to turn. Overall—132 ft. × 33 ft.

Ten pens on each side of the feeding passages will provide accommodation for 200 pigs.

c. The boiling house under the same roof should allow space for feed-mixing and storage. It should be shut off from the piggery by a wall with a doorway, which will exclude steam. There need be no permanent fittings in the boiling house other than a water supply, sink, and boiler, and sometimes a whey tank. Where cheese-making is practised the desirability of a gravity supply to the whey tank should be borne in mind when siting. The boiler can be so designed as to supply circulating hot water for warming the pens in cold seasons which may be a desirable thing in northerly or especially exposed districts. At the other end of the building it may be convenient and useful to provide space for a pig-weighing machine. It has been brought to our notice that there is a constant risk of infection from untreated swill being carried from the boiling house to the pens on boots and clothing. We have come to the conclusion that this difficulty cannot be entirely overcome by alteration in design; it is in the main a management problem.

CONSTRUCTION

321. Bare corrugated iron should be avoided altogether in the construction of piggeries. Timber should be restricted to positions where pigs are unlikely to come in contact with it.

322. *Walls* may be brick, concrete, or stone with rough or absorbent surfaces rendered in cement up to three feet in height. All angles should be bullnosed.

323. *Divisions*. Brick is frequently used and on the whole seems to give satisfaction for pen fences and divisions. Precast concrete slabs may also be used. The view that massive solid concrete walls are unsuitable has already been referred to. By suitable design it is possible to unite adjacent pens when desired, using

THE HOUSING OF PIGS

grooved uprights so that slip-in "planks" or slabs of cast concrete may be inserted or removed as desired.

324. *Roofs* may be of tile, slate, or asbestos cement. If a ridge roof is employed ventilation at the apex should be provided. Further reference is made to this matter in paragraph 328.

325. *Floors*. Fine cement "bounced" with a broom just before setting and insulated from cold ground best combines sanitary conditions with comfort. Insulation may be achieved by laying the concrete 2 in. thick above either a layer of hollow clay blocks, asbestos-cement hollow sheets, or 8 in. of coarse hardcore having considerable air-space. The part of the floor where pigs will lie should be raised 3 in. above the rest of the pen.

Falls of one in seventy-two should be given to all floors or pavings in the direction of a drain outlet.

326. *Drainage*. It is essential for the prevention of the rapid spread of disease that every pen should be independently drained. No internally communicating channels should be allowed. The preferable method is for outlets to conduct liquid to a common external open channel formed as a cill on the foundation and discharging to a gully and thence to a liquid manure tank or drain. Outlets should be baffled to avoid draught by the provision of vermin-excluding metal flaps.

Provision against backflow of liquid from the dunging passages to the pen should be made by a check-drop of $1\frac{1}{2}$ in. to 2 in. at the opening between them.

327. *Lighting*. Roof lighting at the rate of 50 sq. in. per pig is most effective, particularly in double-rank houses. Unless frosted glass is used there may be danger of "scorching" and sunstroke. The light may be introduced by means of glass tiles, proprietary ventilators, or by glazed louvres: If glass substitutes are employed for their ultra violet ray admission they mostly require to be used vertically—in windows or monitor-type roofs. Lighting by windows requires one square foot per pig and is best arranged by an adjustable hopper-type window opposite each pen in single-rank houses. It is most important that dunging passages are well lighted, otherwise they will not be used.

328. *Ventilation*. We are indebted to the National Veterinary Medical Association for the following remarks:

"Pigs, being comparatively hairless, are more susceptible to errors in the ventilation system than haired or furred animals. The optimum temperature for pig houses is agreed by all authorities as between 68° and 72° F., and for younger pigs kept indoors it may be higher. The cubic capacity per head of pig should normally be 200 to 250 cu. ft. and the hourly requirement is 800 to 1000 cu. ft. of fresh air per 500 lb. live weight. The irreducible minimum of fixed ventilation inlet area should consequently be 2.6 sq. in. per head of bacon pig (of 150 lb. live weight) assuming an incoming air current of 3 m.p.h., which is a desirable rate of air movement inside the building, *i.e.* $\frac{200}{100} \times \frac{150}{100} \times \frac{1}{10}$ sq. in. The most effective means of controlling the rate of air inlet (which being baffled, should not be greatly affected by direct wind) is by controlling the rate of outlet. This in turn depends upon the type of construction. Adjustable outlets at the roof are good, provided they are intelligently controlled. In practice, this is hardly ever fully possible, partly because of the frailty of human nature, and partly because of vagaries of the wind and weather.

It is consequently being borne in upon the Association that some form of simple air conditioning should replace systems of natural ventilation for large modern piggeries. Where these have been installed, they have given great satisfaction, and but for the war much more progress would probably have been made before now.

FARM BUILDINGS

A suitable system¹ of air conditioning would probably be to arrange a conduit over the pens with adjustable air outlets over each pen. The 'take-in' would be from fresh air at ridge level, and the plenum current would be maintained by a self-regulating fan and would be warmed over a simple heating unit employing the principles of pre-heating for conservation purposes. Relative humidity might be disregarded at least at first. There would be no other inlets at all and the only outlet would be the heat exchanger for pre-heating.

More research work is needed before final data are available, but, as a preliminary, it would appear that the air should be warmed to 76° to 85° F., and that a fan system giving some 200 to 400 cu. ft. of conditioned air per hour per bacon pig would be more than adequate."

329. For practical farm purposes the best that can be achieved in the light of present knowledge is by baffled ventilators admitting air from a low level, combined with ridge ventilation. One form of air-admission which is said to have proved very satisfactory is by 3-in. piping laid beneath the pen floor, rising centrally to a height equal to that of the pen divisions and terminating in a mushroom-headed iron ventilator of the pattern usual for reservoirs. The pigs are said to appreciate the standard as a rubbing-post. Where wall-inlet ventilators are used next to the dunging passage, they should not be placed opposite the pen openings. Wire netting of $\frac{1}{4}$ -in. mesh should be placed over all vents, windows, and other openings to exclude vermin.

330. Where a proper balance between inlet and outlet ventilation, with adequate control, has been attained, trouble from internal condensation on roof-surfaces has been avoided so that it has not proved necessary to provide a ceiling even beneath a roof of bare corrugated asbestos-cement sheeting. Further scientific investigation, however, is needed.

FITTINGS

331. The trough is the only fixed fitting, apart from the food preparation equipment in the boiling house. 12-in. half-round salt-glazed drain channels, granolithic or smooth concrete of similar section make satisfactory fixed feeding troughs. The usual arrangement is to have a hinged flat shutter in stout iron hung from an iron rail centrally over the trough, and so arranged as to expose the trough either to the passage (for charging or cleaning) or to the pens (for feeding), and fitted with bolts or special devices which will secure it in either position. In some cases the swing shutter is replaced by a fixed precast concrete screen so placed as to allow limited but sufficient access to the trough from either side. In loose boxes and other dual-purpose buildings movable pig-troughs of galvanized iron may be preferred—they can be taken out when not required, giving increased space. 12 in. to 18 in. of trough should be allowed per pig. Such troughs should be divided by galvanized iron crossbars into 12-in. sections to prevent wallowing.

332. Movable galvanized iron bins in the boiling house are preferable to fixed bins of brick or concrete for the storage of meal. Wheeled tanks are preferable to ordinary boiling coppers for the preparation of swill. The food can be boiled by means of a steam-jet and can be distributed by wheeling the tank along the line of mangers with great saving of labour. Alternatively, a form of tank which can be run on rails or overhead track may be used.

333. If whey tanks are included it should be remembered that lactic acid has a very destructive effect on most materials, including cement and concrete. Glazed surfaces and bitumen seem to be about the only practicable substances which will resist its action.

¹ The Committee has not seen this system in operation and recommends it only for consideration or experiment.

LOOSE BOXES

334. Pen doors should be steel plate $\frac{1}{4}$ in. thick, or wood with metal strapping to prevent gnawing, with fastenings secure against operation by animals. All outer doors, door posts, and other woodwork liable to be gnawed should be strapped or sheeted with metal.

335. Farrowing crates (see Fig. 38 and Plate 12) are now widely used and our evidence supports the view that they are much superior to farrowing rails round the walls. If crates are not used, rails (removable) must be provided in any loose box or other place used as a farrowing pen or for sow and pigs.

336. The Advisory Service proposed in Chapter 5 should provide information of new ventures and experience with specialized pig houses from time to time and, still more important, should investigate by experiment the influence of design and structure on housing environment and the effect of environment on pig health and comfort.

CHAPTER 12. LOOSE BOXES

OBJECTS

337. Loose boxes serve so many purposes that they are one of the most useful buildings on the farm. They can be used for calving, foaling, and farrowing; for rearing young stock including pigs; for the examination and treatment of all kinds of beasts needing attention; and when not required for stock, for storage or even in place of a chaff house.

338. A special form of loose box is the isolation box which is essential on every farm. One or more isolation boxes are required for sick beasts and for brought-in cows and horses for a few days after arrival at the farm. The isolation box does not differ materially from the general-purpose box, but it should stand apart from the other buildings of the homestead. It is considered in detail in paragraphs 351 to 356.

DESIGN

Figures 39 and 40

339. General-purpose boxes are best provided in a range. It sometimes happens, however, that a part of a building mainly devoted to another purpose can be cut off and used for one or two boxes. This may be economical in building, but unless care is taken it is likely to be expensive in labour as special journeys with food may be necessary. Each box should have an external door for stock, opening preferably to a yard; a causeway 5 ft. wide should run from end to end of the range facing the yard.

340. Some maintain that in a range of boxes, a feeding passage should always be provided, others, with equal certainty, maintain that it should not. The Committee is unable to pronounce one way or the other on the evidence before it; but the arguments may be summarized as follows:

In favour of a feeding passage: the work of feeding stock can be done under cover and inspection of animals is facilitated.

Against: a feeding passage is likely to cause draughts; the extra cost of the building is unduly expensive; and in a range of boxes feeding should be done from a cart or trolley taken along a causeway outside the range.

This is one of the matters which must be left for decision to the personal inclination of the farmer, who would, of course, be wise before deciding to make a close inspection of ranges of boxes with and without feeding passages.

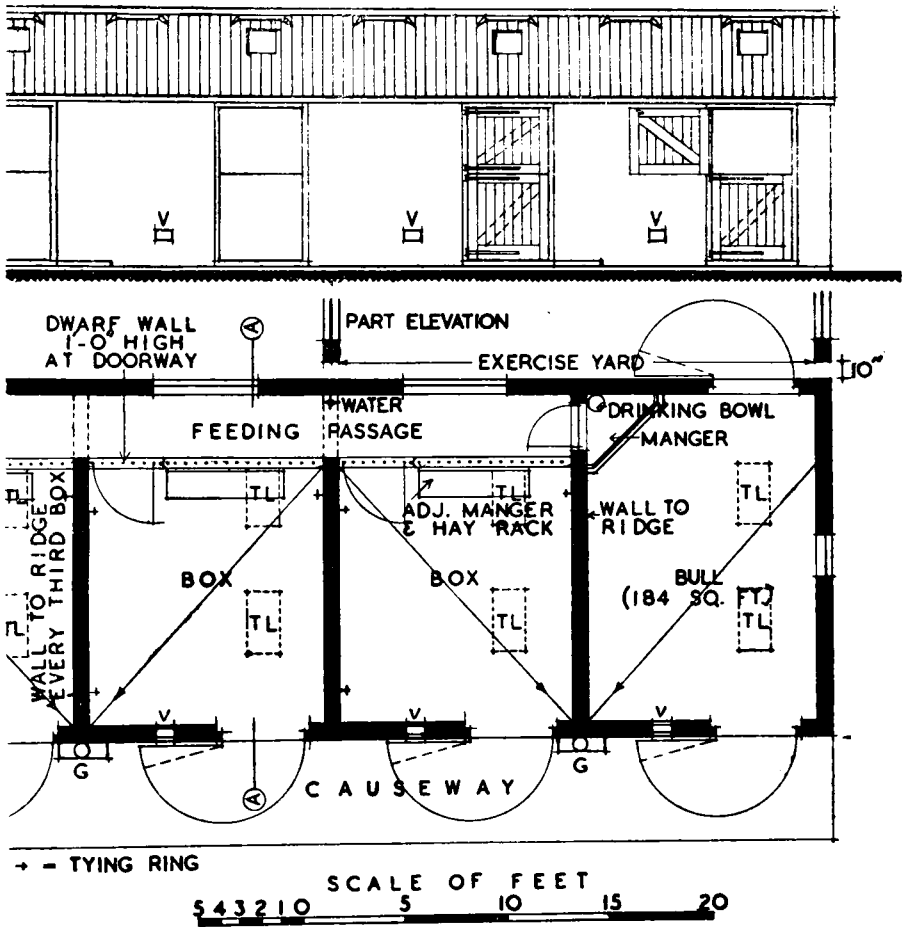
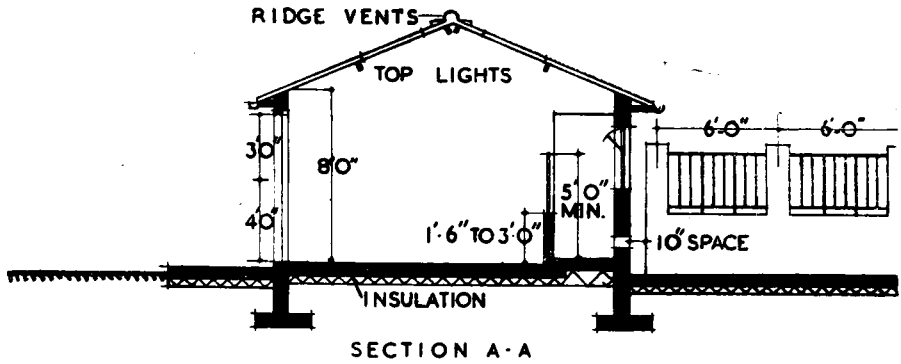


FIG. 39. LOOSE BOXES WITH FEEDING PASSAGE

LOOSE BOXES

341. *Dimensions.* Opinions as to the best size for loose boxes vary from 150 to 200 sq. ft. floor space. These figures should be regarded as minimum and maximum respectively; about 160 to 170 sq. ft. is probably best for general purposes. If the boxes are not square, the shorter side should not be less than 10 ft. The feeding passage should be 3 ft. wide and should lead under continuous cover to the building in which food is prepared. Walls should be 8 ft. high to the wall-plate.

CONSTRUCTION

342. Loose boxes may be constructed of brick or concrete, or framed as described in Chapter 3. Floors and roofs should be insulated as described in the same chapter. The roof should be provided with vents as shown in Figs. 39 and 40. To have one or two boxes with a ceiled roof is useful for sick animals (other than cases of communicable disease which must always be isolated).

343. *The Feeding Passage.* The floor of the feeding passage should be at least 3 in. higher than the floor of the boxes.

The feeding passage should be divided from the boxes by a dwarf wall and tubular steel rails. The wall should be not less than 1 ft. 6 in. high; 3 ft. is normal. Rails may be vertical at 6-in. centres, or horizontal similarly spaced. Total height of wall and rails should be not less than 5 ft. from the feeding passage side. A door from the feeding passage to the box is a convenience. Three feet will be wide enough, opening into the box; the dwarf wall should be reduced to 1 ft. at the opening.

Adjustable mangers and hayracks should be fitted to the rails, thus allowing the same equipment to be used for all kinds of stock.

344. *Water Supply.* Stock of various sizes will use the loose boxes and a fixed water supply in each box is therefore inadvisable. It is also frequently desired to control the intake of water. The most suitable arrangement is to provide a stand pipe in the feeding passage with a hose connexion; alternatively a stand pipe can be provided in each box.

345. *Partitions.* It is unnecessary for partition walls for each box to be carried up to the roof, though the danger of through draughts will be reduced if every third box is provided with a complete wall from floor to roof. Otherwise partition walls need not be more than 8 ft.—the height of the wall plates. This does not save much in expense but it considerably improves the lighting of the range. Solid walls are preferred and should be constructed of brick or concrete.

346. *Lighting* should be by roof lights; windows, if provided, should be of the hopper type. Roof lights or windows should be on the northern or eastern sides and at least 4 sq. ft. of glass for roof lights or 12 sq. ft. for windows should be allowed for each box.

347. *Ventilation* should be provided in the manner recommended for stables in Chapter 10, paragraph 297.

348. *Doors.* External doors should be of half-heck type, framed, ledged, and braced with the lower half preferably covered with stout galvanized sheet metal to present a smooth surface. The lower half should be not less than 4 ft. high. Fastenings should be stout as recommended for stables.

349. *Drainage.* It is usual to give the floors a general fall towards the front wall so that any liquid can discharge on to an external trapped gully.

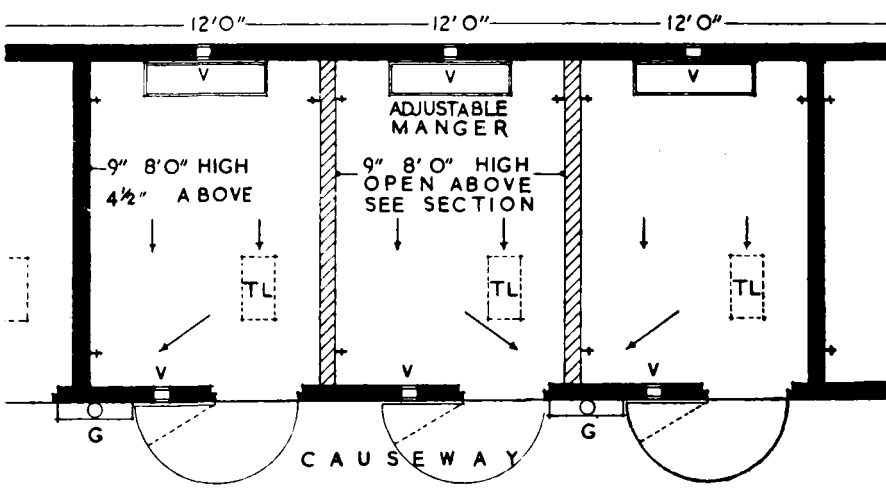
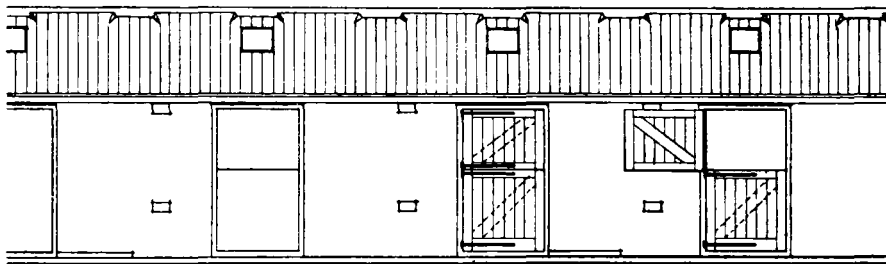
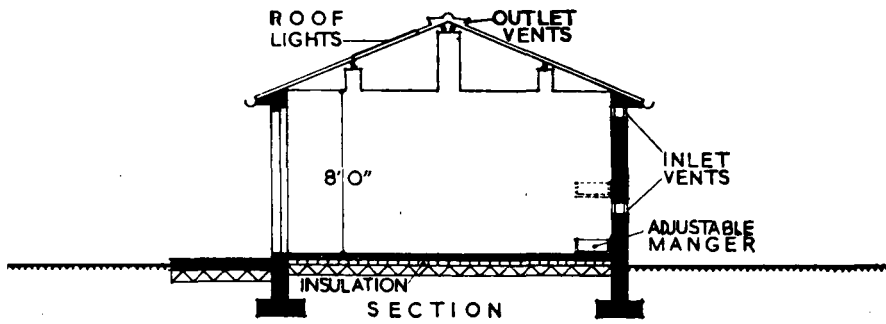


FIG. 40. LOOSE BOXES WITHOUT FEEDING PASSAGE

LOOSE BOXES

FITTINGS

350. Adjustable mangers and hay racks have been mentioned in paragraph 343 above. These should be of the kind described for yards, *i.e.* wooden and suspended on chains. Tying rings should be provided in three of the corners in each box, excluding the door corner, to facilitate easy examination of the beasts. It is convenient to have in one box a beam or rolled steel joist from which an animal can be slung in emergency. In the event of loose boxes being used for any livestock treading muck, it is advisable to provide a stout retaining board running in guides inside the external door frame to keep the pressure of the muck from the lower door. An alternative is to build up sandbags as the muck accumulates.

ISOLATION BOXES

Figure 41

351. Isolation boxes should stand away from other stock buildings and should be designed and constructed so that they can be thoroughly disinfected. This is especially important on dairy farms. Each isolation box must be self-contained without feeding passages or direct communication with other boxes or buildings. A building used for one or more isolation boxes should be surrounded by a 5 ft. concrete causeway; this will facilitate the disinfection of the building and of the boots and clothing of the attendants. The boxes should face south so that sick animals can receive the benefit of fresh air on mild and sunny days. Isolation boxes should only be entered when this is unavoidable. The animal can be fed from the outside by means of a hopper discharging over the manger. The supply of drinking water should similarly be controlled from the outside. A verandah running along the end of two or more isolation boxes will not only allow these operations to be carried out under cover but will also afford protection for bins containing special feeding stuffs or medicines for mixing with the food.

352. *Walls* should be such as to prevent great variations of temperature. Cavity (two 4-inch layers) or solid 9-inch brick, is recommended. They should be rendered internally to a height of approximately 6 ft. and all internal angles should be coved.

353. *Doors.* Both upper and lower halves of half-heck doors should be covered with stout galvanized sheet metal.

354. *The floor* should be laid on a good bed of hardcore, or hollow blocks on hardcore, with a topping of concrete approximately 3 in. thick, coved at its junction with the walls to facilitate cleansing. It should have falls as described in paragraph 349 above. A slightly raised blue brick threshold at the door is an advantage so that the floor can be flooded for disinfection after occupation by a sick animal.

355. *Drainage.* Isolation boxes need special treatment. With these it is desirable to provide an internal untrapped gully or bend within the box and allow it to discharge into a back inlet trapped gully outside the building (see Fig. 41).

356. *A ceiling* is desirable to assist in keeping the temperature of the box steady. It must have a smooth unbroken surface, and if fibrous sheeting is used it should be rendered with a setting coat of lime plaster. The ceiling should be provided near the apex with a vent discharging at the ridge.

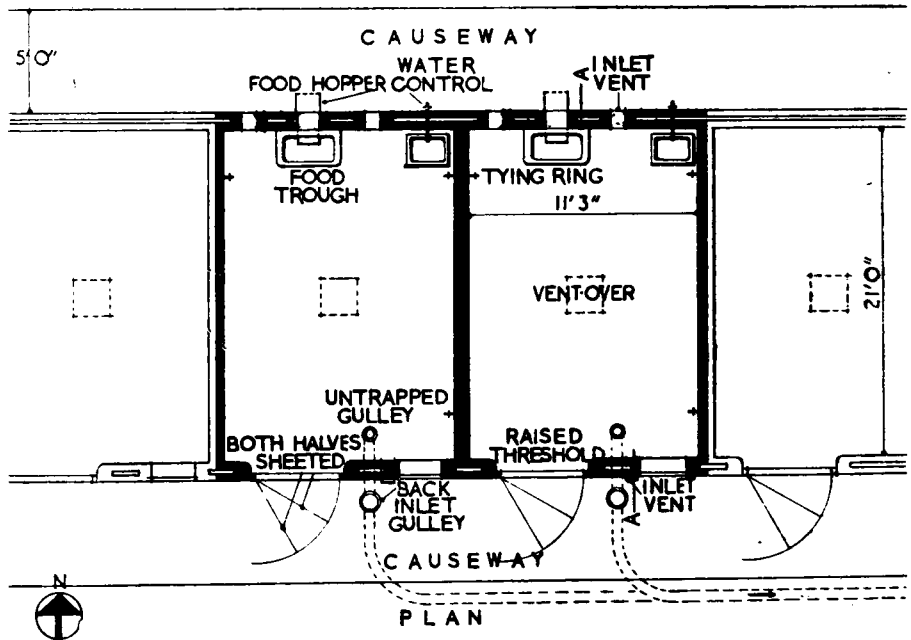
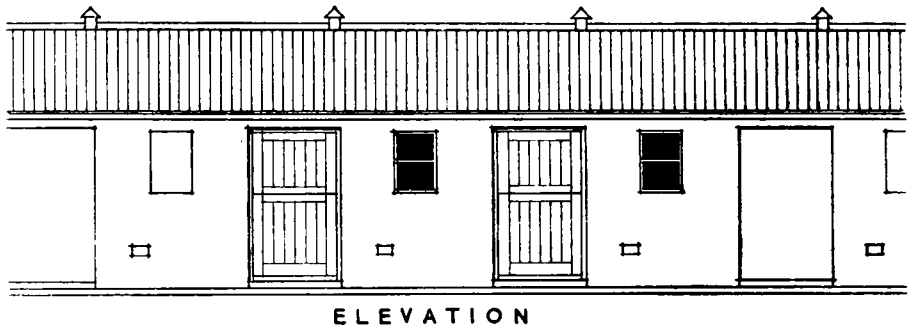
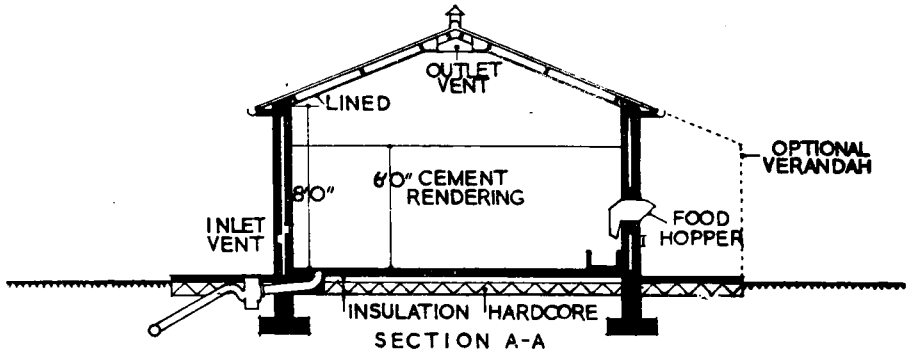


FIG. 41. ISOLATION BOXES

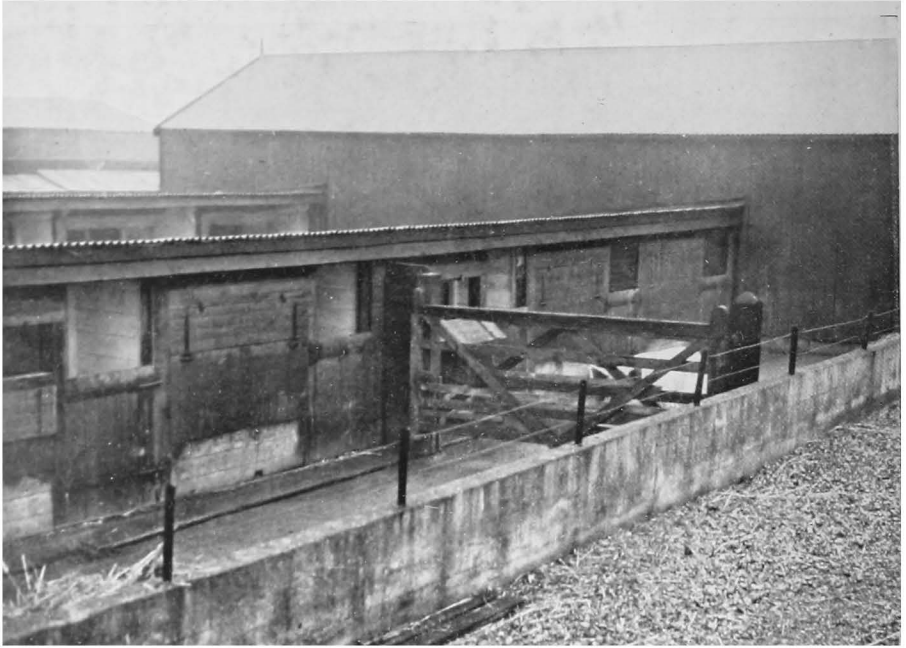


PLATE II. DOUBLE RANGE OF FARROWING PENS FACING SOUTH.



PLATE 12. FARROWING CRATE



**PLATE 13. RANGE OF STIES WITH YARDS ADAPTED FROM
DRAUGHTY DOUBLE-RANGE PIGGERY**
Formerly pigs did badly, now they do well. Note shutters for controlling ventilation
lowered in bottom two yards.



PLATE 14. STRAW FATTENING PENS FOR PIGS

CHAPTER 13. THE STOCKYARD

357. Yards, while an indispensable part of farm buildings, take many different forms and serve a variety of uses. "Crewe"¹ yards for store cattle and for general purposes are found on most farms, save in areas where climate makes them unsuitable (see Chapter 4, paragraph 72). Fattening yards for beef cattle may, according to climate and locality, be at one extreme the solid, well protected "courts" of the north or at the other the "straw yards" often seen in the eastern counties of England. To house dairy cows in yards with a separate milking shed is increasingly common, while to house lots of 50 to 100 fattening pigs in improvised yards with plenty of straw has often proved to be a healthy and economic system.

358. There are in practice two distinct ways of providing yards in the farm layout. First—and this is a characteristic of the British farm—the barn, stables, cowhouse, implement shed, and other buildings may be so arranged as to give one or more sheltered enclosures which, completed by a fence, constitute yards. The second kind of provision is yards separate from the other farm buildings—either close by the homestead or off-lying to serve the more distant fields.

359. A farm needs both yards and enclosed buildings, but there is now a strong tendency, in many districts, to house more of the stock in yards and to make less use of other types of accommodation. The main contention in support of this is that beasts living in yards are healthier. There are the further considerations, especially with dairy cows, that large quantities of straw can be put to good use and that the dung and urine are not wasted. In many cases, too, yards are much cheaper to build or to provide by adaptation than enclosed buildings. Critics of the greater use of yards point on the other hand to the likelihood of bullying and injury to bullocks or milking cows. Yards require large amounts of straw, but where the farming system provides an abundance of straw and relies on the return of this to the land to maintain fertility, yards ordinarily are essential. The kinds of yards and the extent to which stock live in them must be settled by local climate and by the farming system.

360. There is a great variation in the amount of shelter which yards provide. The whole yard may be roofed over; or there may be a roof along 1 or 2 walls or round all 4 walls leaving an open "well" in the middle; or, as in some "straw yards", no part may be roofed in. Further, the sides may be from 5 to even 10 ft. or more high and close boarding or post and rail may be used. The amount of side shelter needed naturally depends on the protection provided by surrounding buildings, and external features of the site. The aim is to provide sufficient shelter by a roof or under the lee of walls, to enable stock to get out of rain or cold winds. Draughts must be avoided.

361. It is convenient to distinguish three types of yard:

- A. The open yard with minimum shelter;
- B. The partially covered yard;
- C. The covered yard.

Evidence as to the advantages of permanent yards compared with temporary structures made, for example, from straw, supports the conclusion that in most circumstances a nucleus of permanent yards associated with and forming part of the farmstead is necessary. Temporary yards do, however, serve a most useful purpose in supplementing the permanent accommodation and in outlying fields. We have therefore devoted a separate chapter to straw yards (Chapter 14).

¹ Sometimes spelt "crew" or "cruiue."

