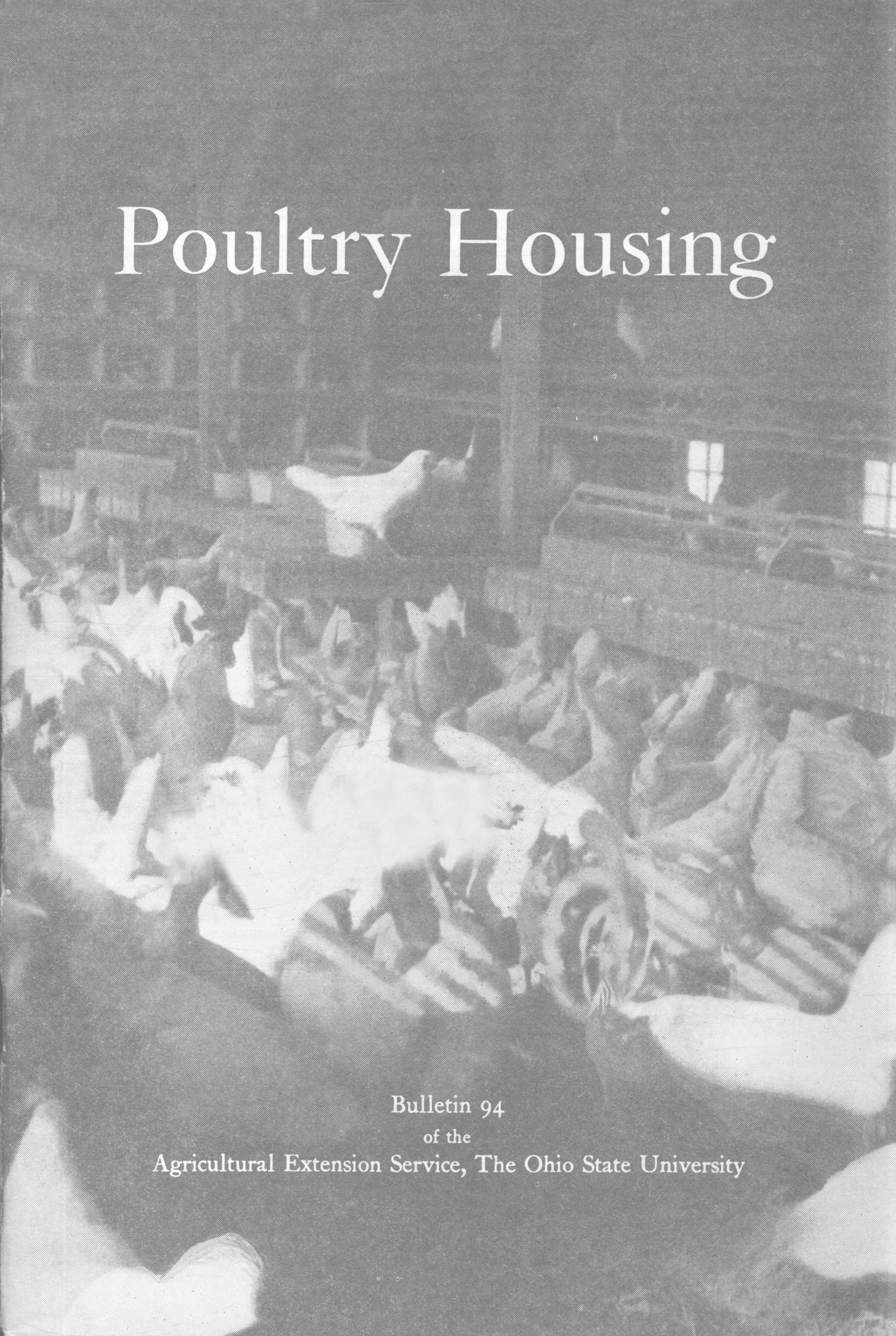

Poultry Housing

Bulletin 94
of the
Agricultural Extension Service, The Ohio State University

Contents

PLANS FOR POULTRY HOUSES

EQUIPMENT FOR THE LAYING HOUSES

Explanation of Terms and Abbreviations

2′-6″ means 2 feet 6 inches.

24″ OC means 24 inches on center, or 24″ from center to center.

T G refers to tongued and grooved lumber.

875 feet B.M. means 875 feet board measure.

Dimensions are measured from tips of arrows.

A 1-2½-3½ concrete mixture contains one part cement, 2½ parts sand, and 3½ parts crushed stone or coarse gravel.

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POULTRY HOUSING

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and

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PROPER housing conditions throughout the year play an important part in the prevention of poultry diseases and the maintenance of high egg production. It is a comparatively simple matter to maintain the birds in good health when they are provided with good housing conditions.