FARM BUILDINGS

362. Whatever the size of the yard, it is desirable that it should be divided into sections so that not more than 15 to 20 beasts are kept in one section. For dairy cows division of yards into parts, each holding only 8 to 10, is often favoured (cf. Chapter 9). The number that can be kept in a section will depend mainly on the breed of cattle—long-horned, large beef cattle will require more room than polled or the smaller dairy breed. There is a variety of opinion as to the area required for each beast, and the only guidance we find ourselves able to give is that it should be between 100 and 150 sq. ft. It is generally accepted that less space is required in a covered than in an open yard.

As an example, a yard with an area of 2000 sq. ft. (say 33 ft. by 60 ft.) could accommodate up to about 20 small polled dairy cattle or up to about 14 large bullocks.

A. THE OPEN YARD

SITING

363. It is inadvisable that the southern side of an open yard should be enclosed by a building or high wall, because this limits the area which will receive sunshine. Apart from this point, advice can be given only that advantage should be taken of the protection afforded by other buildings or Dutch barns, and that the yard must not receive surface or roof water.

DESIGN

364. Shelter to a depth of 21 ft. including a feeding passage should be provided. It should not be less than 15 ft. deep exclusive of a feeding passage. The north side is preferred for the shelter, which would thus have its southern side open to the sun. Frequently, however, the yard is already bounded on the north by another building, and in this case the shelter should be constructed on the east. In large square yards divided as recommended into sections it is often necessary to provide shelter on two opposite sides. It will be seen that the location of the shelter is so much determined by the circumstances of the particular case that we can only advise that the northern side is preferred, while the southern side should be avoided.

365. We have come to the conclusion that it is not essential for yards to be enclosed by walls or clad fencing on more than two sides, providing that these are on the north and east; the other sides can consist of open fencing. It can, however, normally be arranged in farmsteads that two sides are formed by other buildings and a third by the shelter. We think such an arrangement generally desirable and economical, if the open side is on the south or south-west. If two sides are formed by open fences it is desirable that they should be adjacent and on the south and west, as this arrangement gives full benefit from the sun and is less draughty than where opposite sides are open.

CONSTRUCTION

366. *The Shelter.* This building should be 21 ft. deep and 8 ft. high to the eaves or tie-beams. One side and both ends will be walled or sheeted while the other side is open. Brick, concrete, timber, or corrugated iron are suitable. If sheeting is used it should be carried on a dwarf wall of brick or concrete 4 ft. 6 in. high. A shelter of this depth should carry a pitched roof with gutters to carry off rain.

367. *Fences and Divisions.* Though opinions differ, we consider it unnecessary and even undesirable that the open yard should be bounded on the south by a solid wall or close boarded fence. Similarly, on the west, we believe that an open fence is sufficient; on the east and north, however, the yard should always be bounded by a solid wall or close boarded fence at least six feet high.

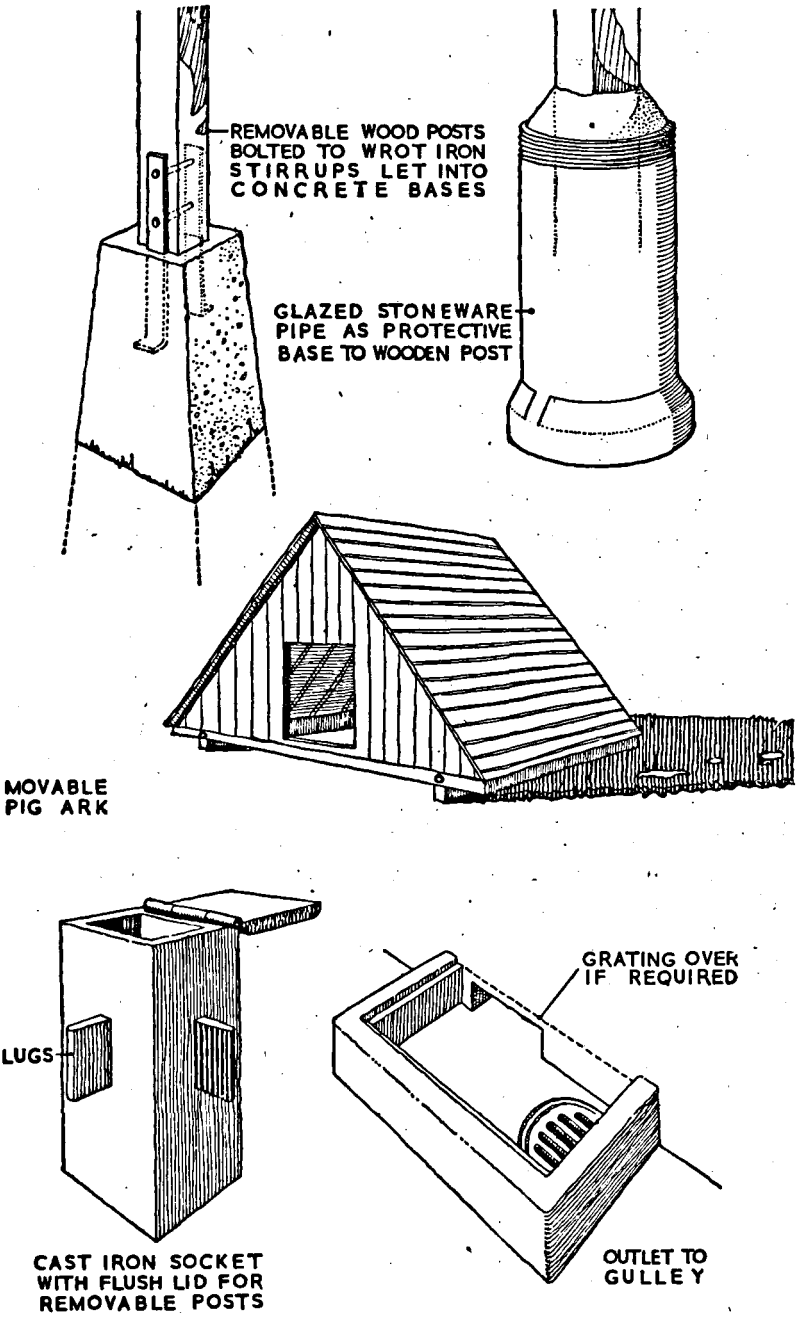


FIG. 42. SOME PRACTICAL DETAILS

FARM BUILDINGS

368. Fencing of the sides of an open yard not formed by buildings or by the shelter and the internal divisions of the yard have been the subject of careful consideration. It appears to the Committee that there may be in the near future developments in the use of mechanical methods of mucking out yards, using the principles of either the bulldozer or the mechanical grab. Such developments would be a great improvement on the slow and laborious clearing by horse and cart. It is clear, however, that if the dung is to be either pushed or pulled out of the yard, fences of the wrong type might easily be serious impediments. Gates as commonly provided would mean that the machine employed would have to do an unnecessary and probably uneconomic amount of manœuvring. We consider, therefore, that this point should be borne in mind, and that it would be wise to construct the fence in such a way that at least some sections of it are easily removable. The point would be met if main posts were at least 15 ft. apart, and the rails and intermediate posts removable.

369. For fencing, both timber rails and tubular steel are satisfactory. Timber posts are liable to decay, especially if dung is piled against them, but it is found that really hard seasoned oak posts last for a considerable time, and if the rails are coach-screwed on to the face of the posts instead of morticed the task of renewing a post occasionally will not be very difficult. Timber posts can also be set in or bolted or strapped to concrete posts 2 ft. high; a simple alternative is to set the posts in drain pipes which are then filled with concrete (see Fig. 42).

370. *Floors.* The yard should have a hard surface of hardcore or concrete. The shelter buildings should have a concrete floor sloped towards the yard and if the yard is not concreted there should be a concrete causeway 5 ft. wide outside the shelter building and along other buildings surrounding the yard.

The advantage of a concrete floor is that the cost of maintenance is low; the disadvantage is that it is initially more costly than hardcore. A concrete floor is very desirable if the subsoil is heavy or waterlogged.

371. *Drainage.* Ideally there should be no drainage from a stock yard because all moisture, including urine and rain, should be absorbed by straw. This ideal, however, is frequently unobtainable in open yards, and hence it is often desirable that drainage should be provided, particularly where the subsoil is non-porous and where straw is not plentiful.

Where drainage is required the floor of the yard should be graded to a convenient collecting point. At this point a street type grating should be fixed over a catchpit 2 ft. square and 18 in. deep below the invert of the pipe; from this catchpit a 6-in. pipe should be laid to another catchpit outside the yard situated so as to give ample facilities for rodding the drain. From this point a 4-in. drain can be laid into a ditch or other channel.

372. *Mangers and Hayracks.* Mangers and hayracks should be provided under the shelter and arranged if possible so that they can be foddered from the outside. Movable mangers and racks hung so that they can be raised or lowered according to the depth of dung are often fitted, but less often operated. They have much to commend them, but if provided they should be used.

B. THE PARTIALLY COVERED YARD

Figure 43

DESIGN

373. Climate or the particular purpose for which the yard is intended may indicate that the minimum protection described above is insufficient. The additional cover can sometimes be provided by the construction of similar shelters on

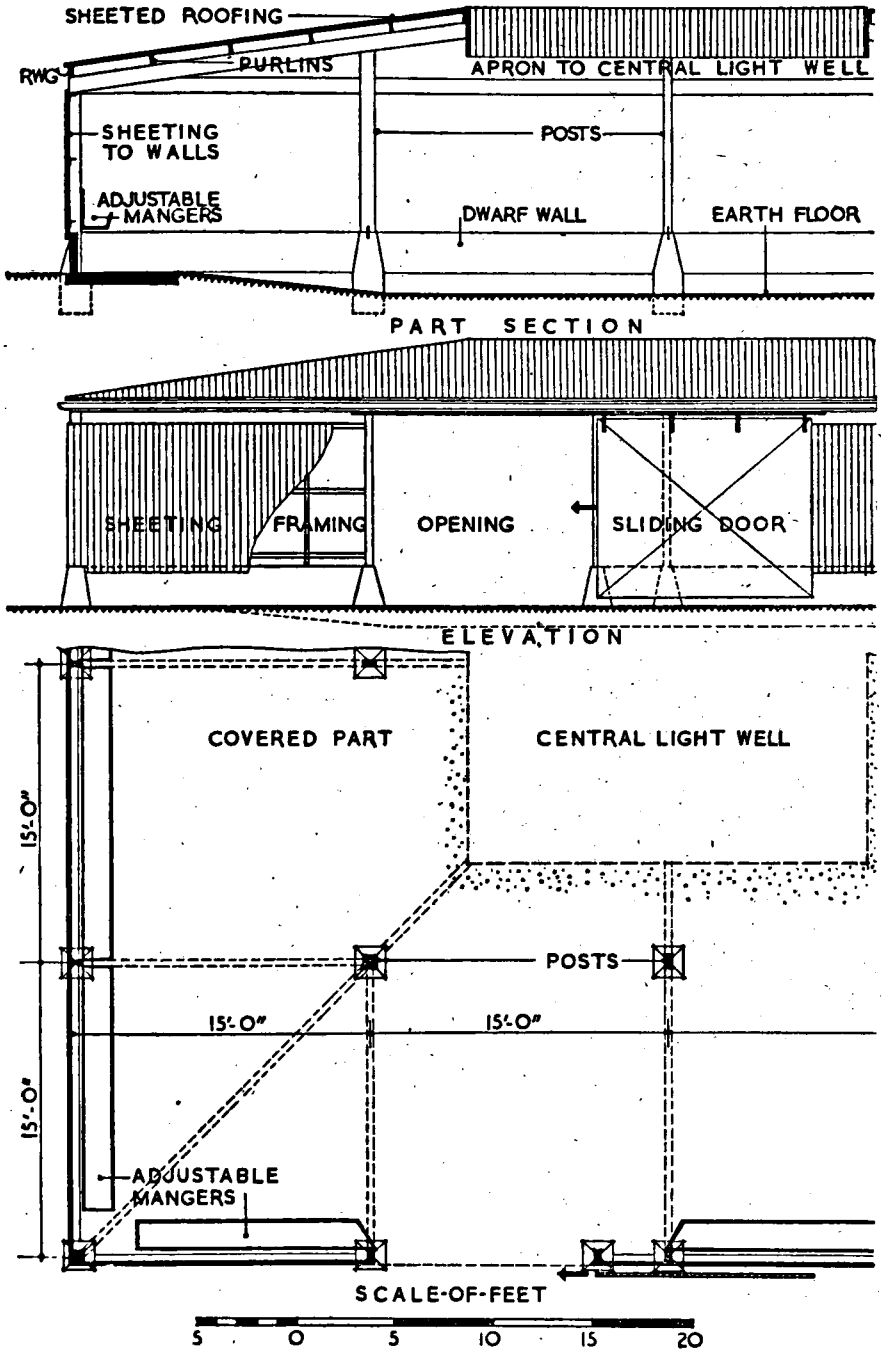


FIG. 43. PARTIALLY COVERED YARD

FARM BUILDINGS

other sides of the yard. If, however, it is desired to increase substantially the area under cover, it is better to carry the roof on one structure instead of providing in effect a number of separate buildings. The shelters described in the earlier part of this Chapter can be used to cover about one-third of the total area of the yard. In the following paragraphs we describe a yard in which eight-ninths of the area is covered.

374. The yard measures 60 ft. square, and provides 3600 sq. ft. of floor space; of this, 3200 sq. ft. is covered, leaving an open space 20 ft. square in the middle. This yard is large enough for about 35 small polled dairy cattle or about 25 large bullocks. A roof of shed type is provided to a depth of 20 ft. all round the yard. A yard of this kind is often used on a site away from protection from other farm buildings. It is illustrated in Fig. 43, and another example is included in Layout C, Chapter 7.

CONSTRUCTION

375. *Walls.* Walls may be solid, of brick or concrete, or consist of piers of the same materials or steel columns or posts 11 ft. high with rails between them, covered with sheeting to a height of 9 ft. If sheeting is used it is better to provide a 4 ft. 6 in. dwarf wall of brick or concrete unless the wall is protected by mangers and other equipment; even in this case some prefer to have a dwarf wall at least to the underside of the manger. The piers, columns, or posts will carry the outer ends of the roof principals. There should be two openings at least 12 ft. wide on opposite sides of the building, the roof being broken above them. Steel-framed and metal-covered doors or overlapping field gates should be fitted to the openings.

376. *Roof.* Piers, columns, or posts corresponding to the wall posts, but 13 ft. high and 15 ft. from the wall, carry the inner ends of the roof principals. The covered part of the yard will thus consist of a series of 15 ft. x 15 ft. bays, and the roof will have a slope of 3 ft. to the outside. If steel columns are used, they should be benched in concrete, and timber should be treated as advised for the fences of the open-yard. Care should be taken to ensure that concrete posts are sufficiently reinforced, and all arrises should be rounded.

377. The advantages of this type of construction are that the cattle can always find shelter from the wind and rain and that the sunlight can always enter the yard at any time of the day. The warm air from the cattle and from the manure tends to rise through the opening, thus preventing excessive down draughts of colder air. Mechanical muck clearing will not be easy with this kind of yard unless special equipment is devised for it.

378. *Floors, Drainage, Fences, and Divisions.* The conclusions reached in regard to floors, drainage, fences, and divisions for the open yard apply also to the partially covered yard.

379. *Mangers and Hayracks.* Mangers and hayracks can be supported by the outer column of the building. Food will usually be taken into the yard by horse and cart and this should be borne in mind in arranging the fittings.

C. THE COVERED YARD

Figures 44 to 46

DESIGN AND CONSTRUCTION

380. *Walls.* This type of building may have no walls as it frequently happens that surrounding buildings provide the necessary side protection. If separate walls are needed they should be of the same general type and dimensions as for the partly covered yard. Many prefer, however, covered yards to be lower than

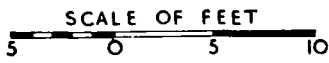
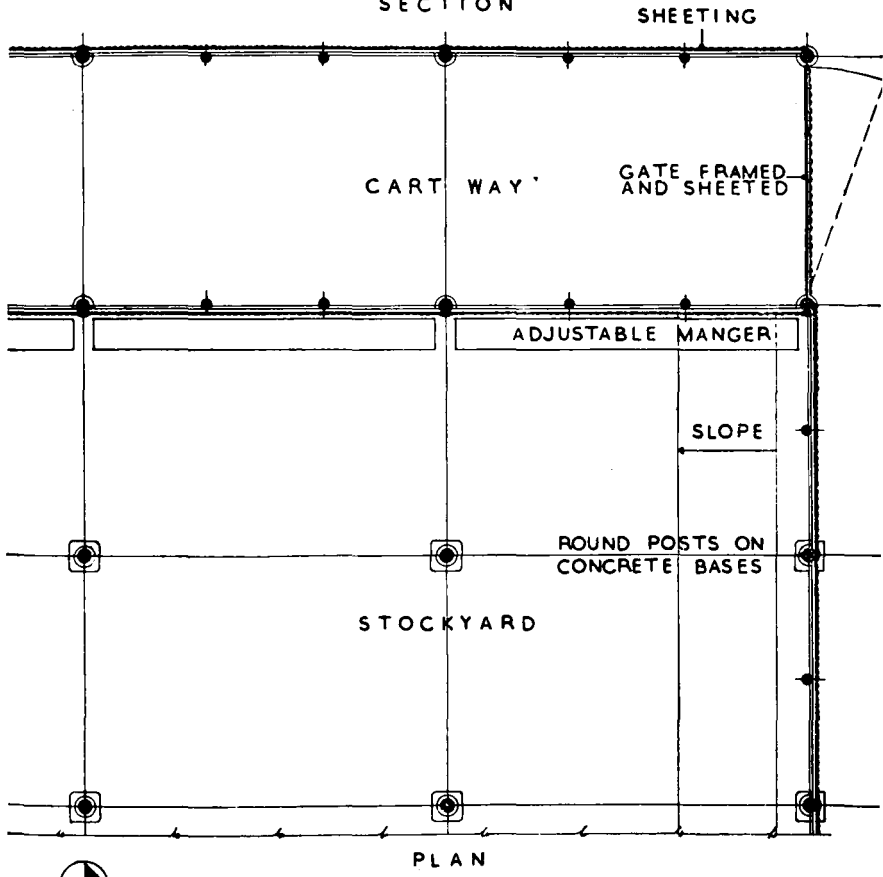
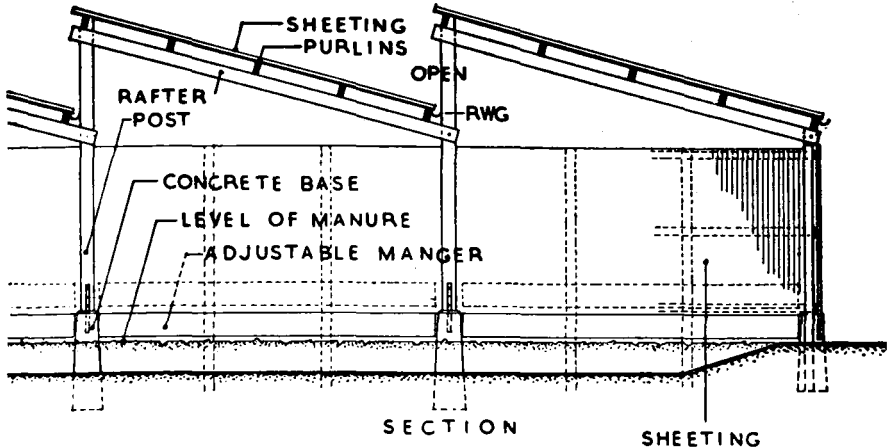


FIG. 44. COVERED YARD

FARM BUILDINGS

11 ft. to the wall plate. In this case 10 ft. will be found satisfactory, the open space below the eaves being reduced to 1 ft.

381. *Roofs.* It is very desirable that in a building of this nature there should be the minimum possible number of isolated columns in the yards. Where it is not possible to span the area required without intermediate supports, care should be taken to see that these intermediate supports come in line with the dividing fences. Fig. 44 shows a way in which this may be achieved.

The Committee has inspected an interesting covered yard, roofed on the "saw-tooth" system, which is of course familiar in industrial buildings. The system deserves careful examination by the Advisory Service for use in farm buildings. The yard is illustrated in Fig. 44.

382. A serviceable form of roof covering is asbestos-cement sheeting. It is worth noting that this can now be procured with slits in the ridge of the corrugations to prevent condensation and give additional ventilation. Alternatively, Yorkshire boarding, laid in accordance with the following specification, is satisfactory.

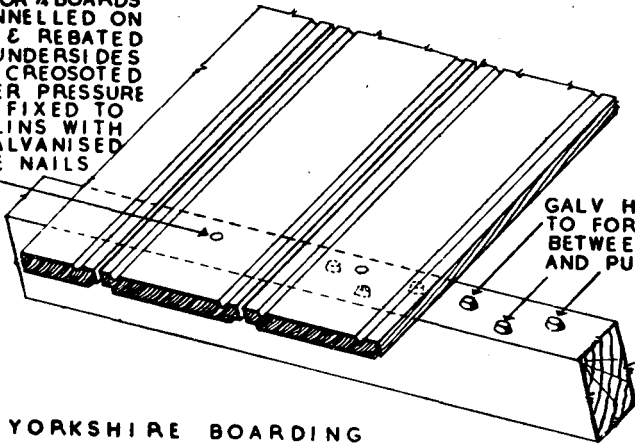
Timber roof-trusses are provided with purlins, and over these are laid 7 in. by 1 in. or $\frac{3}{4}$ in. boards. The boards are spaced about $\frac{1}{2}$ in. apart and each board is so fixed that it does not come in contact with any other wood. For this purpose galvanized hobnails, in groups of three, are driven into the purlins with their heads projecting above the surface by at least a $\frac{1}{2}$ in. The boards are fixed to the purlins with a single 4 in. galvanized wire nail in the centre of the board. This allows the boards to curl up, shrink or swell without splitting, and gives a $\frac{1}{2}$ in. clear space between the boards and the purlins. The boards should have a groove ploughed about $\frac{3}{8}$ in. wide and about $\frac{3}{8}$ in. distant from the edge of the board on the outer face, and for the whole length of each board, and a slight rebate on the underside edges. (See Fig. 45.) Thoroughly seasoned timber should be used, and this preferably creosoted under pressure. All nails should be galvanized.

383. Points specially to be borne in mind are that if the building is not surrounded by other buildings the eaves should be constructed to overhang considerably and thus give additional shelter. To prevent draughts gable ends should be sheeted down in asbestos-cement sheeting to 10 ft. above ground level. Where the building is surrounded by other buildings it is not possible to place the columns carrying the roof of the yard close against the wall of the other buildings without interfering with the eaves guttering of those buildings. A method of supporting the roof in such cases is to build piers on the walls of the outer buildings at 14 ft. intervals. The piers should be raised 2 ft. above the plate level of the existing wall and should be strong enough to carry the weight of the roof trusses. On a 9 ft. wall this can be done by corbelling it so as to form a pier 18 in. square. The roof of the yard can then be supported on these piers and the covering carried out to within 4 in. of the roof of the adjoining buildings. The rainwater from the covered roof can then discharge on to the roof of the outer buildings and be carried away in the eaves gutters of those buildings. This method has proved successful but is open to the objection that each pier protruding through the roof of an adjacent building needs the same treatment as a chimney; and such complications are possible sources of trouble; there are further difficulties if the existing roofs are covered with asbestos-cement sheets. If the roof of the yard is supported independently, rainwater may discharge from it on to adjacent roofs. The columns supporting the roof in this case are used as fence posts in the yard.

It should be noted that when rainwater discharges on to other roofs it may be necessary to enlarge the eaves gutters on them. The two methods are illustrated in Fig. 46.

384. *Floors, Drainage, Fences, and Divisions.* The conclusions reached in regard to floors, drainage, fences, and divisions for the open yard apply also to the covered yard.

7"x1" OR 3/4" BOARDS
CHANNELLED ON
TOP & REBATED
ON UNDERSIDES
ALL CREOSOTED
UNDER PRESSURE
AND FIXED TO
PURLINS WITH
4" GALVANISED
WIRE NAILS

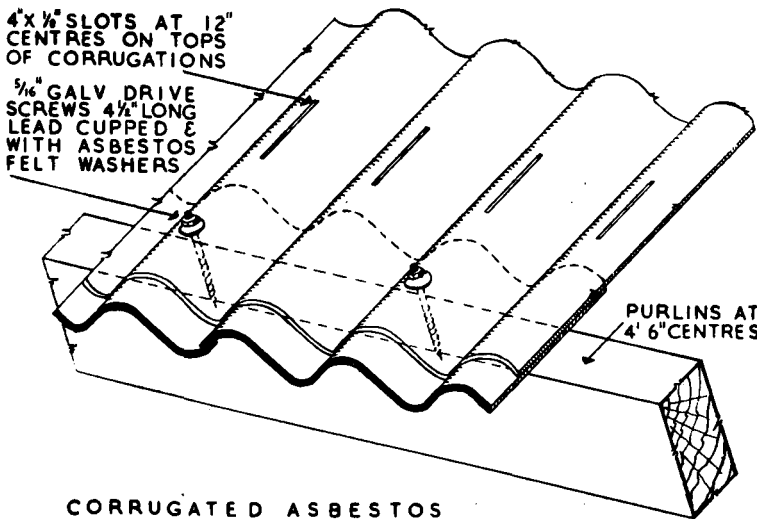


GALV HOB NAILS
TO FORM 1/2" SPACE
BETWEEN BOARDS
AND PURLINS

YORKSHIRE BOARDING

4"x 1/2" SLOTS AT 12"
CENTRES ON TOPS
OF CORRUGATIONS

5/16" GALV DRIVE
SCREWS 4 1/2" LONG
LEAD CUPPED &
WITH ASBESTOS
FELT WASHERS



PURLINS AT
4' 6" CENTRES

CORRUGATED ASBESTOS

FIG. 45. VENTILATING ROOF COVERINGS

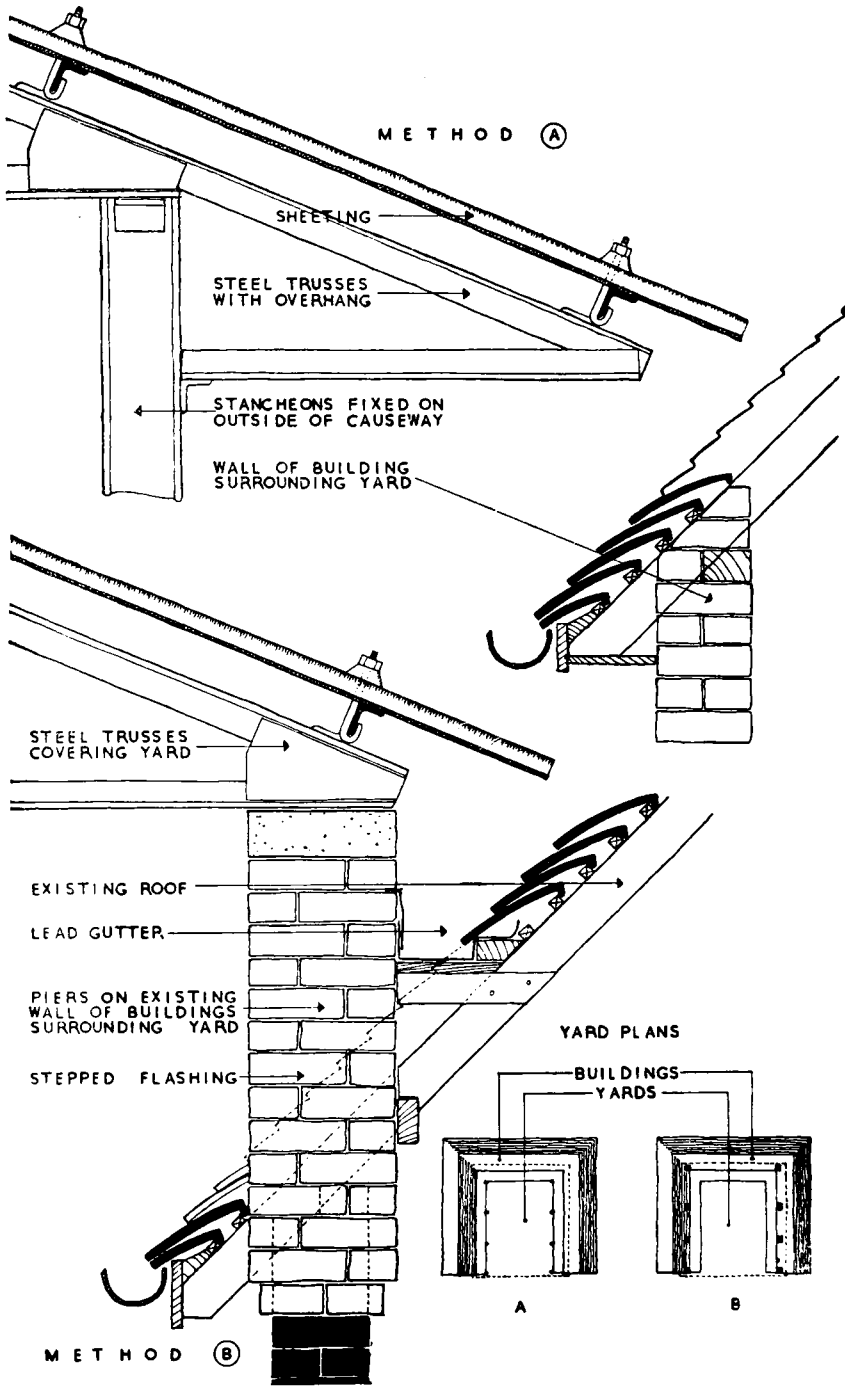


FIG. 46. METHODS OF SUPPORTING ROOFS FOR YARDS

STRAW YARDS AND STRAW BUILDINGS

DUNG STEADINGS

385. When yards are cleared, dung should be taken immediately for spreading on the land in order to save double handling and a possible loss of plant nutrients if it is stored for later distribution. Mechanical clearing of yards may facilitate immediate transport to the fields, particularly if the "grab" method is developed. Clearance by a bulldozer might, however, make it necessary in some circumstances, to store the dung for a time before it can be carted, although vehicles could be loaded by a suitable elevator. It is desirable that if dung is regularly to be stored in a heap or dung steading for considerable periods, protection should be given from rain and surface water. The essentials are a good floor of hardcore or concrete, a light roof, and walls on three sides which should be about 3 ft. 6 in. high. A drainage tank, from which liquid draining from the steading can be pumped back, will reduce the loss of plant foods.

386. In design and construction, account should be taken of the method of transport both from the yard and from the steading itself. Overhead conveyors from yards to dung steadings have, in some cases, been found satisfactory, but an installation of this kind should include provision for the loading of trucks or carts at the dung steading itself.

387. An interesting possibility is the provision of a light roof in sections, carried on supports (perhaps of tubular steel or timber) which can be inserted in slots provided in a concrete base. Advantages of such a method would be that the roof could be erected after dung has been taken to the steading, and could be removed when it is desired to carry the dung to the fields; it could be expected to facilitate loading. In the opinion of the Committee, however, it ought in most cases to be possible so to organize the clearing of yards that the storage of dung is avoided.

CHAPTER 14

STRAW YARDS AND STRAW BUILDINGS

388. The use of straw has been suggested as one way of meeting the shortage of building materials and skilled labour in the period immediately after the war. It is, however, not only in an emergency period that straw can find a place in farm buildings, for in normal times yards and rough shelters from straw may prove a great convenience, as farming practice in parts of the Eastern Counties has long shown.

389. Buildings of this temporary nature are particularly useful for providing storage accommodation and for stock yards. Reference is made in Chapter 15 to the usefulness of outlying Dutch barns, and it is pointed out that this is much enhanced if temporary stock yards are associated with them. The Dutch barn itself may sometimes serve as the stock yard if temporary walls, perhaps of straw, are provided. In regard to storage it is sometimes necessary or desirable to increase temporarily the accommodation already provided by permanent buildings. It seems likely that on many farms there will be a constant need for some temporary buildings to meet needs which cannot be met economically by permanent buildings in the centre of the farmstead. Apart from this continuing usefulness of temporary buildings, a shortage of building materials and labour will persist for some years after the war. During this period, temporary, improvised, and consumable buildings will have greater importance, particularly if the period of stringency is also a period of high costs. The Committee recommends, therefore, that farmers

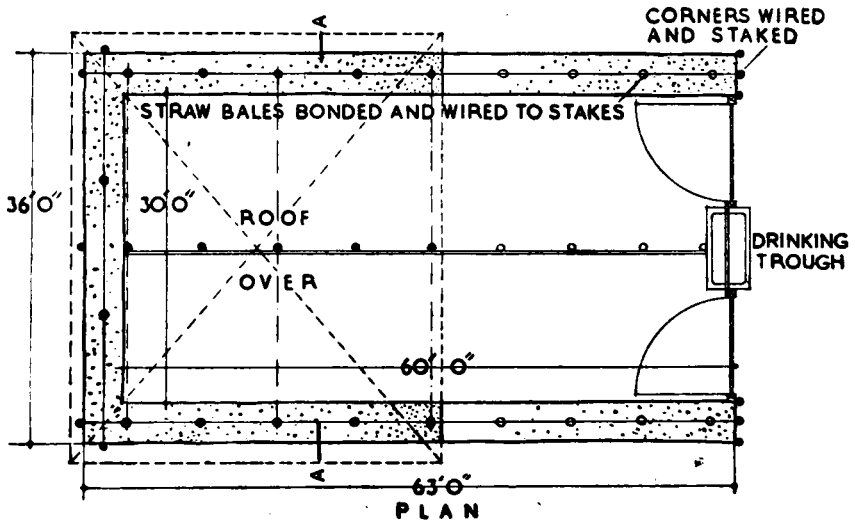
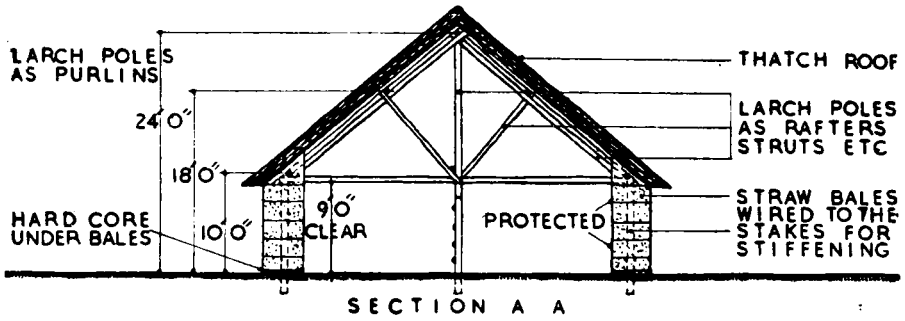
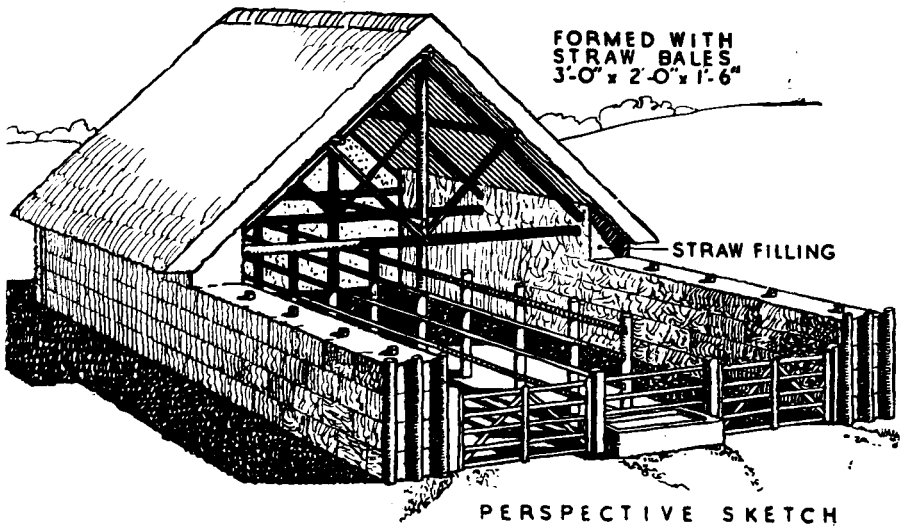


FIG. 47. PARTIALLY COVERED STRAW YARD

STRAW YARDS AND STRAW BUILDINGS

should study and exploit the use of straw both as a permanent means of securing economy in labour and transport without high capital expenditure, and also as a partial solution of the difficulties of the next few years.

390. One way of meeting the need would be to use demountable buildings which could be erected for the time being on the selected site. We have considered this and made preliminary trials but find the immediate prospect poor. Buildings of this kind, if of any size, suffer from the disadvantages that if they are to be strong enough they will also be heavy and awkward to transport, while the rate of depreciation is high. For pigs and poultry, buildings small enough to be moved regularly without being taken down are, however, admirable.

391. The desirability of providing accommodation for livestock away from the farmstead is increased by a system of ley farming, while the use of the combine harvester suggests at once the advisability of using straw as near as possible to the fields on which it is grown. Just as the maintenance of soil fertility indicates "taking the plough round the farm," so economy in labour and transport suggests that stock should accompany the plough.

392. The alternative to the movable structure is, as has been indicated above, a consumable building—constructed of materials so cheap that it can be written off when there is no longer a need for a building on that site or when the building is beyond easy repair. Of materials of this kind likely to be in adequate and general supply, rough poles and straw are the most common though any suitable "waste" material which lies to hand can be used.

393. A number of general points, some of detail, require to be noticed in the employment of straw for buildings.

- a. An important consideration is risk of fire. The loss of a straw building is of no consequence; the real risk is to the stock or implements housed in it. Before deciding to proceed with the erection of straw buildings for valuable stock, implements, or materials, a farmer would be well-advised to discuss the project with his insurance company.
- b. Fleas, particularly troublesome with poultry and pigs, may harbour in thatched roofs of ordinary buildings and, similarly, in all parts of a straw building. In practice this appears seldom to have become serious, and to burn one old straw pig-house and build another is not a major undertaking. It does not appear from experience that other forms of vermin, especially rats, are particularly liable to give trouble in straw buildings.
- c. The life of straw buildings is difficult to estimate. Straw yards for bullocks are usually broken up at the end of a winter, but sheds made with essential timbers and the rest of straw have been kept in use for, at any rate, seven years, while pig-huts with runs made of straw between two layers of sheep netting have often served for at least as long.
- d. Drainage is an important consideration in the siting of straw buildings, particularly if baled straw is used. It is important to prevent surface water, including drainage from the roof, from lying in or about the building. A naturally well-drained site should be chosen, or simple improvements in the drainage should be effected by shallow ditches. Walls can be laid on rubble or brush-wood to prevent waterlogging.
- e. All kinds of straw, including bean straw, may be used, but wheat is best. Broadly speaking, there are two systems in the use of straw for buildings or yards. The commonest is to use baled straw, but various modifications of walls of straw forced in between two layers of sheep netting, or wire,

FARM BUILDINGS

have had great success in practice. The procedure with either kind of walling is simple, though attention to detail is well repaid. A third way of using straw is in the form of mats, made by machine, as for thatching. It may have a number of uses for light, temporary cover.

- f. For roofing, straw thatch may be used, though this requires the full arrangement of battens, etc. A common alternative is to use straw "bats," *i.e.* bundles of straw previously yealmed as in preparation for thatching. Some annual renewal is usually required with straw bat roofs.

394. Straw buildings are obviously unsuitable for housing dairy cows, for a milking shed or stable or for the storage of grain, fertilizers, or feeding stuffs; they are, however, practicable for pig or cattle yards, for pig-houses, and for implement and tractor sheds. Shelter hovels for grazing cattle, mentioned in Chapter 4, paragraph 81, in connection with ley farming, might conveniently be of baled straw. That straw buildings are temporary, indeed ephemeral, goes without saying, but it may well be better to take the risk of fire by housing a drill or other equipment in a straw hovel than to leave it exposed to the weather.

STRAW YARDS

Figures 47 and 48

395. Straw yards of many kinds are to be seen, their use having greatly increased during the war through straw becoming available abundantly in areas where formerly it was scarce. There are, broadly speaking, two types.

It has been customary in some districts to pitch two, three, or even four straw stacks together either in a line or in the form of a "U" and by means of posts and rails, to complete the remaining sides of a yard. Shelter is thus provided and the straw required for daily littering is on the spot. Sometimes a simple roof as a shelter is provided at one end and this may be of straw bats.

The other main type of straw yard has its walls entirely of bales, though a straw stack may be pitched at one end for extra shelter. Many variations in construction are seen. Notes and illustrations of a straw yard of this type are given in the Annex to this Chapter.

396. *Baled Straw.* The bales should be bonded, as shown in the illustrations. It is, however, necessary to wire the bales together and to stiffen the wall with poles and rails at regular intervals. Poles can be put either outside or inside the wall; if inside they can carry mangers and other equipment. Sometimes the wall is buttressed on the outside by additional courses of bales. The amount of stiffening given to the wall by poles will depend on whether the wall is buttressed in this way, and also on the thickness of the wall. A bale 3 ft. \times 2 ft. \times 1 ft. 6 in. (the standard size for stationary bales, those from pick-up balers being slightly smaller) can be used to form a wall either 2 ft. or 3 ft. thick. Walls only 1 ft. 6 in. thick are too narrow to stand securely without an excessive amount of stiffening with posts. The method of construction selected will depend on supplies of poles and of straw, but the general rule is that the less the weight of straw the greater the amount of stiffening required. Details of walls of this kind are illustrated in Fig. 47.

397. If the yard is to be used for bullocks, from 120 to 130 sq. ft. of floor space will be required per head; 135 sq. ft. would be generally suitable. On this basis a yard 30 ft. \times 45 ft. internal measurements constructed of bales of the above dimensions would accommodate 10 beasts. Two long and one short sides would be constructed in straw; the remaining side, which would be on the south, would be of rails and would include a gate and a drinking trough. For a yard of this

STRAW YARDS AND STRAW BUILDINGS

size with walls 3 ft. thick the following approximate amounts of straw would be required:

HEIGHT OF WALL	NO. OF BALES	WEIGHT
8 ft. (4 courses high)	350	7 tons
10 ft. (5 courses high)	440	9 tons

If the walls are buttressed on the outside the amount of straw required would be proportionately greater; thus about twice the amount of straw would be required if an 8 ft. wall is buttressed by two rounds of bales 3 and 2 courses high respectively.

398. To prevent beasts from pulling, horning, or ramming the wall several devices are employed: sometimes chestpale fencing or woven wire is wired to the stiffening posts on the inside, sometimes stout posts and rails are used, sometimes strands of barbed wire, while in other cases success has been obtained by creosoting the inner faces of the baled walls. The feeding troughs and hayracks may be formed against the wall.

399. Another way of protecting baled walls from the stock and which simplifies feeding is as follows. A post and rail fence from any timber available but of adequate strength is set all round the yard save at the gateway, at a distance of 5 ft. from the baled wall. In the space thus fenced off fresh straw is thrown daily for the cattle to eat and roots are also dropped there for feeding. Straw left over from one day is forked out before putting in fresh straw the next day. With a yard of good size a cart can move all round the fence to drop the fresh straw and roots and this proves in practice an efficient working arrangement. General experience with straw yards strongly favours ample size to allow of easy distribution of fodder. Where 5 ft. is thus railed off all round, a substantial increase in size is naturally necessary.

400. *Packed Straw.* Walls consisting of horizontal strands of wire stuffed with straw, may also be used instead of baled walls for a bullock yard. In this method rows of poles are set in the ground; the distance between pairs of poles being 6 ft. The length of the poles is determined by the amount of dung which it is proposed to make in the yard. 9 or 10 feet out of the ground is satisfactory, but good walls up to 14 or 15 feet high can be constructed. Strong wires are stretched between the poles and straw is then packed between the wires. A wall of this type 6 in. thick has been found satisfactory though probably 9 in. or 1 ft. thick is better. Details of walls of this type are shown in Fig. 48. Strong wire-netting, such as sheep netting, is sometimes used instead of wires, particularly for low walls.

401. Experience with yards of this type over a number of years is not available, but they seem promising. Their advantages are: greater maximum height as compared with baled straw; reduction in the amount of straw required. A disadvantage is that more wire is required. It is claimed that these structures will last for many years, but it is of doubtful wisdom to try to extend the life of temporary structures beyond a few years, especially if this involves over-elaboration of design or construction.

THE STRAW PIG-HOUSE

402. The straw pig-house appears to be coming increasingly into use on farms with plenty of straw. Walls may be of bales or of straw packed between two

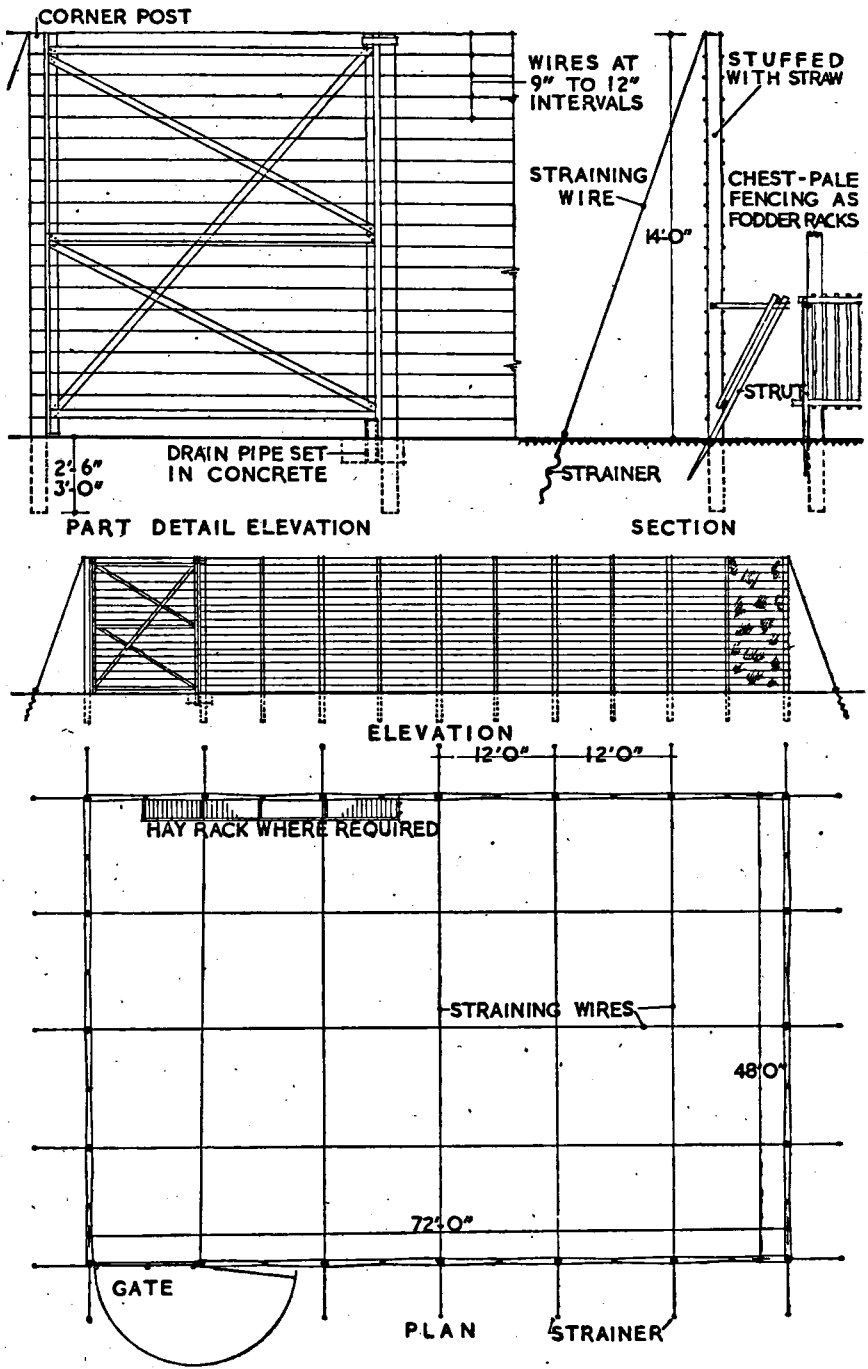


FIG. 48. OPEN STRAW YARD



PLATE 15. STRAW FARROWING PENS



PLATE 16. INTERIOR OF FARROWING PENS SHOWN ABOVE



PLATE 17. PIG HUT

Feeding creep for little pigs railed off ; farrowing rails are fixed inside and sows have farrowed successfully in these huts.

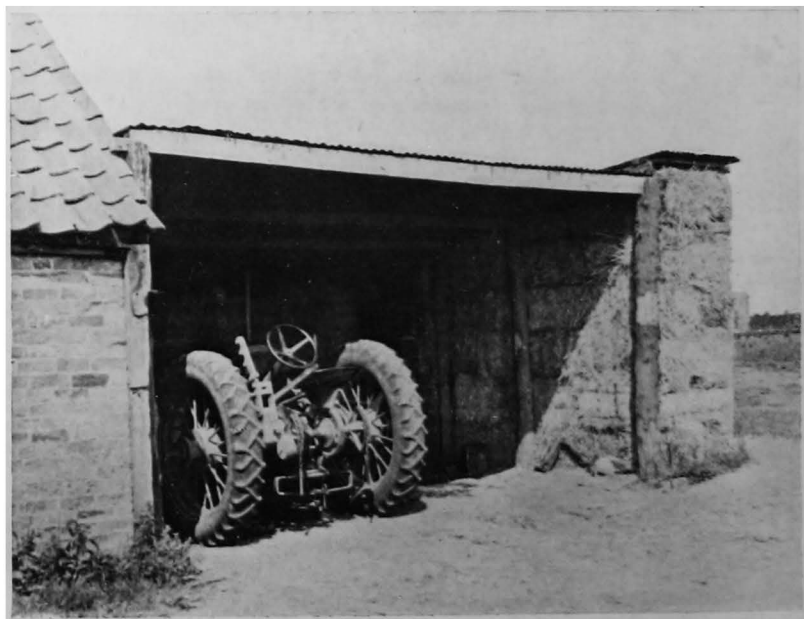


PLATE 18. IMPLEMENT SHED

STRAW WALL ADDED TO BRICK BUILDING; CORRUGATED IRON ROOF

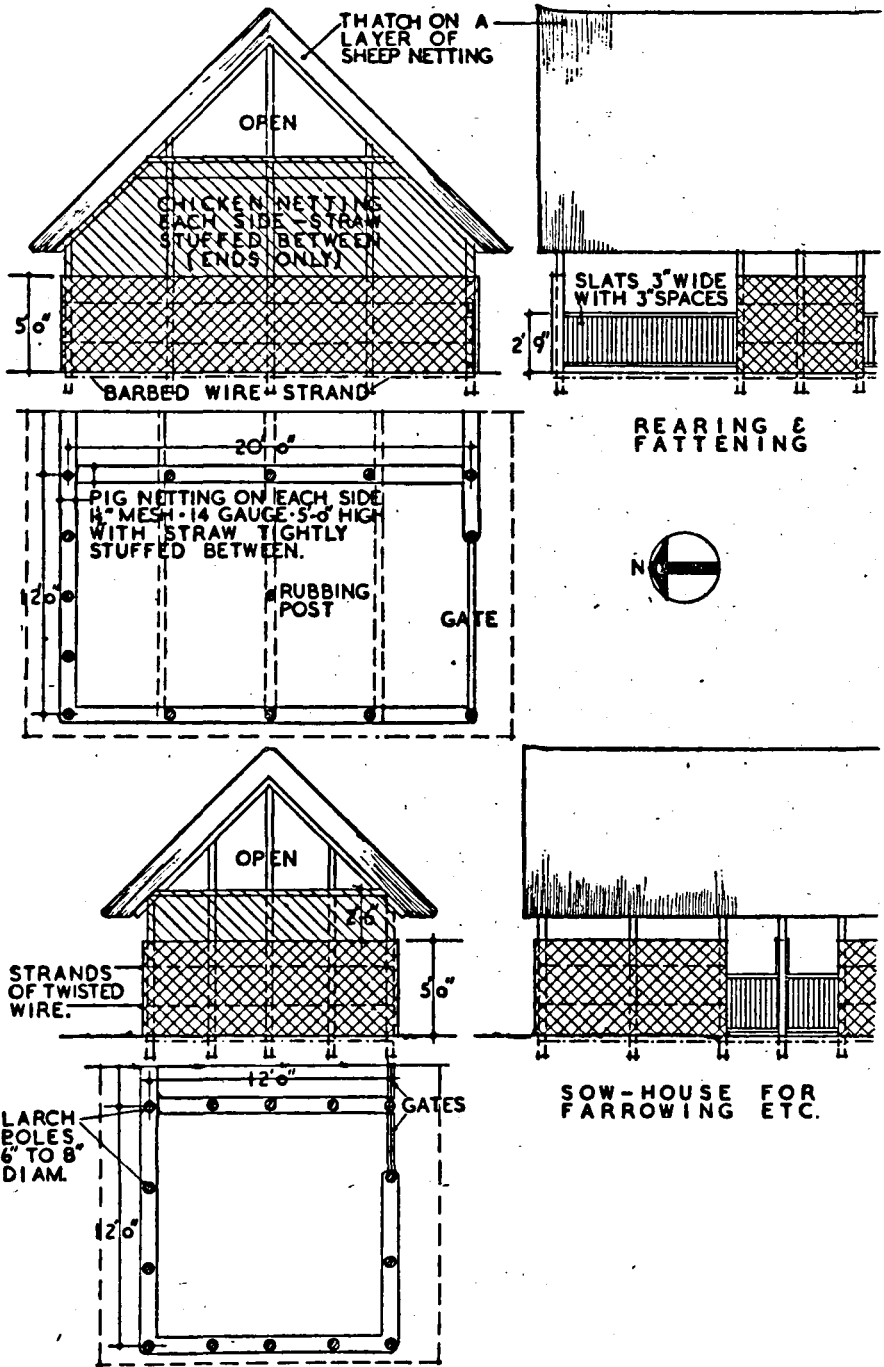


FIG. 49. STRAW PIG-HOUSES

FARM BUILDINGS

layers of sheep netting (for details of each method see paragraphs 396 to 401). In illustration of possibilities, examples are given in the Annex to this Chapter.

STRAW BUILDINGS FOR STORAGE

403. Straw buildings for storage may range from the small simple hovel to the large elaborate structure capable of holding the largest equipment required on farms. Some timber is always required to support the roof, but in a hovel to house one implement a few rough poles laid from one wall to the other suffice to support a straw bat roof. In such a building three sides would be filled with bales and one left open. At little more expense of money and time a much better straw roof may be made or corrugated asbestos may be employed. Notes and illustrations of storage buildings appear in the Annex to this Chapter.

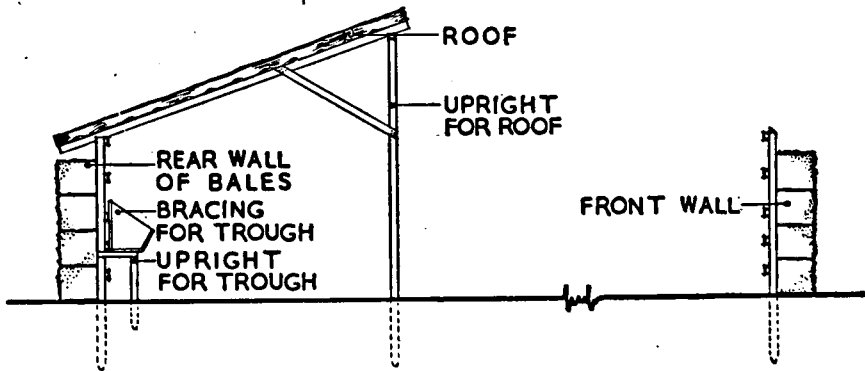
ANNEX TO CHAPTER 14

A FEW EXAMPLES OF STRAW YARDS AND BUILDINGS

I. STRAW YARD AT THE FARM OF COLONEL AND MRS. HIGNETT, EAST LANGTON GRANGE, MKT. HARBOROUGH

The yard is enclosed by a fence, approximately 20 yards square, surrounded by a wall composed of baled straw—one bale wide and five bales high—with the exception of one side and in places where the bales have been built higher to meet the sloping roof. The bales lie lengthwise in the walls (*i.e.* width of wall equals width of a bale=2 ft.). At the back of the yard under the eaves of the sloping roof the wall is only four bales high, leaving a space of about one foot wide between the wall and the roof, to provide ventilation. Against the rear wall, under cover of the roof, is a wooden trough running the whole length of the wall; in the front wall is an ordinary gateway.

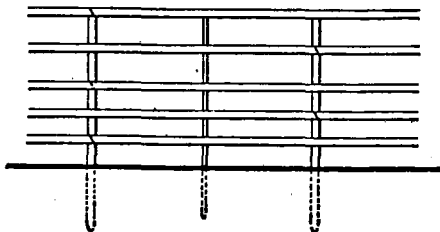
A cross section of the yard from back to front, through the centre, is illustrated roughly below:



The materials used are English soft timber and ash poles, with baled and batted straw. To begin with, two fences comprising larch posts and sycamore runners are set parallel to each other at approximately 22 yards apart. The larch posts are 10 ft. long and are put 3 ft. into the ground; they are erected at distances of 10 ft., and then joined by a series of five sycamore rails, 4 in. x 2 in. Midway between the larch uprights, the sycamore rails are braced with an upright stake of the same material.

STRAW YARDS AND STRAW BUILDINGS

The front wall is built at right angles and on exactly the same principle, except that in the continuity the fence is broken to make a gateway, approximately 10 ft. wide. The larch uprights in this case form the gate posts, and also serve to hold the rails on the fence.



The rear wall is fenced in similar manner to the sides and front—the 10 ft. uprights supporting the rear of the roof. The trough running along the whole side of the wall is attached to the fence. The depth of the trough at the back is 2 ft. 2 in., and it is braced to the fence with an additional boarded wall 2 ft. deep, to make it quite firm. The width at the top of the trough is 2 ft. 2 in. and at the bottom it rests on 3 ft. posts 4 in. × 3 in. placed at 6 ft. distances. This means that the trough is stationary and cannot be raised or lowered in accordance with the height of the shed floor.

The roof is supported at the back by 10 ft. uprights already mentioned, and 14 ft. larch uprights at the front, placed 10 ft. apart. These are joined by 4 in. × 3 in. sycamore runners and big sycamore principals from front to back, which are braced at the angles to give additional strength.

The principals are joined by 10 ft. lengths of split ash runners, placed about 15 in. apart which form the foundation for the roof made of straw battens, put on to form a watertight roof in a similar manner to battening a stack. The straw battens are tied to the ash runners to keep them in position.

The width of the roof is 16 ft. and covers an area of 12 ft. on the flat; the trough takes 2 ft. of this space, allowing the cattle approximately 600 sq. ft. under cover.

There is a ball-tap water trough placed against one of the walls, and providing the cattle with a constant supply of water.

Eighteen store cattle were housed in the yard, which would have held another two without overcrowding, bringing the total to twenty. The amount of straw used for the wall (*i.e.* excluding the roof) is about 20 bales for each tenant accommodated.

Notes on improvements:

- a. Some would prefer to dispense with the trough and to feed from cribs, in which case six or seven cribs would be necessary.
- b. In this straw yard the rails bracing the trough were placed every 7 to 8 ft., and the cattle easily fall on their backs into the trough. It would be preferable to put the rails 4 ft. apart.
- c. The fence inside the baled wall is rather too elaborate; three or at most four rails would have been sufficient.
- d. Thorns or brushwood as a first layer on the roof, followed by hedge brushings, then a layer of straw before thatching, would reduce the weight and improve the pitch of the roof.

FARM BUILDINGS

2. PARTIALLY COVERED STOCK YARD AT LOWESBY, LEICESTERSHIRE

We are indebted to Mr. R. J. Crawford of Lowesby, Leicestershire, for details of a stock yard which has given satisfactory service.

The yard, which measures 60 ft. x 30 ft., consists of three sides built of baled straw, the fourth side being closed by rails and gates. It is divided longitudinally by posts and rails. One-half of the yard is covered by a thatched roof, carried on the walls and the posts of the centre fence. Details of construction are shown in Fig. 47.

3. OPEN STRAW YARD

The essential feature of this structure is that walls are sufficiently high to provide shelter without roofing. For this purpose 14 ft. is a satisfactory height for a yard up to 25 yd. square. Baled straw could be used, but very large quantities would be needed for wall and buttressing unless stout poles reinforced the wall at frequent intervals. For this reason straw is usually packed between horizontal wires spaced at intervals of 9 to 12 in. on both sides of posts 6 ft. apart. The straw is packed diagonally in order to facilitate patching and infilling as the straw settles. This structure is illustrated in Fig. 48.

4. PIG UNIT AT RISBY, BURY ST. EDMUNDS

Straw-sided and thatched buildings have been used for many years by Mr. R. J. Burrell at Risby, Bury St. Edmunds, for fattening and farrowing pens. Larch thinnings are used for posts, and the floor is of chalk littered with wheat straw. The straw walls maintain a warm temperature in winter and cool conditions in summer. The buildings are illustrated in Fig. 49 and Plates 14-16.

5. STRAW BUILDINGS ERECTED BY THE NORTHAMPTONSHIRE W.A.E.C.

The Committee is indebted to Mr. P. J. Macfarlan, Deputy Executive Officer of the Northamptonshire W.A.E.C., for the following notes on straw buildings erected during the war. The buildings are illustrated in Plates 17-22.

a. PIGGERY:

This is constructed solely of wheat straw bales, light elm timber cut from the hedges, old baling wire, and thatched with straw mats, which had already been used on ricks. The walls are all built in alternate layers of headers and stretchers, and care was taken to see that the two wire bands in the lowest layer did not rest on the ground, as the wire corrodes very rapidly. After the walls had been built, the timber supports and baling wire lacing were laid down, and then a layer of up to 18 inches of straw was placed on top and well trodden down. Finally, the straw mats, with plenty of overlap, were secured, using ordinary pricklers. The piggery comprises two separate compartments, each one approximately 8 ft. square; 8 ft. high at the front, and falling to 4 ft. at the rear inside. The number of bales required was approximately 175, and it is estimated that the labour employed would amount to approximately five man days. The actual time taken was rather longer than this, owing to it being necessary to make a number of changes during the progress of the work. It was, of course, necessary to use timber over the doorway to support the bales.

THE DUTCH BARN

b. IMPLEMENT SHEDS

These are somewhat similar, but in the one case use has been made of the existing wall round the yard. Both comprise two compartments approximately 12 ft. wide, and from 21 to 26 ft. deep; and 11 ft. high at the front, falling to 6 ft. 6 in. to 7 ft. at the rear. Construction is similar in outline to that of the piggery, and the same method of making the roof has been adopted. It is found that the slope of the roof is hardly sufficient to give a good run off and the sheds have been damaged at certain spots by damp, and so if others are constructed in the future, it is proposed to give the roof a greater pitch. It is estimated that it would take two men approximately six days to complete one of these sheds.

c. LONG IMPLEMENT SHED

This was the first shed to be built, and was intended to hold the elevator, and so is constructed of two long narrow compartments. These are about 33 ft. deep; 8 ft. wide; 13 ft. high at the ridge and 8 ft. at the eaves. With this fall to the roof it is found that the shed gives very good protection, and almost no dampness is seen. Owing to the shortage of wheat bales, a small number of bean straw bales were used, but these have proved to be unsatisfactory as they tend to collapse after quite a short time. Another lesson was learnt, namely, that it is not satisfactory to place the shed close to the wall of a building, because the bales tend to stay damp, therefore the wires rust very quickly, and so the implement shed next to the barn was given a good clearance.

CHAPTER 15. THE DUTCH BARN

OBJECT

404. Dutch barns can be used for a variety of purposes. The construction will in most cases be similar, but it will be noted that for certain uses additions or minor alterations are suggested. The main use of Dutch barns is for storage of corn in sheaf, of hay, and of straw.

405. The object is to provide cover from rain and easy access for loading, emptying, and threshing. The barns should be sited so that they are easily reached from the fields, provide facilities for threshing, and allow easy access to the granary and straw yards. For hay storage easy access is required from the fields and to buildings and yards. The use of Dutch barns for corn and hay storage saves the time and cost of thatching ricks and wastage in the roof of the rick. The use of the combine harvester may offset the need for Dutch barns on a farm.

406. Tarpaulin rick covers which avoid temporarily the need for thatching or for barns have long been familiar. A rick cover using corrugated iron sheets has been devised, and is illustrated in Fig. 53. For emergencies or for the protection of extra heavy crops, covers of this type should be valuable. Experience may show that they can take the place of Dutch barns.

SITING

407. Dutch barns are in many cases useful on outlying portions of the farm. They should be sited so as to provide access to as many fields as possible, and it is important that there should be a hard track from the barn to the farmstead. It will be necessary for threshing tackle to be taken to the barn unless this is used only as a hay barn, and this should be borne in mind in siting the barn and in laying out roads and gateways.

FARM BUILDINGS

The usefulness of outlying Dutch barns is much enhanced if temporary yards are associated with them; the barn can, for example, be used as one side of a yard. The advantages of this arrangement are that hay or corn crops are carried a shorter distance from the fields, while when dung has been made from the straw, cartage is also reduced to a minimum.

DESIGN

Figures 50 to 52

408. The Dutch barn should be constructed so that in each bay there is at least one day's threshing in the case of corn and a convenient size for this would appear to be 30 ft. \times 15 ft. Sufficient height must be allowed to the eaves so that an elevator can be operated. There must be sufficient space on the loading or emptying side or sides of the barn for manœuvring elevators, and tractors with two or four wheel trailers. We recommend 30 ft. as a satisfactory space for this purpose and this gives a reasonable isolation for protection from fire.

409. Ordinarily it is not necessary to do more than sheet the ends down to eaves level. This can be done either in 24 gauge corrugated iron or timber. In very exposed districts such as the west and north-west of England and in Wales it is advisable to site the barn so that one side faces the prevailing rainy wind and to sheet down one or both ends of the barn to the ground level and the exposed side 6 ft. down from the eaves.

410. The best length, that is the number of units for a Dutch barn, is a matter on which practical opinion is divided. To reduce fire risk, as few as three units are sometimes recommended, but this increases construction cost and is inconvenient in working. For a 250 acres farm a run of six bays is, by most farmers, considered safe and convenient. Where there are two or more barns side by side space between one and the next should be at least 30 ft.

411. In considering size it can generally be reckoned that barns having bays of the dimensions we have given, namely 30 ft. \times 15 ft. \times 18 ft. high, will hold approximately 30 tons of hay.

On some large farms, it is the practice to cover an additional area where threshing can be done under cover. This has advantages and disadvantages which we need not recite as they will vary considerably in each case. We would, however, stress the importance of covering the whole span with one roof rather than covering the span with two or three roofs with valley gutters. With modern methods of construction it is possible to cover in wide spans either with single trusses supported only at the sides or with trusses supported not only at the sides but also intermediately with upright columns. Thus two barns each 30 ft. wide with an intermediate covered gangway 15 ft. wide can be covered in one span of 75 ft. carried on two or four rows of columns.

CONSTRUCTION

412. The most common construction is with H. section steel stanchions on concrete foundations and secured to them by efficient anchors. The bases should be banked up in concrete to a height of 6 in. above finished ground level, and weathered. A curved roof has the advantage over a ridge roof of greater head-room, which lessens the chance of damage to tie-beams.

413. Some Dutch barns have reinforced concrete posts. We have no information as to the life of these posts for this particular purpose, but every care should be taken to see that waterproof cement is used and that protective spurs are placed around the feet of each post to prevent damage from wheels.

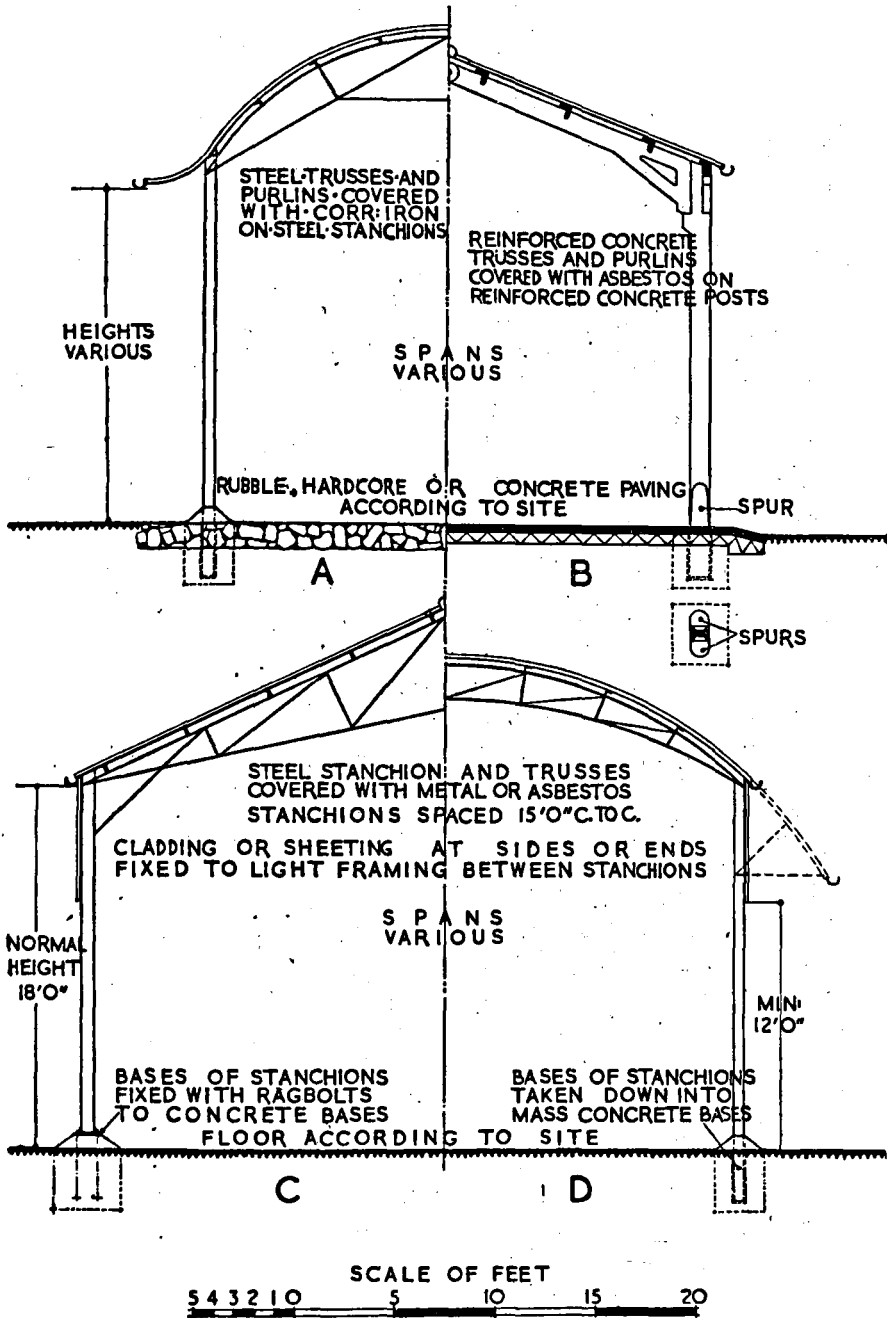


FIG. 50. STANDARD DUTCH BARNS

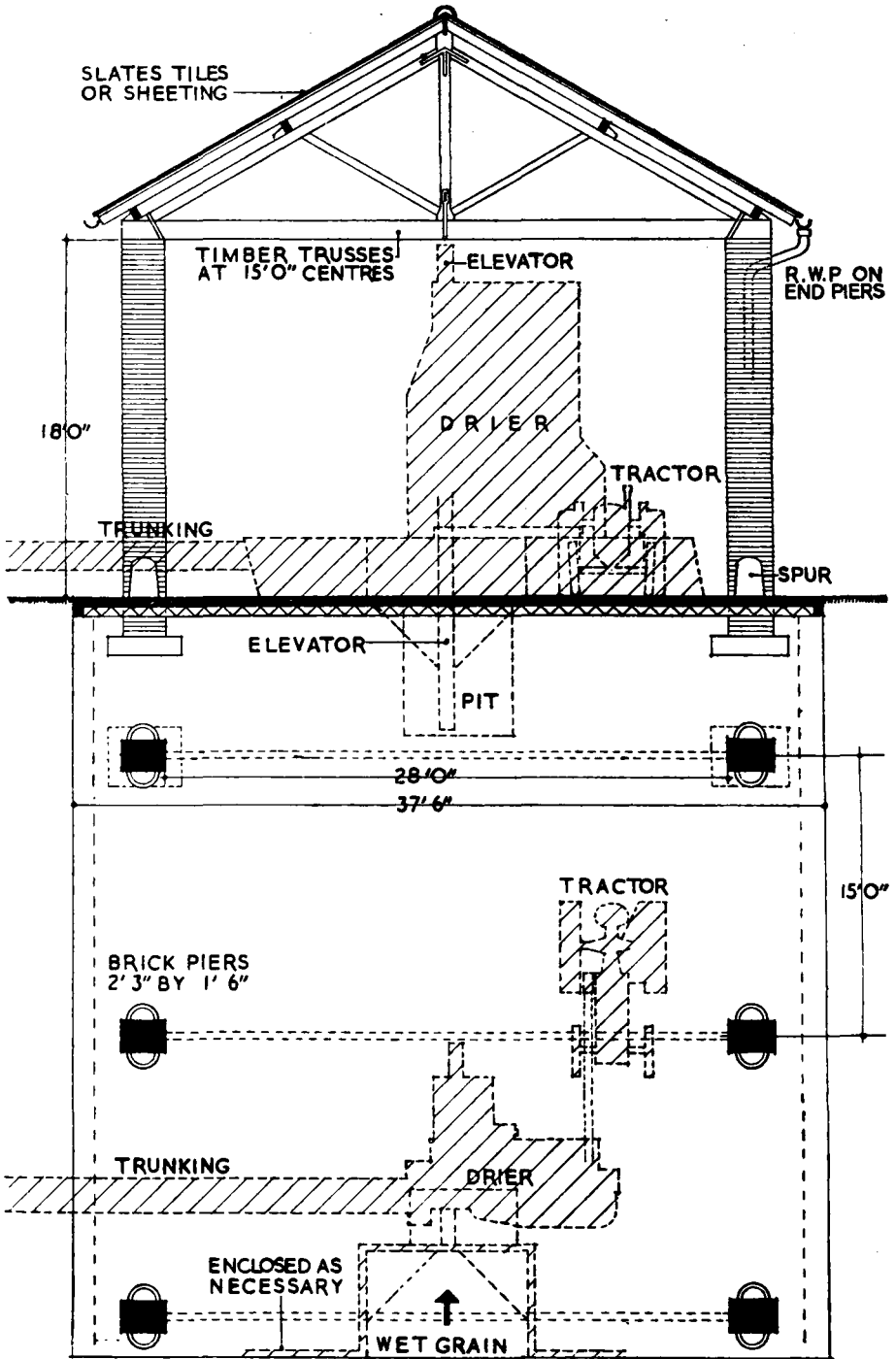


FIG. 51. CORN DRIER IN BRICK DUTCH BARN

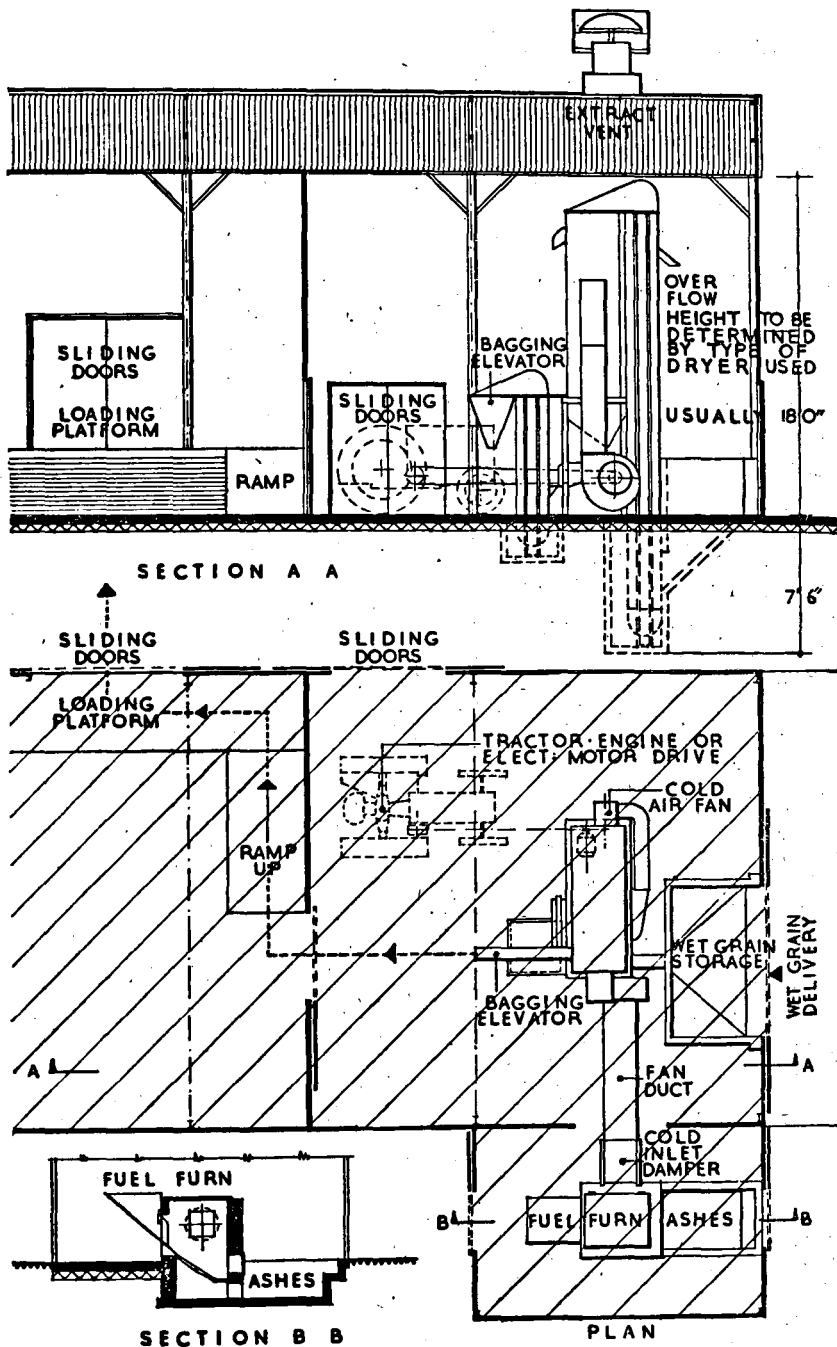
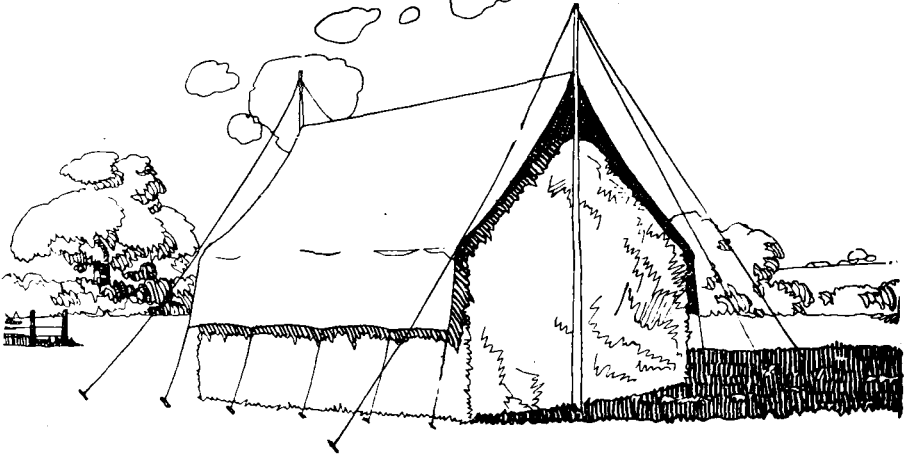


FIG. 52. CORN DRIER IN STEEL DUTCH BARN

TARPAULIN FIXED WITH
ROPES AND TENT PEGS



CORRUGATED IRON SHEET
FIXED WITH SCREW EYES

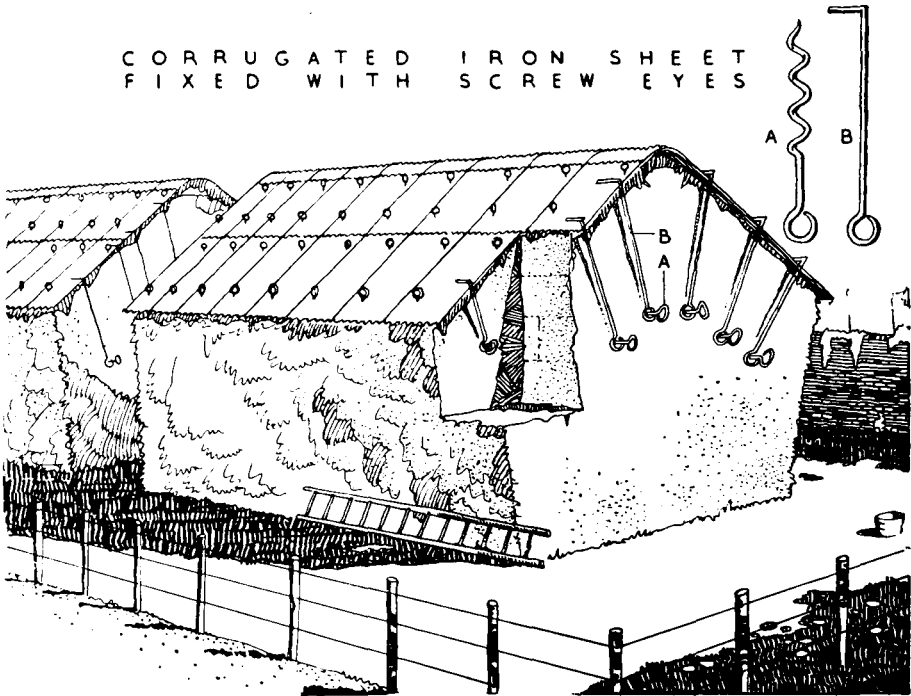


FIG. 53. RICK COVERS

THE DUTCH BARN

414. Yet another form of construction is brick piers carrying a framed roof covered with tiles or slates. The initial cost of this is a good deal higher than steel framed and sheeted buildings, but it has the advantage of lower cost of maintenance.

415. Eaves, guttering, and rainwater down pipes should be provided and drainage for the rainwater to a suitable soakaway, or ditch. It is frequently convenient to collect the rainwater into a storage tank from which it can be supplied to a cattle-drinking trough if the Dutch barn is at certain times of the year used for housing stock. A considerable quantity of water can be collected from the roof of a building of this type and opportunity should be taken to use it. Fixed lining in the roof is not necessary or recommended. The sheeting of the sides can be carried on angle iron rails fixed to the stanchions, and if these rails are bolted to the stanchions they can be easily removed and the sheeting taken away either permanently or periodically as may be required for easy access and use. It is advisable that the lower 18 in. of the sheeting should be bent out at an angle of 30° to throw off rainwater.

416. Where it is desired to load the barn from an elevator delivering above the eaves line this can be arranged by the following method. Two of the curved sheets are omitted from the roof in the middle of each bay on the appropriate side of the building. Two angle iron runners curved to the same curve as the roof are fixed so that the inward edge of the angle iron fits close underneath the adjacent edges of the roof and the vertical side of the angle iron projects above the roof line about 1 in. A separate framed panel is formed of curved angle iron with rollers running on the vertical sides of the angle irons fixed to the roof. This metal frame is covered with corrugated iron sheeting giving a 6 in. overlap on either side. This panel can then be pulled up on to the centre of the roof, leaving a clear space some 4 ft. x 6 ft. through which the elevator can discharge.

417. The floor should be sufficiently hard to take wheeled traffic. It will depend on the rainfall and the nature of the soil whether it is necessary to do more than put down hardcore, and in some cases even this is not necessary. On wet sites it may be necessary to concrete the floor, but this would be exceptional.

DUTCH BARN FOR SMALL HILL FARMS

418. On small farms in hilly country barns constructed of wooden poles of telegraph standard 16 ft. to 18 ft. above the ground with sliding roof are common. The poles are spaced about 15 ft. apart with a 20 ft. span. An independent timber or steel framed roof is formed about 19 ft. wide covered with corrugated iron, and this roof can be raised or lowered between the poles by means of a wire cable, pulley, and winch on each pole. This form of construction has much to commend it for small hill farms where high winds and rain are frequent and it is desired to provide cover for small quantities at a time.

ADAPTABILITY

419. The Dutch barn can be adapted to a variety of purposes. The housing of implements requires little or no alteration to the building, but housing of stock requires minor modification in that provision (*e.g.* sockets set in concrete) should be made for the insertion of tubular or angle iron rails with intermediate uprights between the columns in the depth of the building so as to divide the covered area into sections. Suitable fencing to give a run or yard for the cattle can be provided. Outer walls of baled straw can be used for such a yard (*cf.* Chapter 14, paragraph 389).

FARM BUILDINGS

CHAPTER 16. SILOS

420. Silos may be suitable pits in the ground or built above ground. The latter may be of a variety of materials and either for temporary or permanent use. In deciding the design of a silo the circumstances needing attention include: site, foundation, size, and type of silage material to be used.

421. Silos should be placed to give easy access to vehicles bringing in the large amounts of fresh material and for removal of made silage. They should also be near where the silage is to be fed. To have a well-drained site is important not only for traffic reasons but to ensure a sound foundation (since large silos are heavy) and to facilitate drainage of effluent.

422. The following Table gives the capacity of round silos in tons.

INSIDE HEIGHT OF SILO IN FEET	INSIDE DIAMETER OF SILO IN FEET							
	10	12	14	15	16	18	20	
24	34	49	67	75	86	110	136	} Capacity in tons
25	36	52	71	80	91	116	143	
30	47	67	91	105	119	151	187	
Approximate increase for every foot of ad- ditional height in tons	2	3	4	5	6	7	8	tons

It will be appreciated that the weight of the silage depends upon the herbage under treatment. A cubic foot of made silage (in the silo) weighs from 38-40 lbs.

423. For considerations connected with different types of silage material, for instance chaffed in contrast with long herbage, and for all aspects of the handling of silos and silage, reference should be made to the Ministry of Agriculture and Fisheries' Bulletin No. 37, on Ensilage. We confine ourselves here to brief descriptions, with illustrations, of some types of pit silos and built silos.

TEMPORARY SILOS

424. Temporary silos may be formed by driving stakes into the ground at intervals according to the shape the silo is to take, providing suitable woven wire attached to the stakes and lining with sisalcraft paper. Such structures must be limited in height and care must be taken to ensure that the outward thrust of the silage is not too great for the walls.

425. On the Continent silage is sometimes made by forming an enclosure of hurdles packed with straw. Into this enclosure the silage is dumped and trodden down to a weathered contour. The whole is then protected from the weather by thatching or otherwise, until such time as the silage is required for use. Walls are sometimes made of baled straw supported by stakes.

426. In limestone, chalk, or other hard soil formations, an unlined pit suffices as a silo, provided the site is dry all the year round or sharp drainage can be provided for the pit. On other soil formations a permanent structure is necessary.

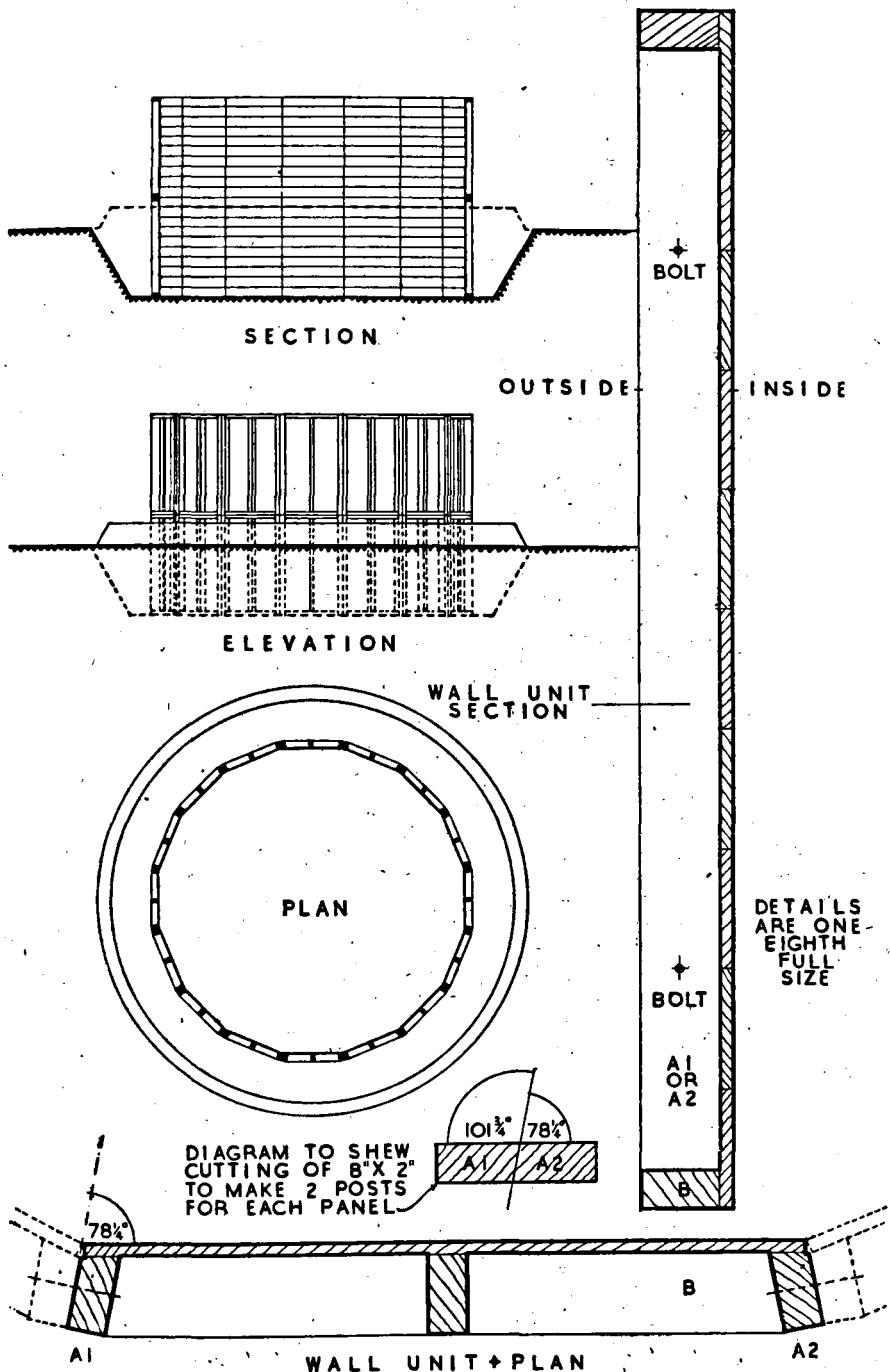


FIG. 54. WOODEN SILO

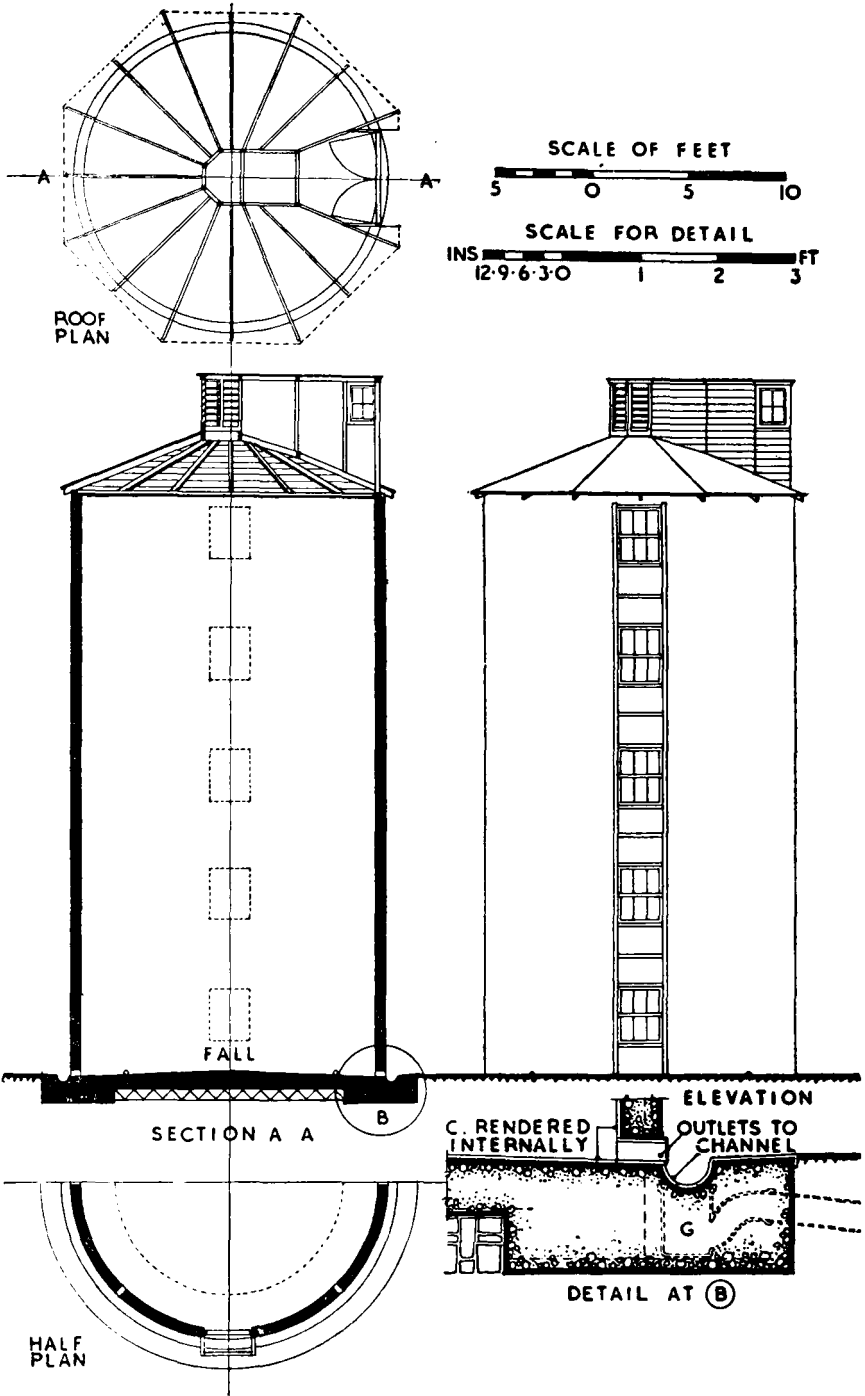
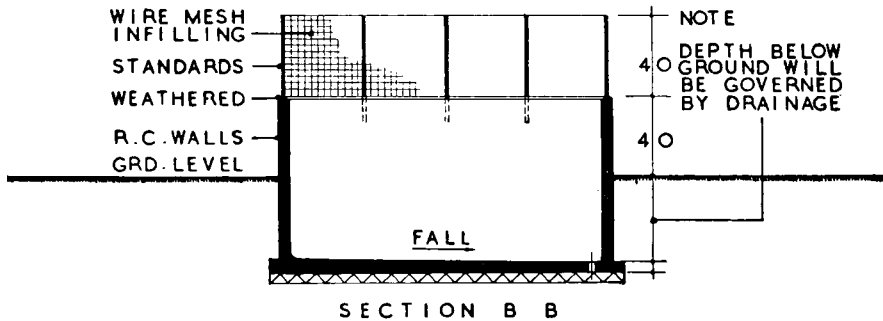
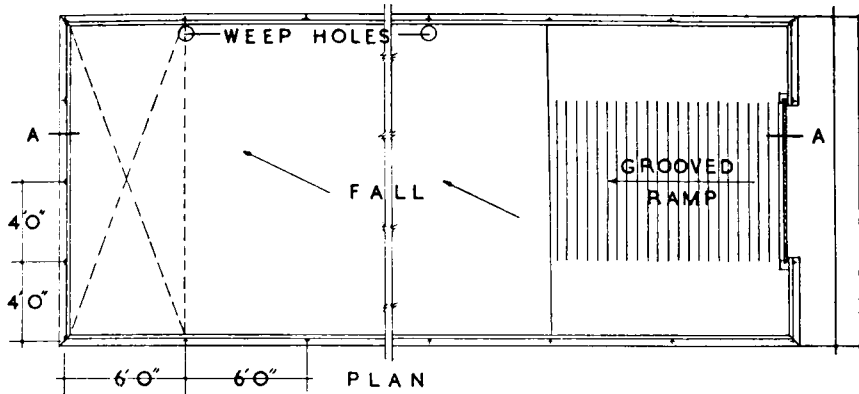
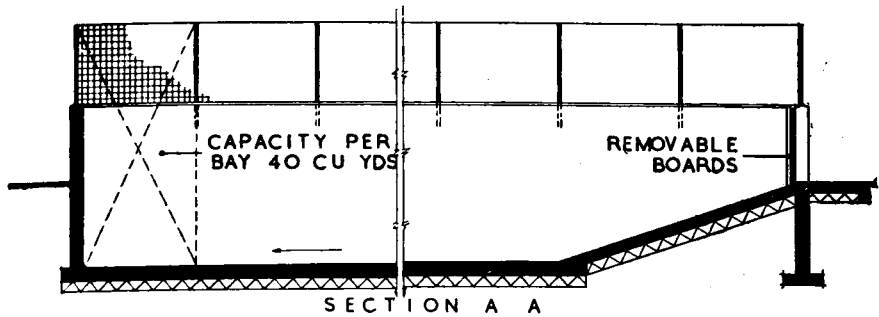


FIG. 55. REINFORCED CONCRETE TOWER SILO



NOTE

4'0" DEPTH BELOW GROUND WILL BE GOVERNED BY DRAINAGE

4'0"

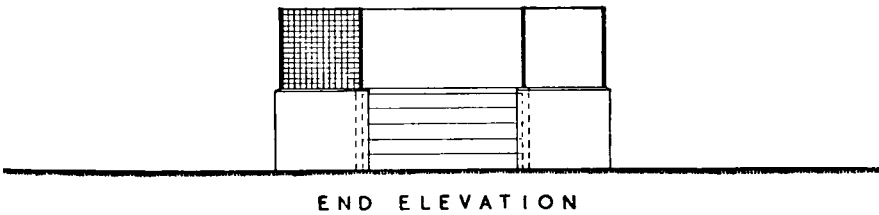


FIG. 56. REINFORCED CONCRETE PIT SILO

FARM BUILDINGS

PERMANENT SILOS

Figures 54 to 56

427. The principal materials used for permanent silos are: timber, precast concrete units, concrete cast on the spot, and steel.

428. Timber silos have been popular with farmers for many years and, although not so durable as concrete structures, have given good service. These are normally of a commercial type and are usually constructed of timber creosoted under pressure. An example of a timber silo is illustrated in Fig. 54.

429. Various types of prefabricated silos of precast concrete units are on the market which have proved quite satisfactory in use. These have the advantage of being movable and also they can be erected by farm labour. Particulars can be obtained from the Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W. 1.

430. Concrete silos, tower or pit, and built *in situ*, are probably the most satisfactory. Tower silos, a typical example of which is shown in Fig. 55, are usually circular in plan and can be built to varying heights and diameters. The cement lining should be acid resisting. Their design and erection need the services of a specialist. A pit silo is illustrated in Fig. 56. Ramps for easy filling, roofs (fixed or sliding), and a number of other variations in structure are frequently seen.

431. Steel silos have been built but are not so durable as concrete or wood, because of rust and of corrosion caused by silage juices.

CHAPTER 17. STORAGE BUILDINGS FOR BULK GRAIN, SEEDS, AND FERTILIZERS

432. The main storage building or granary has been dealt with in Chapter 8. It may be necessary to have additional grain storage and this may be provided in a building which also provides storing and mixing space for fertilizers.

433. The three essentials of permanent storage buildings for grain, seeds, and fertilizers are that they should be absolutely weatherproof, arranged with a view to ease in handling the materials, and should exclude vermin. The control of vermin is dealt with in Chapter 21. The amount of storage space required for these purposes will depend on the circumstances and practices of each farm; for instance bulk storage of grain may be unnecessary and the amount of fertilizers stored will depend on farming practice. It is therefore necessary that the buildings and any divisions and fittings should be as simple and adaptable as possible. One large building can provide storage for all these materials, but permanent space for bulk grain and seeds should be cut off by a wall from floor to roof, in order to avoid fertilizer dust contaminating the grain. Bulk grain and seeds may be kept in the same part of the building.

434. To facilitate the loading and off-loading of vehicles a ramp and a loading platform should be provided, or the doors should be wide enough to admit a cart or lorry. The ramp may be inside or outside the building. The platform should be about 3 ft. 9 in. high, so that the recommended height of the walls of the standard building described in Chapter 3 will be insufficient in this case unless both ramp and platform are external to the building and are not to be protected by the roof. For storage buildings of this kind a height of 10 ft. to the wall plate is therefore recommended. Solid walls of brick or concrete, as described for the granary in Chapter 8 are not necessary, but there should be a solid plinth wall to a height of 4 ft. 6 in. in order to resist lateral pressure of stored materials.

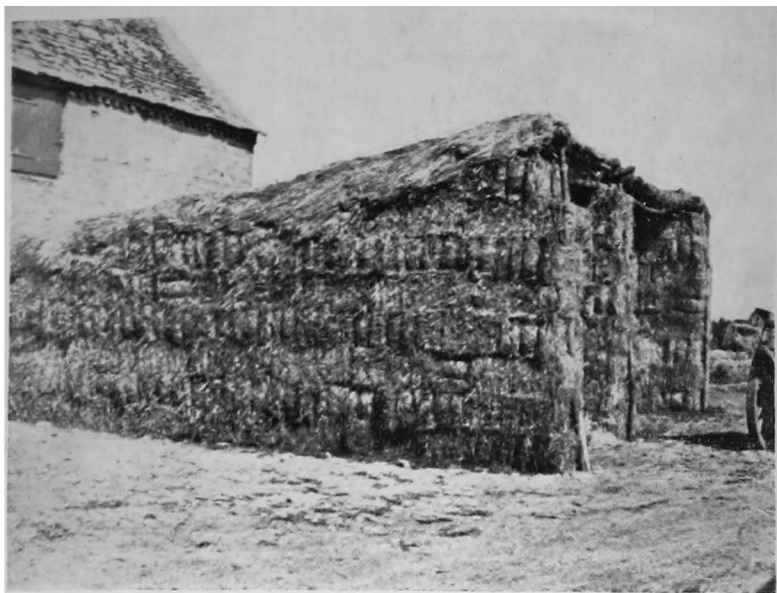


PLATE 19. A STRAW AND POLES IMPLEMENT SHED



PLATE 20. ANOTHER STRAW AND POLES IMPLEMENT SHED

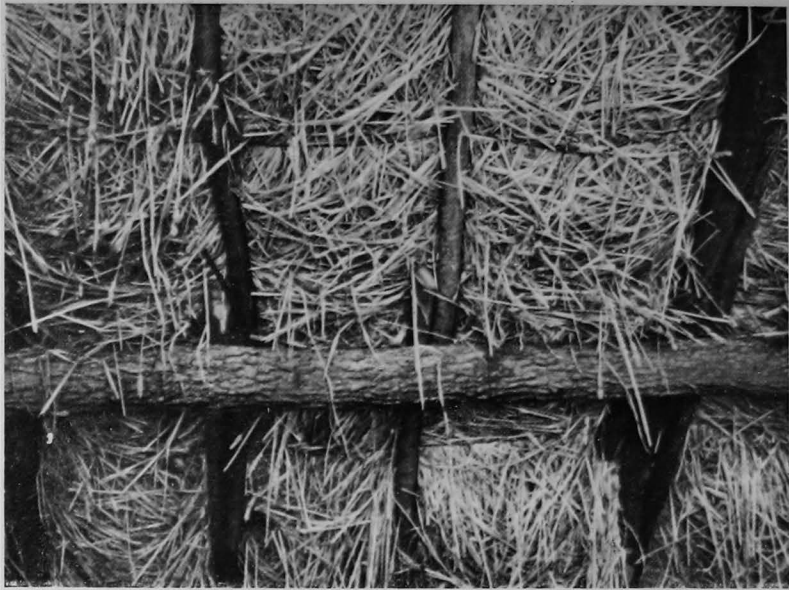


PLATE 21. POLES AND LIGHT BATTENS IN THE STRAW ROOF



PLATE 22. STRAW ROOF
HELD DOWN BY BALING WIRE AND THATCHING PINS

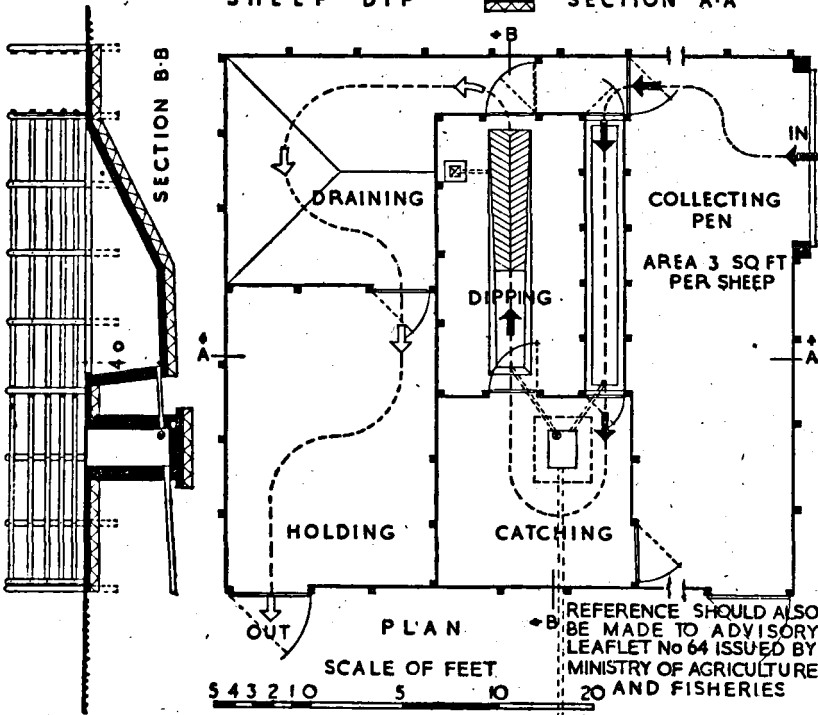
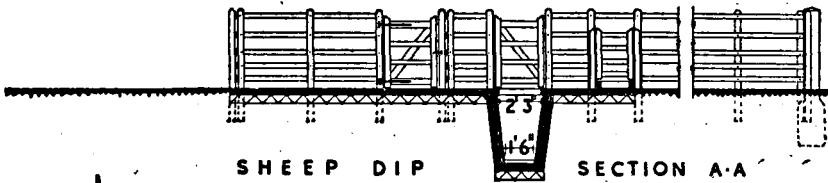
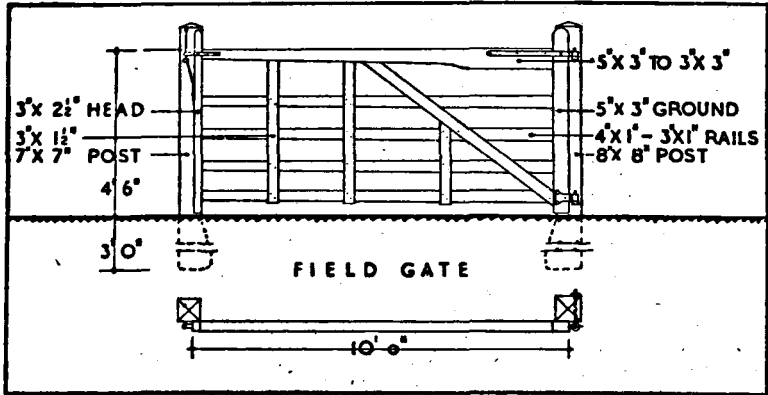


FIG. 57. SHEEP DIP

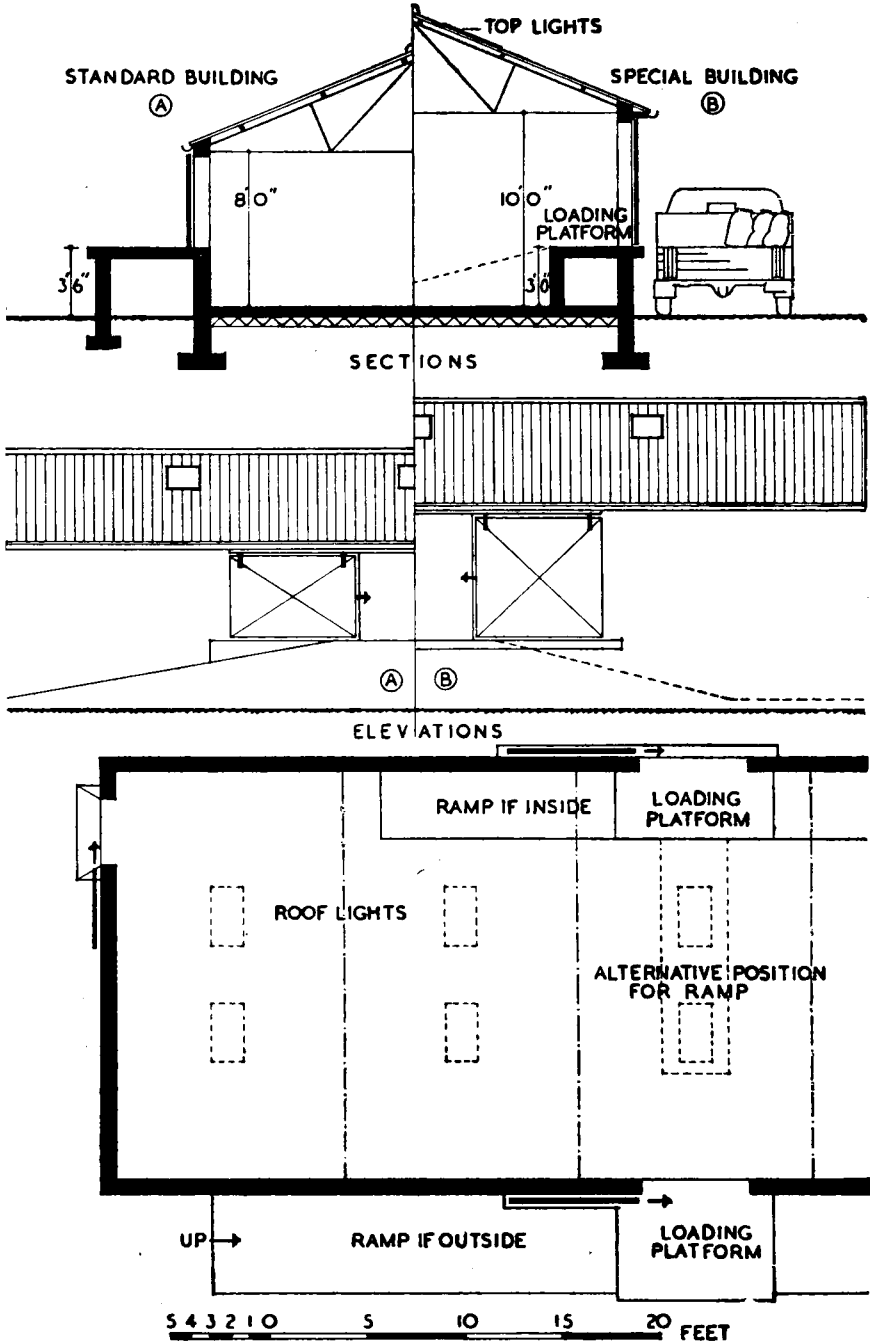


FIG. 58. BULK GRAIN AND SEED STORES

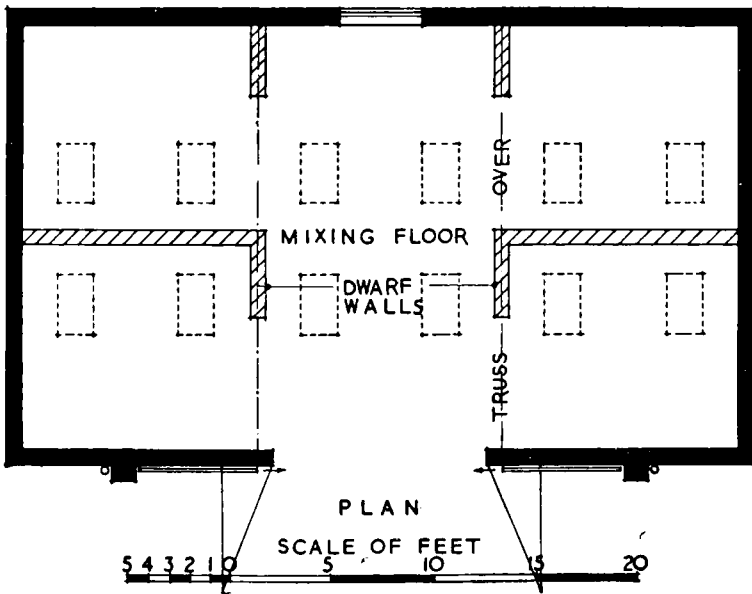
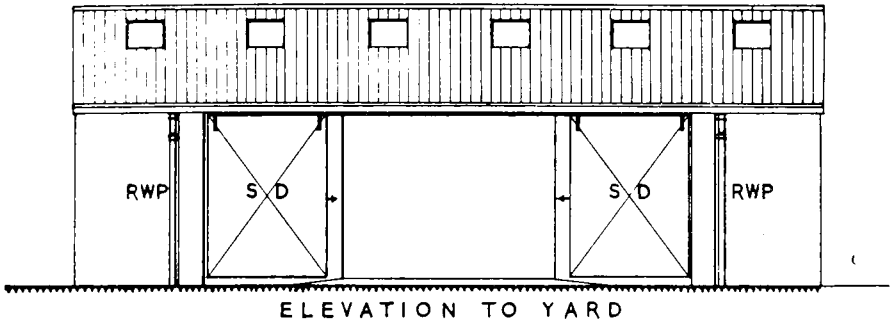
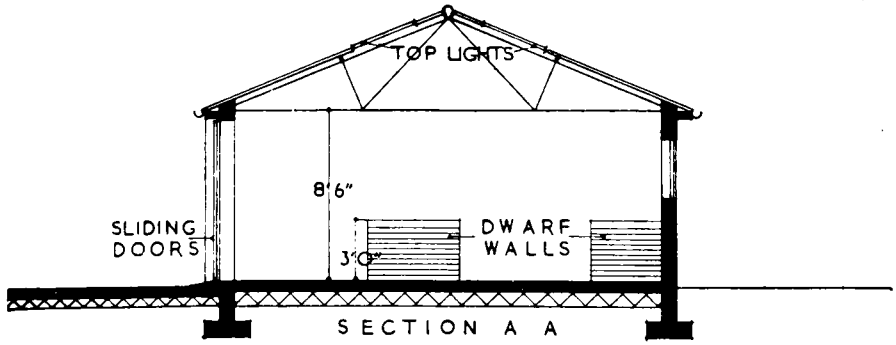


FIG. 59. FERTILIZER STORE

FARM BUILDINGS

BULK GRAIN AND SEED STORES

Figure 58

435. It is possible that on some farms there will be sufficient room on the first floor of the granary for the storage of bulk grain for ultimate sale in addition to grain that will be consumed on the farm. If not, grain may be stored in sacks or bins in a single-storey building. The building itself calls for no special comment, except that vermin must be rigidly excluded as described in Chapter 21.

436. Provided the corn is sufficiently dry, storage in sacks is convenient. If, however, grain is not delivered to the store already sacked, it should be kept loose in heaps not more than 4 feet high. Such heaps should not be in contact with external walls unless it is known that there is no risk of dampness, or the wall is lined. Permanent division of the store into bins is unnecessary; it should, however, be possible to put in temporary partitions to keep crops or varieties apart. This can be done by providing slotted posts into which divisions can be inserted. Such an arrangement (see Fig. 9) makes the building highly adaptable.

437. If bins are provided it should be remembered that the lateral pressure of grain is about two-thirds the vertical pressure; thus the walls of a bin containing 30 tons of grain must resist a pressure of 20 tons. Large bins must therefore be strongly constructed of brick, concrete, steel, or timber; if of timber tie rods will be necessary. If the floor of a bin slopes at 40°, the bin will be self-emptying; this will save a great deal of manual work and in large bins the extra cost is justified.

438. Purchased seeds are almost always in sacks or packages and bins are unnecessary. It will be convenient to provide a number of substantial shelves. Home-grown seed corn can be kept in sacks or in metal bins. Space should be provided for a seed-dressing machine, which in the case of a 250-acre farm may be operated by hand.

FERTILIZER STORES

Figure 59

439. It is not essential to divide the fertilizer store into compartments for different fertilizers, but one or two internal dwarf walls may prove convenient. It is, however, essential that sufficient space should be allowed for mixing. An area adjacent to the wide door should therefore be provided with a specially hard and smooth floor. The mixing area may be enclosed within dwarf walls not more than 3 ft. high, or the floor space available for storage may be similarly divided, as in Fig. 59.

CHAPTER 18

HOUSING OF TRACTORS AND IMPLEMENTS THE WORKSHOP

440. The mechanical equipment of the farm is increasingly important and costly, so that proper care and attention is essential. The first element in the maintenance of implements and tractors is the provision of shelter. A covered space with good light is also required in which they can be examined, adjusted, and repaired. For the storage of spare parts, fuel, and lubricants adequate space capable of being locked up must also be provided. Finally, some workshop facilities are essential even on the smallest farm. All these provisions can be made in one range of buildings; if more than one building is used, they should be close together.

HOUSING OF TRACTORS AND IMPLEMENTS

The farmer's car must also be housed, and it will often be convenient to have the garage in or near the implement sheds.

441. These requirements, which are almost entirely a matter of floor space and not of elaborate fittings, would be met by using the standard buildings suggested in Chapter 3. It is most important that too narrow a span is not selected in a misplaced search for economy. Fig. 60 shows the common overall dimensions of implements.

HOUSING OF TRACTORS AND CARS

442. For the car a separate lock-up compartment is presumably desirable. The tractor may stand under cover with the implements, or it may be given a compartment on its own, or, again, it can be housed with the car. An advantage of closed accommodation for tractors is that they may be easier to start in the morning. The choice will depend on the personal inclination of the owner and on the need for economy, remembering that economy means wise expenditure and not merely parsimony. If more than one tractor is used, separate closed provision is certainly worth while.

The workshop is discussed later in this Chapter; if there is no workshop a bench should be provided in the garage, and provision should be made for the safe custody of spare parts and tools.

There should be a stand-pipe near at hand for radiators and for washing.

An earth or hardcore floor is satisfactory for tractors and is indeed the only safe kind with straked wheels and tracks.

HOUSING OF IMPLEMENTS

Figure 61

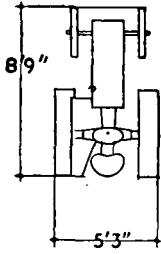
443. Implements require protection from rain and snow only, and hence a completely enclosed building is not needed. It is, however, of the utmost importance that implements can be put in easily and taken out without the need to shift other gear. A serious loss of time often occurs because half a dozen tools must be moved to get at the one which is required. This is best avoided by reducing the walling to a minimum and by arranging that implements enter from the front or back and not from the ends of the building. If it is desired to shut the building, or a section of it, completely (to prevent unauthorized access or for complete protection from weather), sliding doors are suitable.

444. In order to be able to draw an implement into the shed without unhitching from the tractor a pull-through arrangement is necessary, *i.e.* a part of the shed must have both front and back open. This will enable implements to be left where they can be easily man-handled out of the way.

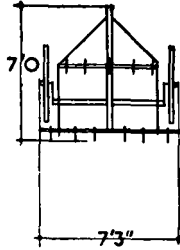
445. The implement shed should consist therefore of a roof carried on the minimum number of posts, the ends of the building being filled in; the front and back of the shed should also be filled in for a few feet from the ends. If possible, the floor, except for the pull-through, should be of concrete and raised slightly above the surrounding ground. Eaves gutters should be provided.

446. The importance of keeping the number of posts to a minimum is obvious; not only does a wide spacing facilitate manœuvre, but there is also less risk of damage to posts, implements, and tractors. The dimensions of the largest implements indicate that 12 ft. in the clear (usually about 12 ft. 6 in. centres of posts) is the minimum, but it is better to arrange that one pair of posts (front and back) is omitted.

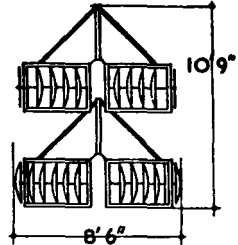
447. For all ordinary implements, the standard framed buildings described in Chapter 3, which provide a clear height of 8 ft. above the floor, will be suitable. The higher the posts the less protection from driving rain is afforded by a given



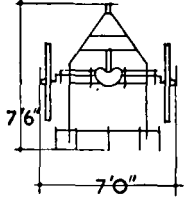
G P TRACTOR



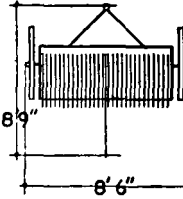
TRACTOR CULTIVATOR



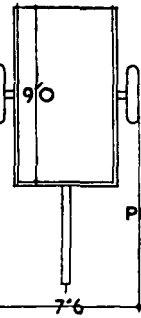
DISC HARROW



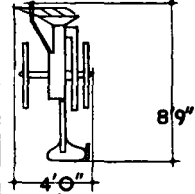
HORSE CULTIVATOR



HORSE RAKE

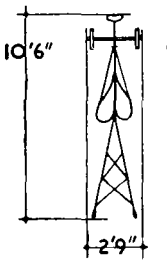


TRAILER

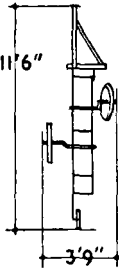


POTATO DIGGER

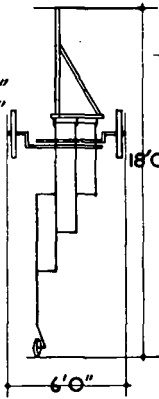
THE AVERAGE SPACE FOR STORAGE REQUIRED BY A COMBINE HARVESTER WITH A 5'0" CUT WOULD BE IN LENGTH 20'0" WIDTH 11'0" AND IN HEIGHT ABOUT 8'6"



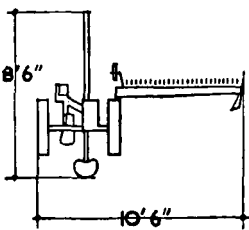
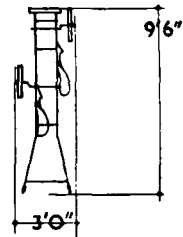
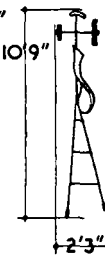
RIDGING PLOUGH



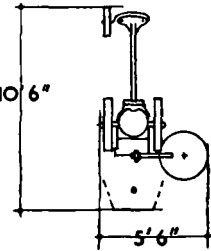
2-FURROW & 4-FURROW TRACTOR PLOUGHS



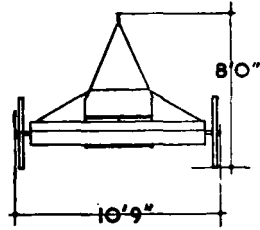
1-FURROW & 2-FURROW HORSE PLOUGHS



TRACTOR MOWER



POTATO SPINNER



MANURE DISTRIBUTOR

FIG. 60. FARM IMPLEMENTS SHOWING COMMON OVERALL DIMENSIONS

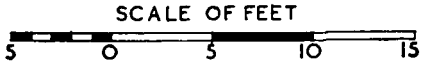
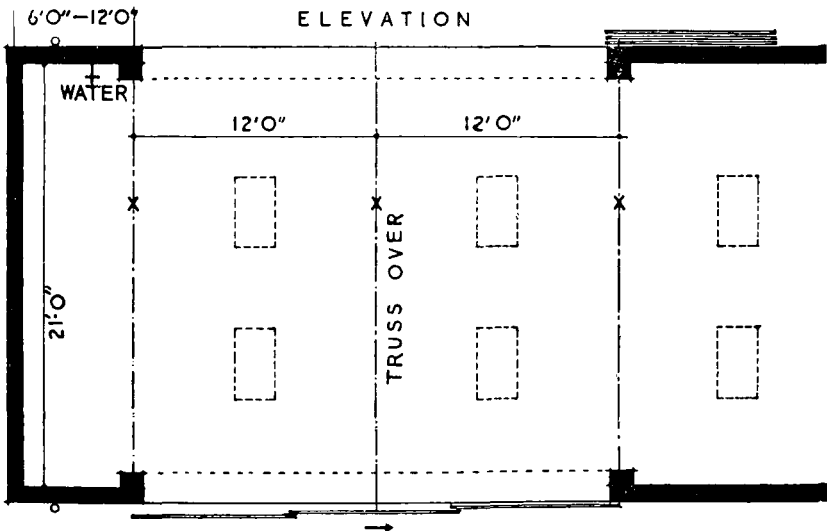
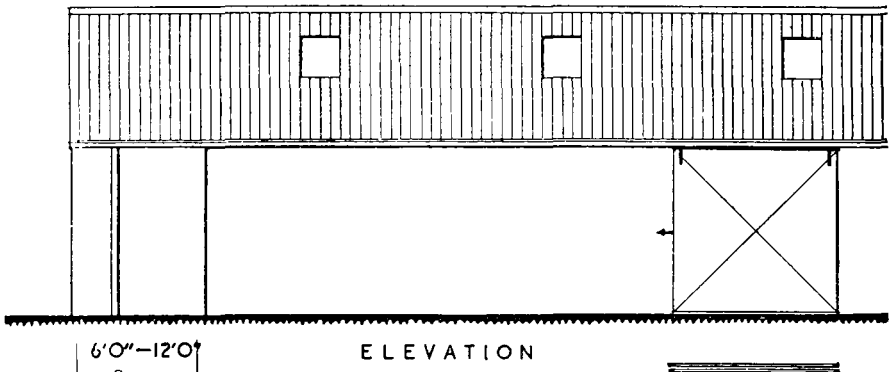
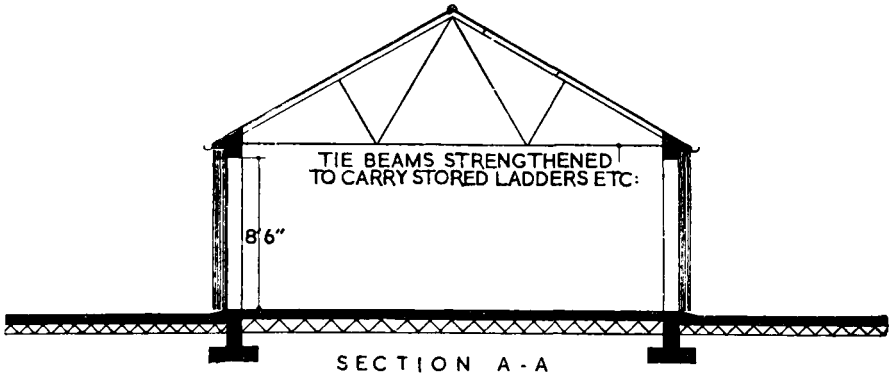


FIG. 61. PULL-THROUGH IMPLEMENT SHED

FARM BUILDINGS

span, and accordingly if a greater height is required a wider building is desirable. Some implements not yet commonly owned, such as the combine harvester, need a greater height. For these special provision should be made, or they may be housed in an old type barn, or in a bay of a Dutch barn.

448. If the roof is framed with tie-beams it is a convenience to have them sufficiently strong to carry ladders and other articles which can be put there out of the way.

TEMPORARY ACCOMMODATION FOR TRACTORS AND IMPLEMENTS

449. It will be frequently necessary to provide some shelter for tractors and implements before permanent provision can be made. Space in a Dutch barn is very suitable, but if no existing building is available temporary structures should be provided. In this connexion a careful study of the use of straw, described in Chapter 14, is recommended, but the risk of fire should be kept in mind.

THE FARM WORKSHOP

Figure 62

450. The extent of workshop facilities depends on many factors such as the size and kind of farm, the proximity of repair depots, and the availability of mechanical skill on the farm. It is undoubtedly the case that more mechanical and engineering knowledge is being and needs to be acquired by modern farmers and farm workers; training in such matters is now an essential element in preparing to undertake farm work. The probability, therefore, is that adequately fitted workshops will have to be provided on most farms in the future. A system of visiting technicians and craftsmen would make this more necessary.

Repairs to gates, buildings, yards, and fences cannot be done quickly and well without some workshop facilities. There are farms on which the chief cause of deterioration of buildings has been the occupiers' prolonged failure to attend to minor repairs.

451. A substantial bench with a vice is the basic need but facilities for working in wood and in metal are becoming indispensable, while on a large farm horse-shoeing may have to be provided for. A suggested layout is shown in Fig. 62. This workshop contains a forge, an anvil, a bench with a metal drill and vice, and a space for shoeing horses. An overhead runway with a pulley block would be a convenience. A manger with a tie ring is provided. Water should be laid on to the workshop.

Shoeing will rarely be done on a farm of the order of 250 acres. If no provision be made for it then the workshop might consist only of the left-hand half of the building shown in Fig. 62, but with corner bench and hand drill included in it.

452. It may be some time before accommodation on this scale is common on our farms, but the Committee is certain that great improvements must take place along these lines in the very near future to ensure efficiency in the increasing use of mechanical power. It should be one of the functions of the Advisory Service, proposed in Chapter 5, to assist owners and occupiers in the design, fitting and tool equipment of the workshop.

STORAGE OF FUEL AND LUBRICATING OIL

453. The storage of fuel oils is controlled under regulations and orders made under a number of Acts of Parliament. They are administered by local authorities. Landowners and farmers are therefore advised to consult their local authorities when preparing plans for the storage of petroleum and oil.

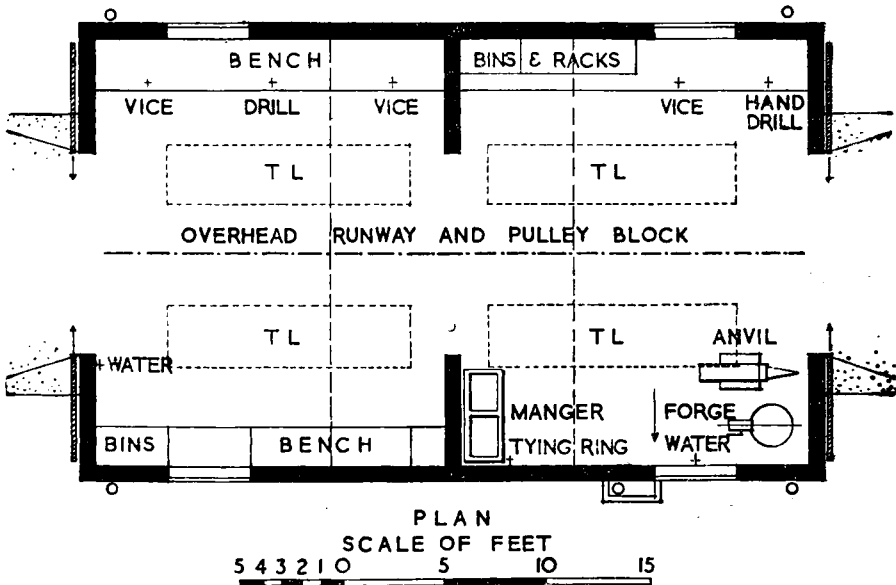
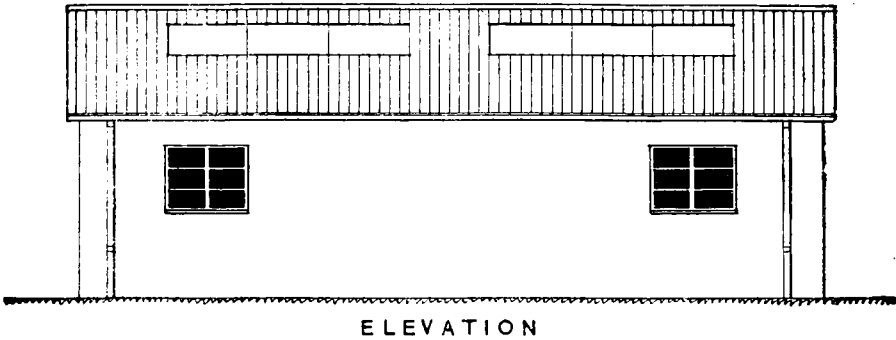
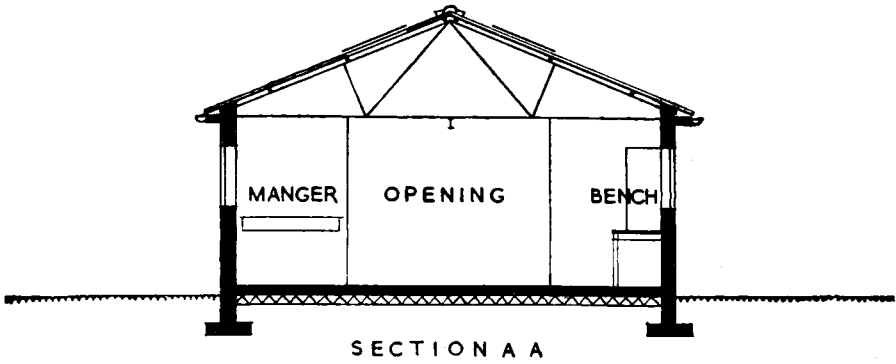


FIG. 62. WORKSHOP

FARM BUILDINGS

CHAPTER 19

BUILDINGS FOR THE SMALL FARM

454. All the essential principles for buildings on farms in general apply to the small farm, for which, however, there are certain peculiarities and special difficulties in application. Small farms are of many types, some under private ownership, some connected with County Council or other official organizations.

455. It is not within our terms of reference to probe the possibilities of increase or decrease in numbers of small farms of various kinds after the war. But possible tendencies to change in form and policy of small farms have important bearings for us, so that we commence by stating certain opinions on these tendencies which have been communicated to us from experienced sources.

456. Formerly many of these holdings were in the hands of local shopkeepers and tradesmen—baker, butcher, etc.—who being obliged to keep one or more horses, found it convenient to own a piece of grassland and, if possible, to mow some hay and even grow some roots, corn and straw for their horses. Frequently they extended this undertaking into a small farm and many were County Council tenants. With the displacement of the horse by the motor van this class of man has largely gone from his land. His holding often had rough improvised buildings and his successor may require something more modern and capacious.

457. The lower limit of desirable size for the ordinary general small farm, *i.e.* not specialized, depends on the type of land. For instance, in the Black Fen, 25 acres appears to be regarded as satisfactory, wheat, potatoes and sugar beet being the principal crops; in vegetable areas 10 acres was formerly regarded as a reasonable size for general work or vegetable growing, but now 15 to 20 acres is looked on as necessary save where there is considerable specialization, *e.g.* some glass or cut flowers. Apart from these special areas, over the country generally not less than 50 acres seems to be considered necessary for a successful small farm. Consequently, it is about 50–100 acres for general farming that should be in mind in considering farm buildings on the small scale.

458. A good many farms of 50 to 100 acres have some mixing and other barn machinery, especially for grinding, though it may well be that the small man may find it easier to rely entirely on the merchant for grinding in future, even for what he grows himself. In designing buildings there is no need to make special provision for housing machinery: it should be possible to put in the necessary amount of solid floor to accommodate any desired machinery. The double storey store and machine house needed on a larger farm is not justifiable on a small one.

459. Drastic adaptations will be necessary before the combine can come into use on small farms, though co-operative use may extend. On the whole it is considered important that a Dutch barn should still be provided, a structure of this type being readily adaptable for many purposes.

460. Round many large towns there are great numbers of farms from 5 up to 50 acres, all grass before the war, and used simply as walks for cows living solely on imported concentrates, bought hay and straw. If this form of feeding remains impossible after the war, and if better standards of hygiene are insisted on, farms of this kind will have to be re-equipped with buildings. Some may be merged, two or three at a time, to make larger farms: but even so, the result may not be a very large farm. Through labour and other difficulties, milking may be given up on some of the really small farms during the next ten years, in which case the land will have to be turned to some other purpose and, therefore, once more, there is the necessity for great adaptability in the buildings.

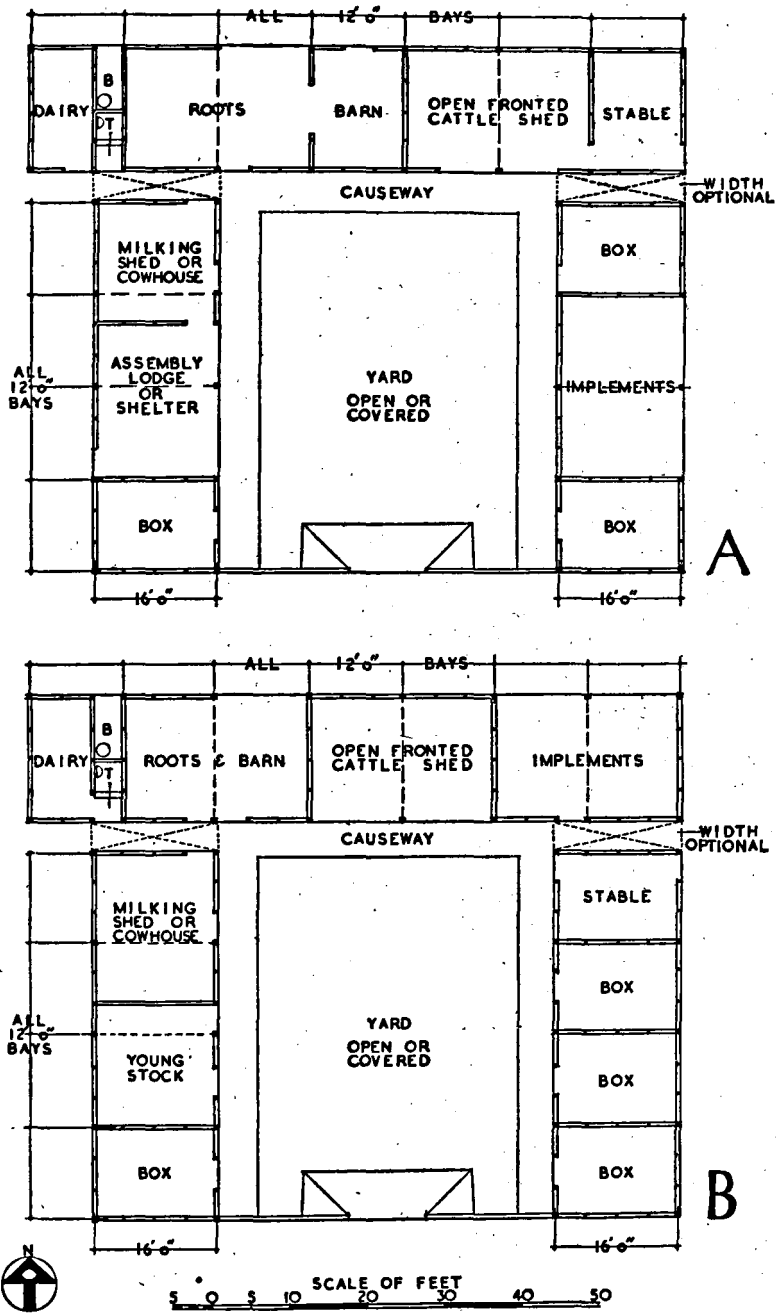
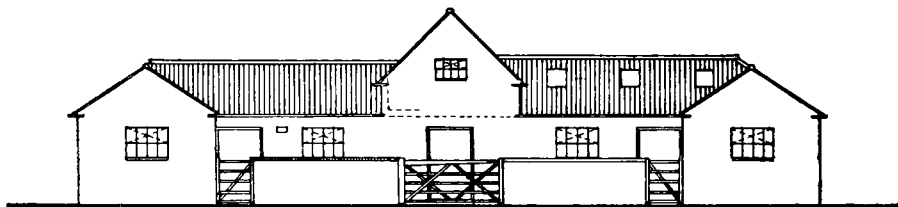


FIG. 63. BUILDINGS FOR THE SMALL FARM, EXAMPLES A & B



NORTH WEST



SOUTH EAST

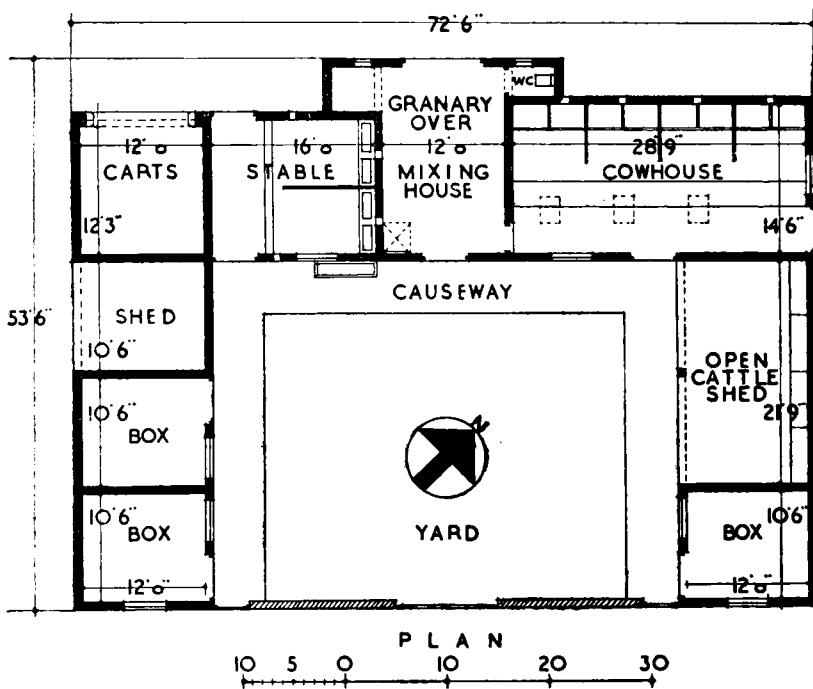


FIG. 64. BUILDINGS FOR THE SMALL FARM, EXAMPLE C

BUILDINGS FOR THE SMALL FARM

461. In the light of the foregoing and other relevant views, the following considerations are of great importance in deciding on the layout and form of buildings for small farms:

- a. Adaptability: this is even more necessary than on larger farms, for buildings must inevitably be fewer on the small farm, though their uses over a period of years may be no less varying. Yarding of milking cows thus has strong attractions.
- b. Within the small class, the less the area of the holding, the less the building provision is likely to be, for in general the productive capacity of the land will be less. The tendency, common in the past, to give the small farm a reduced-scale replica of all the customary buildings of a larger farm should therefore be resisted. The dominating consideration is what buildings are essential for the size and type of farm, having in mind the physical circumstances and broad farming characteristics of the locality. Where the small farm is highly specialized there must be appropriate specialization in buildings within the limits set by the productive capacity of the holdings. There are remarkable examples of alternatives to costly buildings on some small farms. For instance, very early peas, outdoor tomatoes, French beans and other vegetables may be grown under cloches till danger of frost is past, and the cloche plot is sometimes surrounded by a wall of baled straw, 2 or 3 bales high, for extra protection. The straw, when unfit for use, is composted. Another successful alternative to permanent glass houses is a structure—sometimes quite large—of big, standard, glass sheets for both roof and sides, with the skeleton made from job lots of wood discarded from a builder's yard.
- c. Each building on a small farm will naturally be smaller than its counterpart on a larger farm, for some implements will be smaller and there will be less material to store. Reduction in size must not, however, be carried to a point at which working convenience is jeopardized.
- d. Specialization on a small farm may be highly successful, as with high-priced vegetables or cut flowers, but trouble from crop or livestock diseases or changes in price and demand may for a time force the occupier away from his specialization. Specialized buildings should therefore be planned so that diversion to other purposes is not inordinately difficult.
- e. The cost of buildings is often relatively high in relation to the productive capacity of the holding in the case of very small farms. The difficulty cannot be met by cheap material and inferior work. Certain of the buildings must be sound and permanent, though for some purposes such as light storage (containers and bags) a cheap, mass produced shed, or, better still, one made by the occupier from standard materials, is a means of economizing.

462. Of the considerations in paragraph 461, adaptability is particularly important. It may be ensured, in either of two ways:

- a. What amounts to little more than a range of shedding built on three sides of a rectangle with a long back and two short arms (to allow for subsequent extension) and yards occupying the surrounded space. Little roofing may be necessary for the yards because of their small area.
- b. A single building with floor and roof only, but such that external and internal walls and partitions can be arranged at will.

These alternatives have been described for the larger farm in Chapter 7, but we give below notes on special points for their use on the small farm and some specimen layouts and designs.

FARM BUILDINGS

463. Buildings consisting essentially of a range of shedding could be provided by a series of units with a 16 ft. span and 12 ft. bays. Provision could be made for each unit in turn to be sub-divided into three so that having determined the number of 12 ft. main structural units necessary as the equipment for a holding, partitions could be put in at will at any interval of 4 ft. in the length or width of the building.

464. Such an arrangement is shown in drawing A (Fig. 63) which comprises 15 units arranged in three blocks suitable for a 50-acre holding. The north block consists of 7 units sub-divided as follows:

Dairy	1 unit (12 ft.×16 ft. span)
Roots and Barn	3 units (36 ft.×16 ft. span)
Open fronted cattle shed	2 units (24 ft.×16 ft. span)
Stable	1 unit (12 ft.×16 ft. span)

South and at right-angles to the above, two blocks have been placed one on the east and one on the west each containing 4 units divided as follows:

East Block—north to south:

Loose Box	1 unit
Implement Shed	2 units
Loose Box	1 unit

West Block—north to south:

Milking Shed or Cowhouse	1½ units
Assembly Lodge or Shelter	1½ units
Box	1 unit

The above buildings enclose a yard approximately 48 ft. square, which can be left open, or partly or wholly covered. If it is covered, the lodge can be converted into loose boxes or be used for other purposes. The "box" could be used for pigs, calves, storage and general purposes.

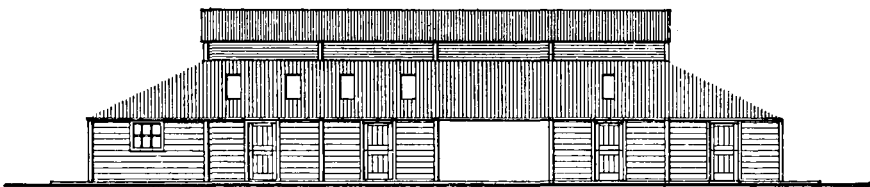
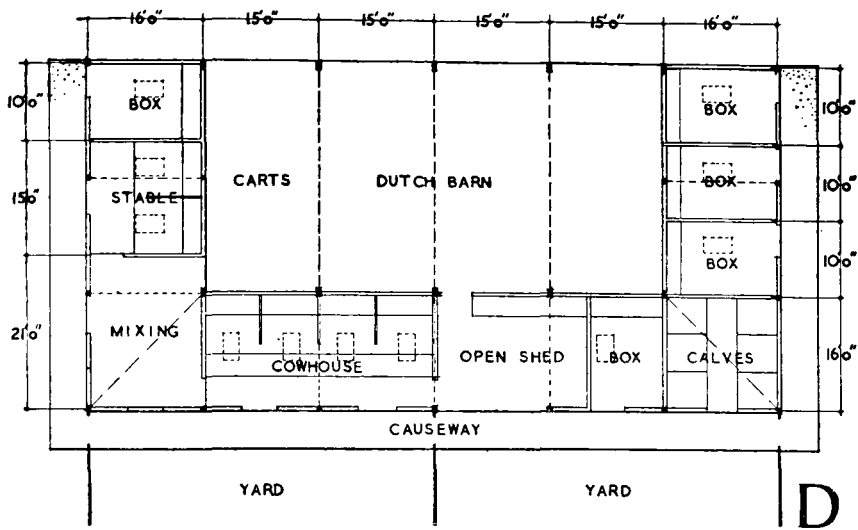
465. An alternative to the above is shown in drawing B (Fig. 63) made up of the 15 units but with some adjustment of the various partitions, and increased closed accommodation for cows and additional loose boxes.

466. If precast concrete units are used in the above designs there will be difficulty in linking the two wings with the main block. It is therefore suggested that the arms should be independent structures connected with the north block by flat roofed units at least 4 ft. wide. A width of 10 ft. would be necessary if it is desired to allow entry of carts to the yard at these points, but in this case it may not be essential to provide a roof.

467. Reference has been made earlier to the sub-division of the 12 ft. structural units into three bays. Each or any of these 4 ft. bays, whether internal or external can be filled in as necessary in any of the following ways:

- a. Solid walling.
- b. Solid walling up to a height of 4 ft. 6 in. and with sheeting over.
- c. Solid walling up to a height of 4 ft. 6 in. with glazing or a window over.
- d. Sheeting.
- e. A doorway. (If larger doors are required, two or more bays could be used for the purpose.)

In considering methods of construction and materials careful reference should be made to Chapter 3.



ELEVATION OF PLAN 'D'

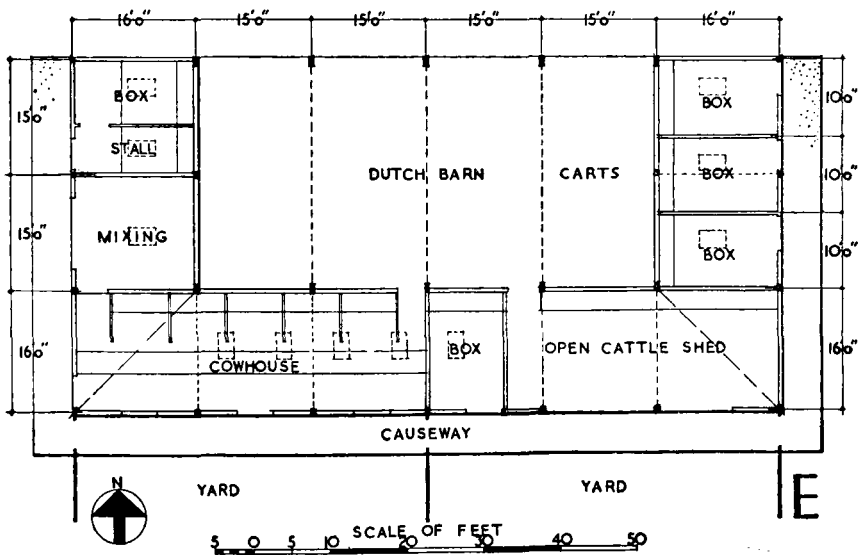
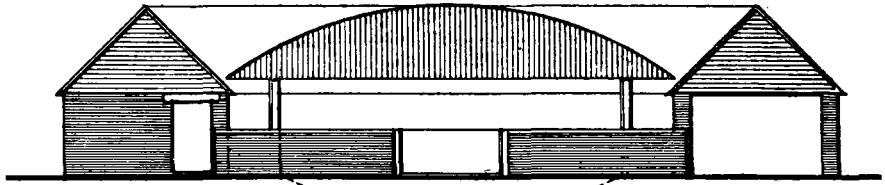
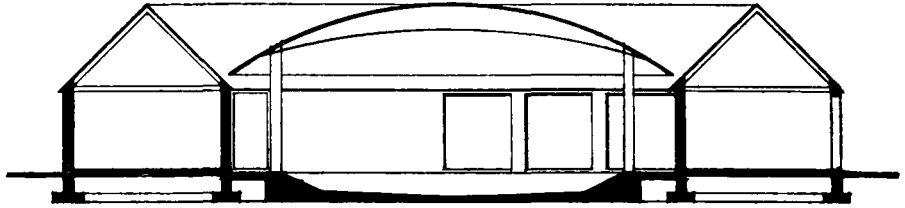


FIG. 65. BUILDINGS FOR THE SMALL FARM, EXAMPLES D & E



ELEVATION



SECTION

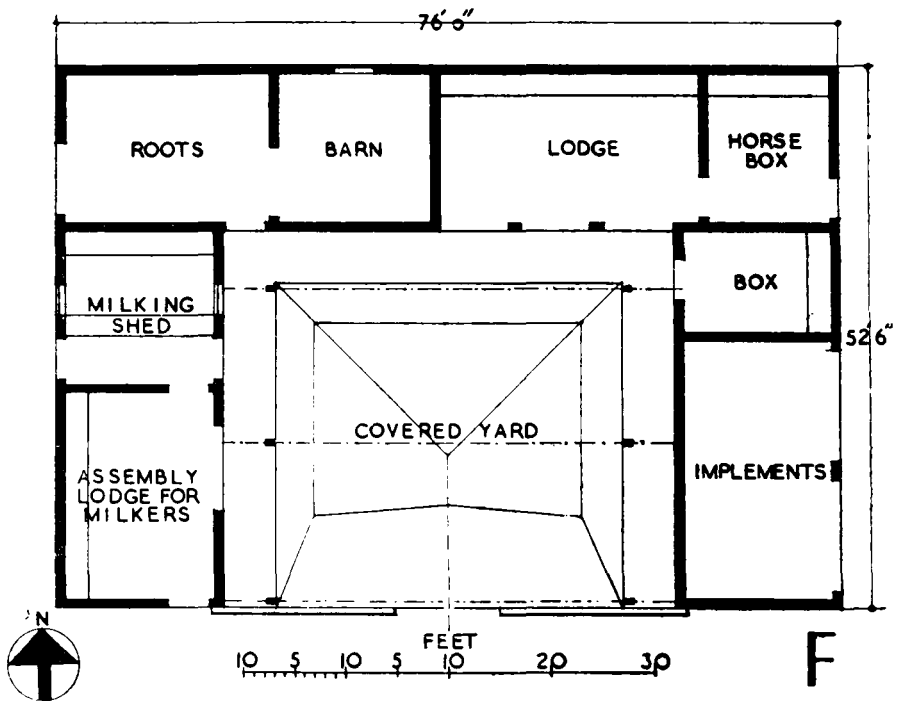


FIG. 66. BUILDINGS FOR THE SMALL FARM, EXAMPLE F

BUILDINGS FOR THE SMALL FARM

468. It may be desirable, particularly on dairy holdings, to provide space for the storage of grain and concentrates at first floor level. Drawing C (Fig. 64) which, it must be observed, is not based on unit design and construction illustrates such provision.

469. In some northern counties equipment arranged under one roof is favoured for small farms as illustrated in drawings D and E (Fig. 65). This practice is common in Europe. Drawing D shows a Dutch barn of 30 ft. span and 4 normal 15 ft. bays in length having a series of 16 ft. lean-tos on three sides of it. It has been assumed that the barn will be east to west, and the lean-tos will be on the west, south and east sides. On the west, a box, a stable and mixing house have been provided; on the south, a cowhouse, a box, and an open shed; and on the east side three boxes and a calf house. As previously stated, all the lean-tos are 16 ft. deep and have 15 ft. bays to correspond with the bays of the Dutch barn.

In both of the above buildings access for feeding to all compartments would be possible under cover. Implements would be kept in one bay of the Dutch barn or in an additional lean-to on a portion of the north side. Against the convenience claimed for this "one-roof" system must be set the added risk of the spread of fire.

470. We have received a memorandum on small holdings from the County Land Agents Association prepared in the light of 30 or more years' experience of their members. The memorandum, which deals with holdings of from 5 to 50 acres states that the members of the Association have had considerable experience, not only in the layout, design, and erection of a large number of the new farm buildings necessary for equipping small holdings, but in the modernization and adaptation of buildings already existing on the land purchased, as well as extensions and alterations to meet changes and progress in agricultural practice. Though necessarily it covers in many matters the same ground as the preceding passages in this Chapter and parts of other Chapters of our Report, we give with the permission of the Association, the extracts from it which are contained in an Annex to this Chapter. Drawing F (Fig. 66), which is based on a plan submitted by the Association, illustrates the memorandum.

ANNEX TO CHAPTER 19

Extracts from a Memorandum submitted by the County Land Agents' Association

LAYOUT

a. This is of special importance, particularly to small holdings, and may be considered under the following headings:

- i. *Site.* This should be carefully selected in relation to suitability of subsoil and economy of working the holding. Allowing for other considerations obviously the best position is as near as possible to the centre of the holding.
- ii. *Orientation.* Aspect is governed by situation and should aim at shelter and maximum of sunlight. For this reason a "U" shaped set of buildings, with yard in centre and facing south is the ideal and is capable of being adapted to any one of the three positions in relationship to the house, viz. behind or on either side.
- iii. *Access.* Good roads are of vital importance and, as far as possible, allowing for (i), preference should be given to proximity to public roads, although, taking the long view, it may be more economic in some cases to make up a farm road to the site.

FARM BUILDINGS

- iv. *Position.* The buildings should be as near as possible to the house, although it is advisable to leave plenty of width all round the buildings, not only for the manœuvre of vehicles, but for any possible extension to the set.
- v. *Drainage.* It is very important to keep the buildings and surroundings dry, and, therefore, the premises should be so sited to allow free disposal of surface water, sewage, etc., without risk of contamination of water supplies for cattle.
- vi. *Public Services.* Proximity of village or town, water, gas and/or electricity is of great importance, and it is hoped in future these will be made more readily available. Often small holders have overhead electricity cables across their land but cannot themselves have a supply.
- vii. *Amenities.* Finally a very important factor in the case of "bare" sites is the planting of trees and hedges as far as possible round the house and buildings, but not too near. It is surprising how a little attention given to this makes the new holding become an integral part of the countryside.

It is seen that it is impossible to lay down a hard and fast line for layouts.

STABLES

b. The stable has always been an expensive part of the accommodation on an arable holding (stall divisions, extra hard floor, hay racks, harness room, etc.) but with the greater use of the tractor a large amount of stabling is becoming redundant. A number of small holders now own a tractor or get their heavy cultivations and harvesting done by contract and, therefore, in many cases, one horse only is now necessary.

Consequently, it would appear that a utility box, with suitable manger of an adaptable type in new sets meets the small holders' requirements: if not required for a horse it could be easily used for other stock. A good floor would still be necessary. Harness rooms are not now necessary, as the small quantity used can be kept in the barn, or hung on the wall behind the horses.

LOOSE BOXES

c. These are of the greatest possible use on small holdings. In view of the varying conditions of farming and the personal inclinations of the individual farmer, as many as possible of these should be provided, and of such a size as to be capable of housing all classes of stock from a foaling mare or calving cow, to a litter of pigs. With a good floor and an adjustable manger this can be easily achieved.

COWSHEDS

d. This is *the* most expensive and difficult building to deal with. The extent of cowkeeping varies largely according to the locality, whims of tenant and current agricultural policy. On a change of tenant, or price of produce, cowsheds often become redundant.

Catering for the specialized desires of a tenant in regard to milk production is always unwise, and with the growth of arable farming will probably be more so.

Small holdings vary greatly in this respect, *i.e.* from the complete dairy holding to one with two or three cows. It appears, therefore, that one solution to this difficult problem is the provision of good accommodation for a minimum of three or four cows to be known as the "milking shed," and if more are kept, then to

BUILDINGS FOR THE SMALL FARM

milk in "relays," using a system of open shedding and/or other suitable cover, which if not required for cows, can be used for bullocks or other stock.

CATTLE YARDS

e. The covering-in of yards varies with the climatic conditions; a large number in the eastern and southern counties are open. Any attempt to carry the roof of a covered yard on the walls of surrounding buildings is apt to lead to difficulties of construction and maintenance, and it is better, therefore, that a covered yard roof should be supported independently of the surrounding buildings. Concrete paving is highly desirable, and drainage to a suitable tank, with pump for emptying.

DAIRIES

f. The old-fashioned dairies as such are out of date, as a very small number of small holders make butter. The accommodation now required is for cooling, sterilizing, and a boiler. A simple solution to the cooling problem is the provision of a circular underground water tank, constructed in cement rendered brickwork about 8 feet deep. All available rainwater gulleys should be connected to this with solid jointed pipes to prevent any contamination. In the absence of a mains supply this forms a stand-by storage and at the same time, by means of an all-brass lift and force or semi-rotary pump in the cooling house to fill a small cistern and a separate return from the cooler to the tank, a very efficient cooling system can be installed. This has proved very effective in practice. Even with a mains supply a great saving of water is effected by means of this underground circulating tank.

BARN AND STORAGE SHEDS

g. These vary in different parts of the country, *e.g.* in some a loft is considered essential—but not so in others—a root shed is common in the Eastern Counties but not in the north and west.

A loft involves more expensive construction and increased labour. The ideal appears to be one large building with one access, and a good floor, capable of storing corn and/or roots, etc. A short division wall for the separation of produce meets most requirements, even for a complete dairy holding, when it becomes known as a "mixing shed."

STORAGE OF MACHINERY AND IMPLEMENTS

h. Requirements in this respect vary considerably according to the type of holding and the equipment of the tenant. It is only possible to provide the minimum for the average arable holding. If reasonable protection from weather is afforded, one building only is necessary with large opening. This building is one of the chief offenders in bad layouts, being usually detached—badly situated, and built of cheap materials. This, in our opinion, is false economy, as its life is very short, and in the case of statutory small holdings, carries a short loan period, and its upkeep in painting, etc., expensive. For this reason, it is better embodied in the main set and of similar construction.

Either a tractor or motor car, or both, are now owned by a large number of small holders, and it is necessary at least to provide an enclosed shed for them.

It should be large enough to allow for a bench, have a good floor and be away from stock. An enclosed bay of the cart shed would meet the normal requirements of small holdings and could be used for storing implements, if not required for car or tractor.

FARM BUILDINGS

PIGGERIES

- i. The provision of piggeries is a very debatable point. Their design depends so much on the breed and type of pig farming to be adopted but very many varied designs are already available, based on experience in this and other countries.
- Being a specialized building, it should normally be separate from the main block. On many small holdings the provision of a couple of pigsties appears to have proved a useful part of the equipment, but on others, loose boxes are sufficient.

POULTRY HOUSES

- j. Except on specialized poultry holdings, it is considered these should be of a portable nature, and be provided by the tenant to suit his own desires.

SILOS

- k. Even under war conditions, extension of the production by small holders of silage is very slow, particularly in the eastern counties.
- As silage can be made in the rick or pit, it is considered that a silo is not an essential part of the equipment of a small holding.

WORKSHOPS

- l. The provision of a workshop on a small holding is useful, although it cannot always be arranged. Where possible it should form part of the tractor or car garage, oil store, etc., and be situated well away from stock.

PLANS

- m. Should be prepared by qualified professional men with a thorough knowledge of farm requirements.

CHAPTER 20

THE IMMEDIATE POST-WAR PERIOD: IMPROVISATION

471. Arrears in repair and maintenance of farm buildings are already heavy and many existing structures have long been outmoded. Future agricultural policy may involve more and differently designed buildings. The greatly increased output of milk, on which general opinion is insistent, will alone necessitate great building changes, while the progress of science and invention will bear increasingly on the function and use and therefore on the form of all buildings for the land. There must be anticipated therefore a long continuing demand for agricultural building work. It has begun to show itself plainly now; it will suddenly become much stronger when the war ends; and its duration will be long and strong if our agriculture attains a stable form.

Mr. J. L. Davies of the Milk Marketing Board in a paper *The Production, Marketing, and Supply of Milk* read to the Nutrition Society in London on 3rd July 1943, made an estimate of increased requirements and improvements for the accommodation of dairy cows. This is a valuable guide.

POST-WAR IMPROVISATION

472. Upon the ceasing of hostilities, the claims of repairs and new erections for housing will, presumably, be completely dominant. Consequently, for some three or five years or even longer, any work done on farm buildings will have to be mainly with material and labour not wanted for housing. The cardinal shortage is apparently expected to be in skilled building labour rather than in general labour or in materials, so that agricultural building work in the immediate post-war period must rely on materials and methods requiring the least possible use of skilled labour.

473. To make advance provision for this period of difficulty it is necessary to make some assumptions as to the amount and nature of the demand.

474. That much straightforward repair and maintenance work will be necessary is quite certain. The need for widespread alteration to make very old buildings more suitable to present uses is also plain. While the volume of these classes of work cannot be estimated, it is possible to decide which among the commoner materials will be scarce and how, if at all, substitutes can be provided. How repair and alteration work can be made less dependent on skilled labour is also an important related question. Upon these matters we recommend consultation with the Ministry of Works (see also paragraph 479 d).

475. Demand for more substantial building work on farms (new buildings, enlargements, etc.) in the immediate post-war period will no doubt be conditioned most of all by the expectation farmers and landowners hold for the future of their industry. But assuming such a reasonable confidence as will create a general desire to equip farms with sufficient and good buildings, a choice will often have to be taken between improvising with the materials and labour immediately to hand or waiting for some years for normal building resources. If plans are to be made for assisting the production of improvised or temporary buildings, the demand for them must first be estimated. It will depend on the general attitude of occupiers and owners to the choice between waiting or improvising.

476. All such inquiries as we have been able to make show general opposition to improvised and temporary buildings for farms save for small or special and transient uses. Tenants are averse from even a small rent increase for a building of short life or not answering fully the requirements of working convenience. They insist, too, on the expensiveness of upkeep of many adapted or temporary buildings. All these objections appear to be supported by landowners, though it seems probable that the smaller occupier-owner would be more inclined than others to be content with discarded wartime huts or other improvisations if they were cheap. All insist that for housing stock, especially cows, improvisation cannot be satisfactory.

477. Some immediate demand for new or enlarged buildings there will certainly be, however. Such building priority as agriculture is allowed will presumably be given to increasing the accommodation for dairy cows. For more storage for implements, tractors, and fertilizers, and for accommodation for young stock, the demand will have to be met by improvising with such labour and material as is available, and a practical examination of the possibilities is therefore needed at once.

478. This examination must begin by settling what improvised and temporary buildings will mean in practice. A temporary building may be a new erection in materials of short life—it may be from three years for straw to perhaps seven to ten years for sheeting and structural members stripped from some temporary wartime hut, office, or other building. Its maintenance would not be attempted: it would simply be kept in working order, at least possible cost, until a permanent structure could be provided. In some cases temporary alterations to existing farm

FARM BUILDINGS

buildings might be worth while, e.g. a little-used dilapidated storage shed may be turned into calf pens or a pig house.

The improvised building would be some wartime erection altered to suit a farming purpose. As wartime buildings, suitable for such alteration, were made only for short life, most of these improvisations would probably give only temporary service on farms though every economic possibility of ensuring longer life should be exploited.

479. With these acceptations of the improvised and the temporary building, the questions for examination are:

a. *Use of straw for hovels, shelters, and yards.* This has been dealt with in Chapter 14. At present, in many localities, it is limited by scarcity of balers and baling wire.

b. *Use of scrap war material from dismantling of unwanted huts and other erections or from other war sources.* We recommend the preparation of a list of materials likely to be available, with estimates of their quantity and notes on their location, their transportation, their characteristics, and hints on their use. In some cases restorative treatment of material may be required; for instance, re-tarring or re-painting of galvanized iron sheets. It would be helpful if this could be done centrally before purchase for farm use.

c. *Adaptation of wartime huts and other structures to farm uses.* We have learned, through the Ministry of Works, that a large part of such buildings are of concrete frames with concrete panel fillings. These are mainly concentrated in large groups and thus mostly at a distance from farms. Their dismantling and re-erection is skilled work, their transport heavy, and it may be easier to put up new ones of the same type on farms than to move existing ones. Some buildings, e.g. iron huts or wooden, will probably be available, however, and as to these we make two recommendations:

- i. The preparation of classified lists with notes as in (b) above;
- ii. The testing, followed by demonstrations at selected centres, of adaptations of the various available types to various farm uses.

Here and there the enterprising farmer or owner will seek out near-by surplus wartime buildings and make his own adaptations. We hope such initiative will have every possible official encouragement.

d. *Mass prefabrication.* We have dealt with this in Chapter 3, paragraphs 32 to 43, and made recommendations for early action. In that Chapter we have in mind the longer future, but it may be that prefabrication can be applied to the immediate needs of the post-war period. We recommend early consultation with the Ministry of Works on this separate possibility. There can be no further progress, however, nor any conclusions of practical value unless an understanding can be reached with manufacturers. They, on their side, would no doubt like to be assured of the number of orders they might expect for any standard type of building which they turn out on mass lines. On the agricultural side there naturally arise questions as to cost, as to the forms of the standardized buildings and the range of types that makers would be prepared to produce, and as to continuity of supply. An immediate need is, therefore, to bring representatives of potential makers and potential users together so as to settle as soon as possible whether or not the idea of standardized mass production for agricultural buildings is to be developed or not.

480. We have judged it inexpedient to defer completing our Report until the questions set out in this Chapter have been resolved. We recommend that as developments occur the possibilities should be made known by Bulletins from the Advisory Service proposed in Chapter 5.

PART III. OTHER ASPECTS OF FARM BUILDINGS

CHAPTER 21. EXCLUSION AND CONTROL OF INSECTS, RODENTS, AND OTHER PESTS

481. Rats may cause trouble or may nest in any farm building, especially where grain and feeding stuffs are stored or stock are housed. Mice, too, are familiar predators of stored food. Insects, mites, and various moulds (fungi) may frequently cause great loss in granaries and stores for cake.

In this Chapter ways of controlling rodents (rats and mice) in farm buildings generally are discussed, and special precautions against rodent, insect, and other infestations for grain and feeding-stuff stores are also explained. The Chapter consists essentially of expert statements furnished to us by Mr. A. G. Jenson of the Infestation Branch of the Ministry of Food, and Mr. C. D. Hornby, M.Sc., A.I.C., Chief Technical Adviser for Land Pests Destruction, of the Ministry of Agriculture and Fisheries, to both of whom we make grateful acknowledgment. The constructional details recommended in these expert statements emphasize the importance of sound construction and good workmanship together with simplicity of design. Some of the precautions recommended are for dealing with certain constructional features in existing buildings, which would not be included in modern designs, *e.g.* ducts ought to be avoided (see paragraph 489 b vii).

INSECTS, MITES, MOULDS, AND BACTERIA

482. The steps advocated in the ensuing paragraph are such as to ensure the most adequate protection it is practicable to achieve in grain and food-stuffs stores. Where the quantities stored are too small to warrant these full precautions, expert advice should be taken as to the best selection of protective measures.

483. *Precautions against damp.* Adequate precaution should be taken against damp, which provides favourable conditions for insects, mites, moulds, and bacteria. Damp may be caused by one or more of the following:

- a. Direct penetration by some easily remediable cause, such as a leaking roof, faulty gutters, and down pipes, badly fitting windows and doors, broken window panes, etc.
- b. Capillary attraction through brickwork or concrete from the ground.
- c. Condensation on internal cold surfaces.

484. Precautions which should be taken against these causes are as follows:

- a. Roofs should be soundly constructed; gutters and down pipes should be of strong durable material such as cast iron; doors and windows should be fitted with good workmanship; and all the foregoing should be properly maintained and repaired when defective.

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- b. A continuous damp-proof course should be incorporated in all new buildings to prevent damp from rising by capillary attraction through foundation walls and ground floors to the superstructure. The walls will be required to have an effective damp-proof course of sheet lead, asphalt, vitrified stoneware, or slates bedded in cement mortar in order to comply with the local building by-laws, and this damp-proof course is required to be laid beneath the level of the lowest timbers, and in the case of a solid floor not higher than the upper surface of the concrete, and to be not less than 6 in. above the surface of the ground adjoining the building.

If a concrete floor is used on the ground floor a continuous damp-proof course should be incorporated in the thickness of the concrete and continued vertically, if necessary, to make a water-tight junction with the wall damp-proof course.

A typical specification for a concrete ground floor of this type should be as follows. The ground surface enclosed by the external walls of the building should be covered with a minimum of 4 in. cement concrete spade finish and reinforced, if necessary, with steel rods or mesh; a damp-proof course of asphalt, pitch mastic, bituminous felt, or some other proprietary material should then be laid and the floor finished with a further layer of cement concrete of a minimum thickness of 2 in. to prevent lifting up. This should be finished either trowel-smooth or with granolithic paving.

- c. A concrete or granolithic paving is liable to show concentrated condensation owing to its hard smooth surface. Similarly, a stone flag floor is subject to the same disadvantage and this type of floor is not recommended. Timber flooring, on the other hand, is not liable to concentrated condensation, but has other disadvantages.

Walls, if finished with a gloss paint or a hard plaster are liable to heavy condensation, whereas unpainted brickwork or a porous plaster does not show the damp in the same way, but these finishes nevertheless hold the moisture in the pores of the material. In the latter case, damage may not be caused to the grain to the same extent as in the case of concentrated condensation, which is liable to cause extensive local damage to goods in contact with it.

For these reasons grain stores should be well ventilated with air bricks at frequent intervals both near the floor and ceiling, and in the case of pitched roofs which are open to the store below, these should also be ventilated at the ridge level, with a suitable type of ventilator which will prevent rats and birds from gaining access. The question of driving snow should not be overlooked when selecting the ventilators.

485. *Elimination of harbourages.* Harbourages for insect eggs, larvae, pupae, and adults should be eliminated. The following are a few examples of the more usual harbourages:

- a. Hollow timber stud partitions.
- b. Cracks between different materials, such as brickwork and steel, or brickwork and timber either in the form of structural timber or joinery.
- c. Joints in boarded floors.
- d. Joints in wall boards or match board linings and the space behind such linings.

486. These harbourages should be eliminated in the following manner:

- a. Partitions should be made solid, either by using proprietary brand partition blocks or light precast concrete slabs jointed in cement mortar. The slabs

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can be made with concrete having as an aggregate light material such as foamed slag or pumice stone.

- b. Cracks should be well pointed up solid with cement mortar during construction.
- c. The floor joints should be caulked and filled flush with the floor with an elastic jointing material, to prevent them being filled with dirt.

The use of a wall lining with joints and a space behind is not recommended. If it is desired to keep sacks away from the wall, vertical battens fixed to the walls can be used, but they should be constructed so that they can be easily removed for cleaning. The use of bolts with wing nuts for this purpose is desirable to facilitate removal by the farm staff.

487. It is essential that all buildings in which grain is stored should be kept in a high state of cleanliness, and horizontal and inaccessible surfaces upon which dust can collect should be reduced to a minimum. Horizontal surfaces, *e.g.* on tops of partitions, should be avoided, the design being either with a steep slope or slopes or a rounded top. The use of rounded members for roof trusses and purlins to reduce dust bearing surfaces is recommended where possible. Skirtings should be cast in with the concrete floor in the form of a wide cover which can be easily cleaned, and the use of a timber skirting fillet is not recommended.

If a boarded floor finish is required, this should be in the form of movable "dunnage" consisting of single boards or framed board sections of convenient size which can be lifted and removed for cleaning and treatment if necessary, thus allowing the floor beneath to be swept. If the framed sections are adopted they should be laid "battens uppermost" to avoid mouse harbourage beneath.

488. Immovable bins should be constructed of precast slab concrete partitions with rounded internal and external angles. Movable metal bins which can be removed for cleaning are also satisfactory. Alternatively, bins should be constructed with removable timber partitions as described in Chapter 8.

RODENTS

489. Many of the foregoing precautions are suitable for the prevention of rodent infestation, but the following additional notes will also apply:

a. *Infestation during construction.* This may be caused by rodents already on the site or attracted to it by foodscraps left by the building operatives. Rats, particularly, may inhabit burrows, cesspools, old drains or land drains on the site of the buildings. All old drains or cesspools should therefore be removed and filled in before building work is commenced, and open ends of land drains should be picked up and connected to an alternative means of drainage which will take them away from the site and leave no possibility of access to the building.

Other sources of infestation may be from the sewer in the road with which the drains from the new building will eventually be connected. Access to the new drains may be gained by rats during the time when the sewer in the road is open and the connection is being made from the new building drains. If the work involved necessitates the sewer being open for more than one day, precautions should be taken by means of inserting a temporary stopper or similar device on the open sewer to prevent this mode of infestation.

Adequate supervision of the building contractor should be arranged, if necessary by the appointment of a competent clerk of works, to see that the best workmanship is used, and that such details as the following are attended to:

- i. All pipes and cables entering the building should be properly built in.
- ii. Concrete floats or floors should be properly laid over the whole of the space between the walls to prevent any access through them.

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- iii. Brick and steel, and brick and timber should be properly pointed with mortar where they join.
 - iv. Cavity walls should be properly constructed with no access to the cavity.
- b. *Exclusion of rats and mice.* The following features should be incorporated in the design of new buildings:
- i. Foundations and footings of all external walls should be taken down to a minimum depth of 2 ft. below finished ground level, unless the building is constructed on a concrete raft.
 - ii. Air bricks should have openings of not more than $\frac{3}{8}$ in. in any direction.
 - iii. Beam filling, *i.e.* the proper building up in brickwork of the spaces between floor joists and ceiling joists and between rafters, should be properly carried out. Where off-sets occur in walls at floor level, the brickwork should be carried up to the underside of the floor boards if a timber floor is used, and should be carried round the ends of the joists. Similarly, the brickwork should be carried up to the underside of the roof-covering at the eaves. This reference to proofing of timber floors is made, as in some cases it may be essential that this type of floor be adopted, although the use of concrete or proprietary hollow tiles is recommended where practicable.
 - iv. Pipes passing through walls should be proofed with metal sleeves which should be continued at least 18 in. on either side of the wall, and should be only slightly in excess of the diameter of the pipe. This is most important where pipes are lagged with a material which can be easily gnawed by the rats, and the sleeve in this case should be only slightly in excess of the diameter of the pipe and lagging.
 - v. Gulleys and waste receivers should have a water seal which should be maintained, and should be of the back inlet type. Other types of receiver, if used, should be covered with a grid. The reason for these precautions is to prevent the rats from gaining access to the premises either up the rain-water down-pipes or up waste pipes.
 - vi. External doors of buildings used for food stores, such as ground floor or basement doors, doors on to loading decks or escape stairs, should have a kicking plate of sheet iron or other suitable metal at least 12 in. high nailed on the face and turned round both edges of the door, with a similar plate on the frame or lining and having a good overlap on to the adjoining brickwork or plaster. The plate on the door should be taken down to within $\frac{1}{4}$ in. of the threshold, and that on the frame or lining down to the floor level. Doors and frames which may be damaged by vehicles, implements, or animals should also be metal bound. All thresholds should be hardened with granolithic so that doors remain close-fitting.
 - vii. Chases and ducts, vertical or horizontal, should be constructed so that there is no means of access to them, and as an added precaution vertical chases should be sealed off at each floor by packing metal turnings or wire netting round the pipes to fill the chase completely at ceiling level. In ducts a similar precaution should be taken where these pass through walls.
 - viii. External down pipes should have sheet metal cowls fixed round them to prevent upward travel. The cowl should stand out at least 9 in. from the pipe and face downwards, and should be cut and pointed into the brickwork.
 - ix. If it is necessary to keep any windows open at night for ventilation they should be covered with an inner frame supporting a $\frac{3}{8}$ -in. wire mesh.

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c. *Restriction of invasion by rats and mice.* With good floors and foundations the passage of rats from one building to another will be considerably impeded. Where drainage channels pass from one building to another, a grid should be fixed at the partition wall. Where a water-pipe or electricity conduit is carried through a wall, the hole broken through to allow the passage of the pipes should be made good.

The wooden first floors of granaries often have trap-doors to permit the use of hoisting tackle. The edges of these trap-doors should be metal bound. Where hoist-ropes pass through the floor and not through the hoist-opening, the holes should be a good fit to the rope.

d. *Proofing of existing buildings.* In the post-war period, the problem of rendering existing buildings vermin-proof may possibly arise. This will be exceedingly difficult work since so many of the buildings now in use have neither foundations nor effective floors. It is impossible to lay down any general principles since each case will need consideration on its own merits. It should be the aim of all such reconstruction to produce a building meeting as closely as possible the specification of a vermin-proof building as indicated earlier. The chief need will probably be the provision of sound floors.

CHAPTER 22. FIRE PREVENTION

490. In considering the risk of fire, the Committee had before it a memorandum from Mr. G. Stafford, Fire Manager of the National Farmers' Union Mutual Insurance Society, Ltd., which follows in full. We must not be taken as agreeing with all the recommendations in the memorandum: for example, that a Dutch barn should be at least 20 yards from another barn, rick or building. Nevertheless the memorandum gives a great deal of useful guidance, and with permission it is reproduced in the following paragraphs.

CAUSES OF FIRE

- " 1. Speaking generally, farm fires mainly originate through:
- a. Human carelessness.
 - b. Failure to appreciate, or disregard of, fire danger when organizing farming operations.
 - c. Bad planning of farm buildings, plant, and installations.

The antidote to (a) is "disciplinary co-operation." Negligence is not, in the main, wilful. Generally it is mere thoughtlessness. During the war there are many regular and casual workers on farms to whom agricultural pursuits are novel, and who have not appreciated the extraordinary potential dangers on a farm or who do not stop to think that enjoyment of privileges, such as smoking, must be regulated by weather conditions and the nature of the job on which they are engaged at any moment. A "personal letter" pamphlet to each man or an exchange of views "in debate" between employer and men on fire precautions may help in improving the situation.

- " 2. To particularize on causes of farm fires, the principal, in order of demerit, are:
- a. Smoking.
 - b. Spontaneous combustion of new hay ricks.
 - c. Children with matches.
 - d. Trespassers and persons using rights-of-way through farms.

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- e. The burning of cavings, hedge trimmings, etc., without due regard to distance from buildings and produce.
- f. Threshing engines and tractors.
- g. Careless housing of motor cars, tractors, etc.
- h. Inattention to engines and machinery and neglect to lubricate shafting and gearing.
- i. Amateurish electric light installation and omission periodically to inspect and test wiring, switches, plugs, etc.
- j. Indoor storage of unslaked lime.
- k. Use of oil lamps.

" 3. Something can be done to minimize if not to eliminate these perils. Suggestions are:

- a. Do not prohibit smoking *everywhere* on the farm. People will smoke, regulations or no regulations. If men are working at the homestead it may be possible (and it is certainly advisable) to arrange staggered "breaks" during which they may retire to a suitable room or shed where they can smoke without imperilling anything. If the man ploughing wants to smoke, let him. He can endanger nothing. Tolerance in this respect would perhaps, in time, abolish the dangerous practice of surreptitious smoking in the barn, or behind a rick, or in the hay loft. *And farmers themselves should take care to set a good example.*
- b. Overheating is regarded by many farmers as a needless risk. It is practically unknown in Scotland and Northern Ireland but for some reason—climatical, possibly—it cannot entirely be eliminated in England. More care should be taken in making hay and a closer watch kept on new ricks. No rick should contain more than 20 tons or be more than 6 yards wide. A larger rick is most difficult to test for overheating. Every farmer has not the means of discovering the centre of heating or has the experience to tackle it when discovered. However, practically every farmer has a good idea whether a new rick is all right or not. Advice should be immediately available to the farmer who suspects overheating but is uncertain of what action to take. This Society has a scheme whereby overheated hay ricks are tested, free of charge to the farmer. Some 250 farmers of wide experience undertake the work of inspection, each Inspector having a testing-rod made specially to the Society's design. It is indisputable that steps taken consequent upon these inspections have prevented very many serious fires. The scheme has saved many thousands of tons of hay. Most spontaneous combustion fires have occurred to large ricks of rubbishy or badly made hay; to ricks of rich hay not periodically tested during the "danger period"; or to ricks where overheating has been discovered but where the farmers' knowledge of how to set about the trouble is slight. It is significant that, during the war, instances of spontaneous combustion of hay have been fewer than in many years preceding the war. During the war hay is precious stuff and worth, to the farmer, much more as feed than as a sellable commodity. Does this point to the farmer now taking much more care of his hay than he did pre-war? War-time experience does not warrant "spontaneous combustion" being placed No. 2 in the "list of causes."
- c. In practically every case the action is not wilful and the child is so frightened by the outbreak that a recurrence is unlikely. Farmers and men should keep matches out of reach of children, and barns and rickyards should be "out-of-bounds" to them. Schools could do much to bring home the point to the children. Evacuation of children from the towns

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- and the spread of urban areas are circumstances responsible to a great extent for this particular danger.
- d. Trespassers are usually tramps, courting couples, and motorists picnicking. It is difficult to prevent these people trespassing. In the majority of cases they do not wilfully raise fires. It is sheer negligence or thoughtlessness. Ricks should not be built near public rights-of-way and, if possible, buildings should be well clear of these paths.
 - e. With more arable farming, this cause of outbreak is very much on the increase. Too many "bonfires" are made too close to stubble, stacked produce, and buildings. Thought is not given to the possibility of change in direction of wind or the extreme danger of a running stubble fire.
 - f. Spark arrestors should not be removed from the smoke pipe of steam traction engines when on farms. The arrestors should be inspected more regularly. Ash boxes should be kept in good repair and inspected closely after banking up the fire for the night. Too many serious fires are caused by sparks emitted through the smoke pipe (usually when opening the throttle to get the engine over soft ground or over an obstacle) or through hot ashes escaping from the ash box on to litter which has carelessly been permitted to accumulate under the engine. Elevator engines cause numerous fires. An inexpensive metal covering over the engine would prevent wisps of hay from falling back down the elevator and contacting hot parts, or any part, of the engine. Tractors brought up to stacked produce to drive threshing drums, chaff cutters, etc., cause many fires through back-firing or through faulty or inefficient exhausts. A sheet of metal should be stood 12 to 18 in. from the horizontal exhaust to act as a baffle plate. From a fire risk point of view the modern vertical exhaust is an improvement. It may not be out of place, in this section, to suggest that two 1-gallon chemical fire extinguishers be affixed to each portable threshing drum and a similar extinguisher kept handy by a baler or elevator when in use.
 - g. Many fires have been traced to faults in the electric wiring of motor vehicles. It is difficult to obviate this risk as very few people would be prepared to disconnect the battery on putting up the vehicle for the night. In the main, however, garage fires are due to carelessness with petrol, and the usual garage collection of odds and ends helps feed an outbreak. *Tractors put away for the night should be allowed ample time to cool down before being sheeted over.*
 - h. The farm's "power unit" is something deserving appropriate accommodation. More often than not it is cramped into a timber partitioned-off section of a building. The engine house should be roomy, have a concrete floor and if possible should be bricked off from other rooms. If the place is clean and roomy the many "incidents" following the "priming" of engines with petrol on cold mornings would not have such serious consequences. Engine exhausts should be more carefully placed. I have seen quite a few only a matter of feet from Dutch barns. Shafting should be oily-rag wiped once weekly and lubricated immediately afterwards. Much shafting is simply festooned with cobwebs plus dust and hay and straw wisps.
 - i. In very many cases, whilst an original installation may have been put in by a competent engineer, extensions and improvisations are the work of the amateur. Fusing is caused by the insulation being chafed through owing to the wiring having been "slung" over a roof member. It is an essential safeguard that new installations and alterations to existing installations be effected by qualified electrical engineers and in accordance with the Institution of Electrical Engineers' Regulations for the Electrical

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Equipment of Buildings. An annual inspection of an electrical plant and installation is inexpensive and pays for itself in time.

- j. Quicklime should not be stored in buildings. With a little care it can be stored in the open without appreciable wastage.
 - k. Common sense dictates how to keep and use oil lamps. Unfortunately common sense is ignored all too frequently. If considerably more daylight was admitted into farm buildings there would not be the occasion for so much use of portable lanterns.
- " 4. Speaking generally, those who planned farm steadings considered only convenience in the working of the farm. Without doubt, *every* consideration can be given to the fire hazard without significantly impairing convenience of working.
- " 5. In both exterior and interior construction, there is often far too much timber. Interior partitioning by timber is unnecessary. Sheet metal or asbestos is preferable, but in a new steading the partition should be a $4\frac{1}{2}$ -in. brick wall. Roof supports of timber in time become covered with cobwebs, dust and wisps of hay and straw, in other words, everything to help rapid spread of a fire. It would perhaps be more economical and most certainly safer to have light steel truss roofs with incombustible sheeting. Outside walls should not be of timber, in fact as little timber as possible should be used. There are safer and equally serviceable alternatives which do not entail the upkeep of timber. Roofing by thatch should be prohibited.
- " 6. There can be no objection to a square of buildings so long as the yard is not sectioned by two ranges forming a + thereby making four yards. If more than one yard is required, fencing should be used. Experience has proved that a cross-connexion range may easily carry a fire to the opposite side of a square which otherwise would not have been endangered.
- " 7. It is rarely necessary for *all* buildings to communicate with each other internally. Where communication is not necessary the dividing brick or stone wall should be of at least 9 in. in thickness and should be carried one or two feet above the roof.
- " 8. It is understood that communicating hay lofts over cow tyings are discouraged by the Authorities controlling milk production. Such lofts are extremely dangerous from a fire point of view.
- " 9. The "power house" should be bricked off from adjoining buildings and any communication therewith should be by belting or shafting apertures only.
- " 10. Apart from a supply for immediate needs, hay and straw should not be stored in the steading, but in Dutch barns.
- " 11. Dutch barns should not be of more than one span of five bays, and each Dutch barn should be at least 20 yards from another Dutch barn or rick or other farm building.
- " 12. If the circumstances of the farm necessitate the stacking of all produce in the one rickyard thereby risking loss of all produce by one outbreak, that rickyard should be sited so that possibility of spread of the rickyard fire to the steading is reduced to a minimum. Such concentration of produce should, however, be avoided if at all possible. It is significant that the Siting of Ricks Order prohibits concentration of ricks but does not deal adequately with concentration of produce in bulk, *e.g.* Dutch barns.
- " 13. The siting of buildings in their relation one with another should take into consideration the direction of prevailing wind, principally the wind prevailing in late summer and early autumn when harvests are in, and when the weather is reasonably fine and spread of a fire might be difficult to prevent even were there

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no wind. Buildings should not be ranged in the direction of the prevailing wind but athwart it. Dutch barns and rickyards should be so sited in relation to buildings (especially those with chimneys) as not to be in the line of direction of prevailing wind.

" 14. Electrification of farms is long overdue, but is inevitable provided the cost of bringing electricity on to the farm is made to come within the means of the farmer. With electrification the internal combustion engine would not be needed except for distant elevator work; and the electric motor would replace the steam engine for threshing work if the rickyard was not too distant from the steading; and the need to store inflammable oils and spirits to the present extent would not arise.

Electricity may, however, be a hazard unless installed by a competent engineer in accordance with The Institution of Electrical Engineers' Regulations for the Electrical Equipment of Buildings, and unless the installation is regularly tested by a competent engineer.

" 15. The majority of serious farm fires would not have been anything like so serious had there been an adequate supply of water immediately available. Pressure mains cannot be expected but, in planning, fire extinguishment should receive as much consideration as fire prevention. There are usually ponds in various spots on the farm but these are for watering cattle and it is not unknown for these ponds to dry up in times of drought, in which times many fires happen. Usually, however, none of these ponds is near the steading or rickyard. The fire brigade spends much time connecting up with the distant pond even if it does not have to send back to the station for more hose. Endeavours should be made to have a pond reasonably near the steading and rickyard, and to see that it is not dangerously lowered in depth in times of drought when to make much use of the pond would be a temptation. A fire brigade should register brief details of the normal water supply on, and a note of the appliances, personnel and hose that should be taken on first turn out to, each farm in its area. Had there been installed in each farm steading two or three chemical extincteurs and a foam extincteur in the "power unit" much damage would have been prevented."

CHAPTER 23. ELECTRICITY ON THE FARM

491. Electricity in farm buildings has recently been studied by a Study Panel of the Electrical Installations Committee appointed by the Minister of Works. The influence of the use of electrical power and lighting on the design of farm buildings has been discussed between the Chairman of the Study Panel and of this Committee. It should be noted that the layout of buildings for which an electrical installation is represented in the diagram accompanying paragraph 421 of their Report (see Fig. 67) is largely an illustrative one and not representative of our final views on layout. We are in agreement with the conclusions of the Study Panel¹ which, with permission, are given in full in the following paragraphs:

POST-WAR FARM BUILDINGS

" 385. Post-war development appears likely to consist mainly of the modernization and reconstruction of existing farms by the erection of new specialized buildings, or the replacement or extension of existing buildings. It is probable, however, that a relatively small number of new farms will be required, either to replace obsolete farms or for reasons of change in the method or type of farming.

¹ Post-War Building Studies No. 11, *Electrical Installations*, Part VI.

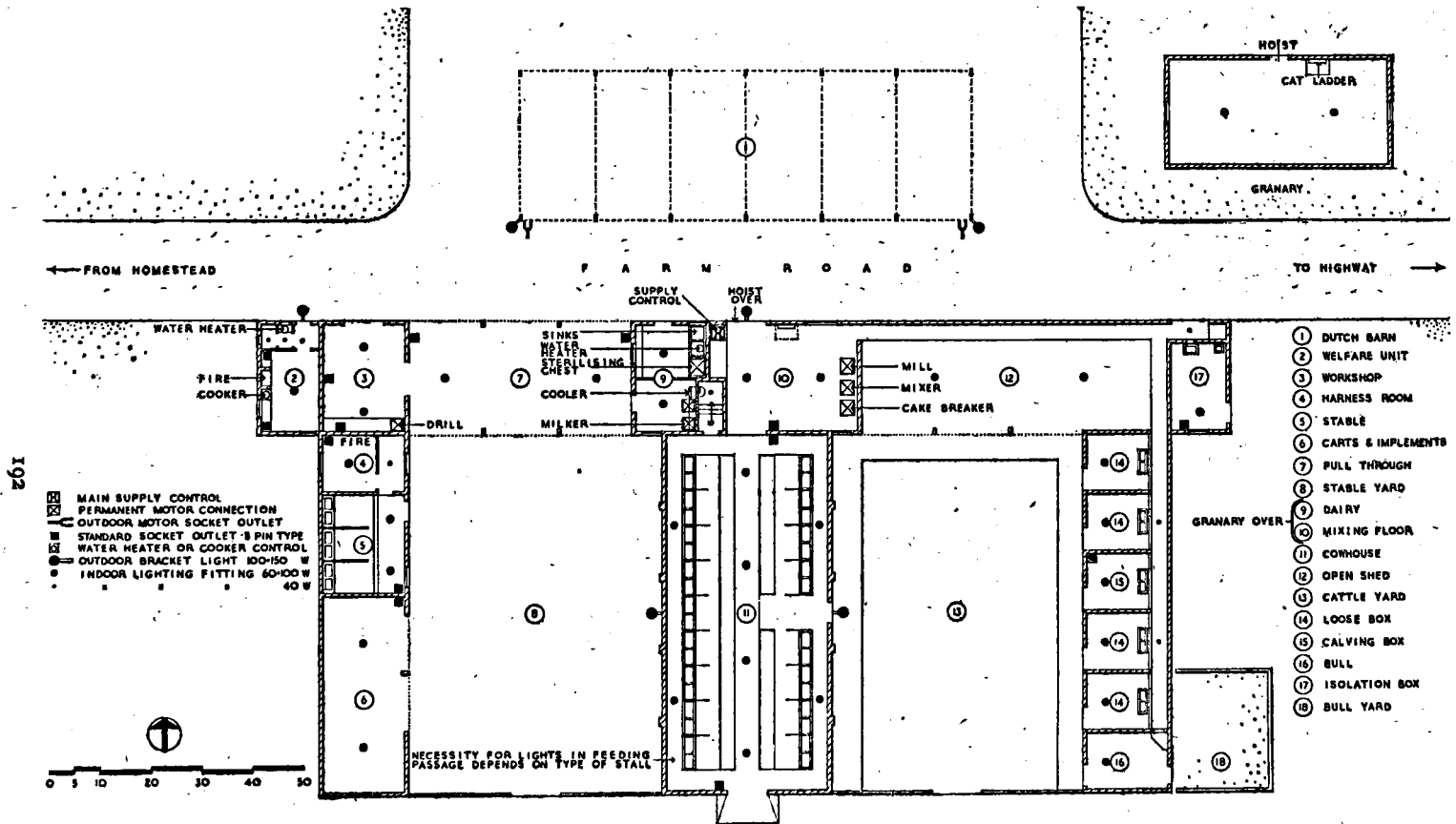


FIG. 67. ELECTRICAL INSTALLATION FOR A FARM

Based on Fig. 11, Post-War Building Studies No. 11

ELECTRICITY ON THE FARM

" 386. Our recommendations have been so prepared as to ensure adequate electrical installations both in these and in existing farm buildings. In England and Wales there is no legal obligation for a landlord to compensate a departing tenant for the improvement of farm property by installing electricity, whereas there is such an obligation in Scotland. This has a serious effect on the provision by English tenants of adequate and satisfactory installations. So long as this situation continues we consider that greater co-operation between landlord and tenant is an essential factor.

" 387. An essential first step in electrification is that full consultation should take place between the farmer, the architect and/or builder, the electricity supply engineer, the electrical contractor, and possibly the maker of any new type of equipment which may be under consideration. The decision whether the supply shall be given from underground or overhead will be taken by the supply engineer, who should also specify the requirements for external fixtures or the like that may be necessary, and the provision to be made for earthing. At this stage consideration should also be given to the route of supply lines, and to the placing of poles with due regard to farming operations and to rural amenities.

" 388. The use of mechanized methods may influence the design of farm buildings. Thus, a two-storey layout is preferable where electrically driven mechanical feed handling and storage is to be adopted, so as to provide for gravity feed from the first floor to the ground floor. This also involves the provision of a structure adequate to support considerable storage weight. Or again, in a dairy no separate boiler room is required when electrical sterilization is employed. In the consultations referred to above, consideration should be given to such factors, in so far as they may influence the design of new farm buildings or of modifications or extensions to existing farms.

FARM ELECTRIFICATION

" 389. In pre-war years electricity had already found a wide variety of applications on the farm. Electric lighting, pumping, milking, cooling, sterilizing, water heating, incubation and rearing, feed grinding, cutting, pulping, threshing, and sawing may be mentioned as typical established practices. A wide variety of other major and minor applications are either established or in course of development both in this country and abroad. Apart from any intrinsic merits of electrically operated processes, increased cost of farm labour will encourage mechanization and automatically controlled processes, and the necessity for making farm work more attractive by reducing heavy manual and repetitive work and minimizing attendance outside normal working hours will have a similar effect.

" 390. In addition, the necessity for providing domestic amenities in farmhouse and cottage equivalent to those available in towns is of increasing importance.

WATER SUPPLY

" 391. In localities in which there is no public water supply, but where there is a suitable local source of water, an automatic electric pumping system will give the same convenience. Where the source is constant, as is generally the case, the pressure tank system may be used in order to dispense with the need for storage tanks and the structural provision required for them, and to give the benefit of a high-pressure water supply. On the other hand, a storage tank system ensures a reasonable reserve of water at times when the pumping plant may be receiving maintenance attention.

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TYPE OF ELECTRICITY SUPPLY

" 392. We assume that after the war electricity will be made generally available in rural areas, and that the great majority of farms will be connected to public supply mains. Although rural three-phase supplies will probably continue to expand, an increasing proportion of farm supplies will be single-phase, particularly in view of the trend towards lower apparatus loadings referred to in paragraph 395.

" 393. If cases should occur of private generating plant being installed as a temporary measure, we recommend that the wiring installations should conform to the requirements for mains supply so that this may be connected without difficulty when it is made available.

THE FARM LOAD AND ITS BEARING ON THE WIRING INSTALLATION

" 394. An investigation and survey of existing dairy and arable farms has been made, and has been of substantial advantage to us in reaching conclusions and in formulating our recommendations.

" 395. The majority of farm electrical appliances depend for their operation on motors or heaters of ratings 0.5 kw. to 10 kw. (*i.e.* $\frac{1}{2}$ to 10 h.p. approximately). Appliances which in the past have exceeded this range of ratings are grinding mills, dairy sterilizers, and steam boilers, for which ratings up to 20 kw. have been common. In both cases, however, recent research and experimental operation have shown that equally effective results can be obtained with equipment of much lower loading. It may be expected that soon after the war grinding and sterilizing appliances having, say, only one-quarter of the rating of those previously used may become generally available. We therefore assume that the majority of new farm appliances will not exceed 5 kw. in rating, though larger motors of, say, 10 to 20 h.p. (*i.e.* 10 to 20 kw. approximately) may be required for grain-drying or grass-drying plant, and a transportable motor of similar rating may be required for threshing or silo filling.

" 396. We have reached the conclusion that the heavier loads are generally grouped fairly closely together, or can be so grouped. Although electricity is essentially a flexible service which enables plant to be placed in any desired location, we recommend that where conveniently possible the main load appliances, *e.g.* for sterilizing, grinding, pulping, etc., should be grouped together so that the cost of power wiring may be minimized.

" 397. The following examples, taken from modern practice of applications of electricity on the farm, indicate the range of service for which an adequate electrical installation should provide:

i. MILK PRODUCTION

a. Cowhouse

Lighting. In a typical single range shed, lighting may be by means of ceiling fittings in a central passageway, or bulkhead fittings on the wall behind the cows.

Socket-Outlets. A number of suitably placed standard socket-outlets (see paragraph 400) for supplying hand lamps, clipping machines, etc., should be provided. These are essential if the best use is to be made of the installation.

Ventilation. A fan may be provided in the roof or gable if mechanical ventilation is required.

Power. The milking machine motor, which may be situated in the dairy, or other room adjoining the cowhouse, or, alternatively in a milking parlour, will have a rating of $\frac{1}{2}$ to 1 h.p.

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b. Dairy

Lighting, and one or two socket-outlets for fan, bottle washers, etc. will be required.

Sterilizer	4 to 9 kw. (These rating cover the range of requirements of herds of 20 to 40 cows.)
Water heater	1 to 3 kw.
Cooler	$\frac{3}{4}$ to 2 h.p.
Water pump, if required	$\frac{1}{2}$ to 1 h.p.

c. Food Store and Mixing Room

A small hoist may be required	$\frac{1}{2}$ to 1 h.p.
Mixing machine	5 h.p.
Grinding mill (new type)	3 h.p.
Cake breaker	2 h.p.

Some of these machines may be situated in the barn or other buildings according to the layout of the farm.

ii. MIXED FARMING

In the case of mixed farming, but where no dairy herd is kept, provision for the following machinery may have to be made:

Grinding mill (new type)	3 h.p.
Chaff cutting, root cutting, or cake breaking	10 h.p.
Mixing machines	5 h.p.
Hoist	1 h.p.
Threshing, sawing, or power for crop dryer	10 to 20 h.p.
Water pumping	1 h.p.

In most cases it will be more convenient for each of the above machines to be fitted with its own motor, but where barn machines, such as a chaff cutter, root cutter, and cake breaker, can be fixed fairly near to each other, one motor may be used to drive all the machines by shaft and belting, without undue loss of power in friction.

Threshers, saws, elevators, silo fillers, and other machines used out of doors around the farm buildings may be driven by weatherproof motors mounted on skids or wheels for convenient handling. Such motors can be supplied by means of trailing cables from a few watertight socket-outlets fixed on the outside of farm buildings in positions chosen so that the trailing cable is not likely to lie across a roadway.

iii. POULTRY PRODUCTION

The wiring installation will be required to provide a number of 3-pin standard socket-outlets distributed throughout the buildings for the convenient connection of incubators, brooders, etc., the total load of which may be roughly estimated as follows:

Incubator room	$\frac{1}{4}$ to 1 watt per egg.
Rearing houses	1 $\frac{1}{2}$ to 2 $\frac{1}{2}$ watts per chick.
Laying houses; lights and drinking-water warmers	2 to 3 watts per bird.

FARM BUILDINGS

LIGHTING

" 398. Electric lighting can of itself greatly improve working conditions and cleanliness in farm buildings, and care should be taken in planning the wiring of both new and existing premises that adequate lighting provision is made in the buildings and where necessary in the farmyard and approaches. The number and size of lamps should be arranged to provide good illumination over all working areas; for example, in a single range cowshed for twelve cows, two lights on the wall along the feeding passage and at least three lights on the wall behind the cows are advisable. Bulkhead type fittings to take 60 or 100 watt lamps are suitable for wall mounting, and should be of waterproof pattern in cowsheds and dairies. In other buildings also this type of fitting has advantages from the point of view of robustness and easy cleaning. Yard and roadway lights should be fixed as high as possible on poles or gable ends, so as to give good illumination without glare. Portable hand lamps should be of Home Office shock-proof type, as described in the Factory Regulations.

LIGHT SWITCHES

" 399. Economy in wiring and convenience in use is promoted by grouped switching of light circuits rather than by individual switches for each light. Two or three-way switching should be used in buildings with more than one entrance and for outside lights. In the latter case, one switch should be provided in the farmhouse. Cord-operated ceiling switches may present advantages in certain situations, such as dairies, and will effect some economy in wiring.

GENERAL UTILITY SOCKET-OUTLETS

" 400. Provision should be made for the use of appliances of moderate power in all buildings. For this purpose 3-pin standard socket-outlets are recommended. These will facilitate the use of hand lamps, portable tools, and many existing small appliances and also make it generally possible to take advantage of new applications and appliances, which may reasonably be anticipated. Socket-outlet circuits would radiate from the service position through the various farm buildings. In new farms and in certain layouts of existing buildings, consideration should be given to one or more ring circuits to carry all the general utility socket-outlets.

" 401. Having regard to the present trend towards mechanization we consider it important that provision for the use of small electrically-driven tools and for battery charges (for vehicles and electric fences) should be made in the implements shed or workshop and in the garage.

FITTINGS AND ACCESSORIES

" 402. It is generally desirable that socket-outlets and plugs, lamp holders, switches, joint boxes, etc., should be of the insulated type. Also, having regard to the possibility of accidental damage in many farm situations, these fittings should be of more robust construction than is generally considered necessary for domestic purposes. Where exposed to water and moisture, fittings such as joint boxes should be filled or plugged with suitable waterproof compound.

FUSING

" 403. Single-pole fusing should be used in conformity with standard practice (see paragraph 34). The use of rewirable procelain fuses should be discouraged and their place should be taken by standard enclosed cartridge-type fuses. Fuses of different ratings should not be interchangeable. The ratings should be clearly and indelibly marked on fuses, and it should be readily possible to distinguish between new and blown fuses by the appearance.

ELECTRICITY ON THE FARM

CIRCUIT BREAKERS

"404. Consideration may be given to the use of quick-acting circuit breakers in place of the consumer's main switch, and possibly in place of circuit fuses.

SYSTEMS OF WIRING

"405. We have considered the various wiring systems which have been used in the past in this country, in the United States, and in Europe. We are satisfied that of the systems previously used in this country none is completely satisfactory under all farm conditions; certain qualifications and reservations apply to every system.

"406. We consider that the adoption of a single system of wiring for farms, which could be recognized as standard, would greatly simplify the reliable and economic electrification of farm buildings, both from the aspects of manufacture and installation.

"407. A standard farm wiring system should satisfy the following main conditions:

- i. The cable must be mechanically strong and resistant to ammoniacal fumes, steam, and damp.
- ii. Its cost should be reasonable
- iii. Its installation should not require such a high degree of skill as to limit unduly the rate of introduction.

"408. A wiring system which complies with these requirements was used to an increasing extent in pre-war years on Swedish and German farms. It uses a metal-taped insulated cable, generally similar to that covered by *B.S. 7*, and provides mechanical, chemical, and electrical protection for the conductors. Although this system would fulfil the requirements of a standard farm system, we consider that it is not to be recommended in view of the relatively high cost of continuous armouring which, however, is essential for only a small proportion of a farm installation. We estimate that the cost of an installation completed in metal-taped cable would be approximately equal to one in vulcanized rubber-insulated cable run in screwed galvanized iron conduit. Both would represent good practice, but we consider that the system recommended in the next paragraph, although less robust than either of these alternatives, provides a satisfactory and less expensive solution, which would facilitate more rapid extensions in the immediate post-war years.

"409. We recommend for use as a general purpose cable, and for adoption as the basis of a standard system of farm wiring, tough rubber-sheathed cable, protected with cotton braid vulcanized on and compounded over.

"410. Cable of this type is particularly suitable for the wiring of existing farm buildings which, as already stated (paragraph 385), are likely to form the major part of the post-war farm electrification programme.

"411. This cable fulfils the requirements stated above except in respect of its limited mechanical protection. A high degree of mechanical protection is, however, necessary only in a limited number of locations, and here suitable protection may be provided by means of insulating conduit. Metal conduit is not recommended since, for safety reasons, it would require to be separately earthed and unless galvanized would be liable to corrosion. As regards the possibility of attack by vermin, practical experience shows the risk to be negligible, if care is taken to avoid rat runs when installing the cable.

"412. Since metal-cased appliances requiring to be earthed will be used in farms, the proposed cable should contain an earth continuity conductor.

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" 413. We consider that similar cable insulated with polyvinyl chloride (P.V.C.) would form a satisfactory alternative, to which the possibility of post-war rubber shortage gives added importance. Such cable may be expected to be generally available in the near future and may, in certain characteristics, possess better qualities than the recommended special T.R.S. cable. For example, P.V.C. cable is understood to possess exceptional resistance to damp, corrosive conditions.

" 414. To reduce the risk of mechanical damage and of accidental contact it is recommended that the wiring should be installed high and well out of normal reach. In dairies, cleat mounting may be used, as this permits of thorough cleansing by hosing down. Mechanical protection is recommended for down-drops to socket-outlets or for connexions to appliances where these are likely to be subject to damage. Alternatively, to avoid mechanical or chemical damage it may in certain cases be practicable to run the wiring more safely on the outside of the building and to bring it in where necessary. If a motor has to be mounted on the floor some distance away from the wall on which the wiring is run, care should be taken to provide adequate mechanical protection for the wiring between the wall and the motor terminal box.

" 415. A permanent diagram showing the position of all cable runs should be provided at the service position.

EARTHING

" 416. Earthed appliances will invariably be used, and one or other of the following earthing arrangements should be made in consultation with the supply undertaking:

- i. To the water-supply main where this is available.
- ii. To the land sheath, if any, of the undertaking's service cable, where this is regarded as satisfactory and acceptable by the undertaking.
- iii. To an effective earth electrode or electrodes which should be subject to inspection by the supply undertaking at the time of installation, and to subsequent periodic inspections by a competent person.
- iv. If the earth resistance in a locality is too high for safety to be obtained by means of direct connexion to an earth electrode system, and if methods (i) and (ii) are impracticable, provision for protection may be made either by means of an earth leakage circuit breaker of appropriate rating or by means of protective multiple earthing, if this method is adopted by the supply undertaking.

SERVICE POSITION AND ACCOMMODATION

" 417. We recommend that the electricity service, which will generally be by overhead line, should terminate when convenient at the centre of the heavier loads. The supply control, consisting of the undertaking's main fuse and meter, also the main switch and fuses controlling the installation, should be fixed in a clean, dry, and easily accessible position. On large farms a separate small room might well be provided to accommodate this equipment. Our recommendations for consumers' supply controls in domestic premises (paragraphs 30-44) should be borne in mind in appropriate cases.

ELECTRICITY SUPPLY TO OUT-BUILDINGS AND FIELD LOCATIONS

" 418. To supply near-by out-buildings, the proposed special T.R.S. cable or P.B.C. cable may be slung from a catenary. For more distant buildings or field locations for hay elevating, sheep rearing, etc., a light open line should be used. In special cases consideration may also be given to the possibility of deriving a convenient supply by tapping the incoming overhead supply line to the farm.

ELECTRICITY ON THE FARM

ELECTRIC FENCES

" 419. Detailed consideration of electric fences has not been undertaken, since these are for field use and do not lie within the scope of the present study. Reference has, however, been made in paragraph 401 to charging facilities for the low voltage batteries from which the apparatus required derives its supply. Electrical fences are growing in popularity in this country, and it may be noted that their characteristics are being considered by the British Standards Institution.

TELECOMMUNICATIONS

" 420. Provision for a telephone and for radio reception will generally be made at the farmhouse. The recommendations contained in paragraphs 106 to 129 are generally applicable.

SUGGESTED INSTALLATION FOR A PROPOSED POST-WAR FARM BUILDING

" 421. The Farm Buildings Committee have kindly provided us with a plan of a proposed type of post-war farmstead. This is shown in Figure 11¹, and as a general example of the application of our present recommendations, the essential requirements of the electrical installation are marked on the plan."

¹ See Fig. 67, which is based on this illustration.

PART IV. RECOMMENDATIONS

CHAPTER 24

PROPOSALS FOR CONSIDERATION BY THE MINISTRY OF AGRICULTURE

492. In the preceding Chapters of this Report we recommend that various matters should be considered by the Ministry of Agriculture. For convenience, they are summarized below:

a. Provision should be made as soon as possible for an Advisory Service and for experiments on farm buildings. An appropriate organization would be a headquarters unit in the Ministry of Agriculture with an Advisory Service on a regional basis, which should be part of the Provincial Advisory Agricultural Service. (Chapter 3, paragraphs 85 and 86.)

b. It is of high importance that the Advisory Service should have full access to the technical knowledge and experience of the Ministry of Works and of the Building Research Station of the Department of Scientific and Industrial Research. (Chapter 5, paragraph 87.)

c. Visits by representatives of the proposed Advisory Service should be paid to certain countries in Europe, North America, and Australasia as soon as possible to study recent developments in farm buildings. (Chapter 5, paragraph 92.)

d. Testing and demonstration of new developments in farm buildings in the varying climates, circumstances, and farming systems of the different parts of the country should be arranged through the Provincial Centres which have been proposed. (Chapter 5, paragraph 93.)

e. The matters on which information should be systematically collected and periodically disseminated by the proposed Advisory Service include:

- i. Results from the proposed experiments.
- ii. Developments initiated on farms and estates in layout, design, equipment, methods and materials of construction, and systems of working of farm buildings, with particulars of cost.
- iii. Reconditioning or adaptation to new uses of existing farm buildings with detailed accounts of successful examples.
- iv. Relevant information from other countries; especially the Dominions, the United States, and the Continent of Europe.
- v. Procedure, materials, and resources or facilities newly arising in the building and associated industries.
- vi. Materials and methods for fencing, water supply to fields and buildings, roads, drainage, and other matters such as sheep dips which are not strictly farm buildings.

(Chapter 5, paragraph 88, and Chapter 3, paragraph 54.)

f. A comprehensive library service, including the maintenance of a bibliography and the preparation and circulation of abstracts of published material, should be an important activity of the proposed Advisory Service. (Chapter 5, paragraph 90.)

g. At suitable opportunity selected examples of the single building type of farm premises should be described in the Advisory Service publications. (Chapter 3, paragraph 27.)

RECOMMENDATIONS

h. The following matters should be investigated by the proposed Advisory Service:

- i. The relation of mechanical loading to farm building layout and design. (Chapter 2, paragraph 21.)
 - ii. The suitability of buildings of the North American barn type. (Chapter 3, paragraph 29.)
 - iii. Mechanical clearing of yards. (Chapter 4, paragraph 75.)
 - iv. The bail system of management for calves. (Chapter 9, paragraph 261.)
- i.** The Advisory Service should provide information on new ventures and experiences with specialized pig-houses from time to time and, still more important, investigate by experiment the influence of design and structure on housing environment and the effect of environment on pig health and comfort. (Chapter 11, paragraph 336, and Chapter 1, paragraph 8.)
- j.** The proposed headquarters unit of the Advisory Service in the Ministry of Agriculture and Fisheries (see (a) above) should have sole charge of building work on the Husbandry Experiment Stations which we understand it is proposed to set up. (Chapter 3, paragraph 96.)
- k.** Steps should be taken at once by the Ministry of Agriculture to discuss with manufacturers the mass-production of standard framed buildings of the following suggested dimensions:—

SPAN	FLOOR TO WALL-PLATE	UNIT OF LENGTH
ft.	ft.	ft.
16	8	12
21	8	12
28 or 33	8	12

The special needs of the post-war period will need particular consideration. (Chapter 3, paragraph 39, and Chapter 20, paragraph 479 d.)

l. At the same time, in order to assist manufacturers to make their plans, the Ministry of Agriculture should make an estimate of the number of buildings of this kind which can reasonably be expected to be required during the first 3 years of peace. It is possibly desirable that the Ministry should supervise the distribution of new buildings, in order to ensure that they are erected where they are most needed, and consideration should be given to this idea. (Chapter 3, paragraph 40.)

m. Consultation should take place with the Ministry of Works as to the provision of substitute materials for repair, maintenance, and alteration work. (Chapter 19, paragraph 474.)

n. A list of scrap war materials likely to be available for use on farms, with estimates of their quantity and notes on their location, their transportation, their characteristics and hints on their use should be prepared. (Chapter 19, paragraph 479 b.)

o. Classified lists of wartime huts and other structures which will be available for use on farms with notes as in (n) above should be prepared; and there should be trials, followed by demonstrations at selected centres, of adaptations of the various available types to various farm uses. As information accumulates it should be made available through the publications of the Advisory Service. (Chapter 19, paragraphs 479 c and 480.)

FARM BUILDINGS

APPENDIX

Written statements of evidence were received from the following bodies, to whom we make grateful acknowledgment:

- The Auctioneers' and Estate Agents' Institute of the United Kingdom.
- The Central Landowners' Association.
- The Chartered Surveyors' Institution.
- The County Councils' Association.
- The County Land Agents' Association.
- The Land Agents' Society.
- The National Farmers' Union.
- The National Federation of Building Trades Employers
- The National Institute for Research in Dairying.
- The National Union of Agricultural Workers.
- The National Veterinary Medical Association.
- The Royal Institute of British Architects.
- The Sanitary Inspectors' Association.

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Numbers in brackets refer to the Memorandum from the N.F.U. Mutual Insurance Society Ltd. reproduced in Chapter 22, and to the extract from Post-War Building Studies No. 11 reproduced in Chapter 23

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¹ Mr. T. W. Haward was taken seriously ill in March 1944, and was unable to take any further part in the work of the Committee. He died in the following December. Sir Frank Engledow has since acted as Chairman.

² Sir Patrick Abercrombie was unable to sign the Report owing to absence abroad.

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⁴ Mr. James Turner left on a mission abroad in October 1944, and has, therefore, been unable to sign the Report.

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