Birds of good breeding, no matter how well fed, will not return maximum profits unless well housed. The poultry house is the hen's home, and to be comfortable, must be cool and well ventilated during the summer, yet provide ample protection during cold and blustery winter weather. Extremes in temperature are always followed by decreased egg production unless the flock is comfortably housed.

Choosing the Location of the Poultry House

Since the laying house is built on a permanent foundation and remains on its original location, careful consideration should be given to the selection of the site, especially its location with respect to other buildings on the farm. The house should be convenient to the other buildings, yet far enough away so that the birds will not be disturbed by other operations on the farm.

Exposure.—The poultry house should be built to face the south or southeast in order to permit the greatest amount of sunshine to enter the house. This exposure gives the birds the maximum length of day and the maximum amount of sun during the day, providing more healthful as well as more comfortable conditions. The factor of exposure is not of enough importance, however, to warrant facing the poultry houses to the south, if it makes them at an angle to the other buildings on the farm, and results in an awkward and unattractive appearance of the entire layout.

Drainage.—A location with the land sloping gradually away in every direction is ideal for the individual poultry house, although for the farm as a whole, a gradual southern slope is to be preferred.

When natural drainage carries the surface water away promptly, the danger of damp floors in the house is greatly reduced. Natural drainage away from the house can be secured in level country by hauling gravel or soil to make a small knoll where the laying house is to be built. Never build the laying houses in a low place where drainage collects from the surrounding territory.

Soil.—A light sandy or gravelly loam soil is to be preferred if the layers are given range. This type of soil dries off quickly following rains, does not accumulate filth on the surface, and yet grows good green crops, thus giving ideal range conditions.

If the layers are to be kept in confinement, the type of soil where the laying house is to be located is of little importance, so long as there is good surface drainage.

Wind Protection.—In selecting the site, always take advantage of any wind breaks that offer protection from prevailing winds. Winds play an important part in the heat loss from poultry houses, and anything that breaks the wind will help to make the house more comfortable during the winter.

Yards.—If the birds are to be given range, the house should be located so as to provide yards, both in the front and rear of the house. The yards do not need to be very large, as the birds will seldom consume the green food more than 150 feet from the laying house. When double yards are used, a more constant supply of green food can be grown by rotating the birds from one yard to the other; also, it is much easier to keep the ranges free from filth and contamination.

Future Developments Should Be Considered.—The site for the location of the house should be chosen very carefully in order to provide for future expansion of the business. One should always have in mind a mental picture of the complete layout. If the plant is likely to be enlarged, allow room for lengthening of the building or for the construction of additional houses in some systematic arrangement.

Fig. 1.—Aeroplane view of a well planned commercial egg farm in Ohio.

Essentials of Good Housing

Good housing includes everything which contributes to the comfort and health of the chicken, and the convenience and ease of the poultryman. A list of the requirements of good housing should include:

1. Protection from extremes in temperature (both high and low.)
2. Control of damp floors (also extremely dusty floors).
3. Proper control of ventilation and prevention of drafts.
4. Admission of large amount of direct sunlight.
5. Ample feeding space and water supply.
6. Properly installed artificial lights.
7. Selection of good building material and proper construction of foundation, floors, and roofs.

Each one of these factors is so important in the successful housing of the flock, that some discussion of each factor at this time is essential.

I.—*Protection from Extremes in Temperature*

This is unquestionably the most serious problem in poultry housing. While attention in the past has been largely centered on the problem of damp floors, poultrymen are beginning to realize that this problem can easily be controlled, whereas sudden variations and extremes in temperature are even more detrimental to high egg production, and also much harder to control.

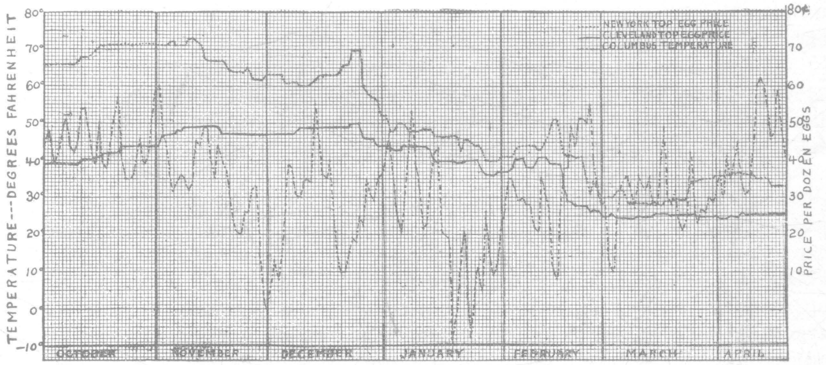


Fig. 2.—Lowest daily temperature at Columbus, Ohio, and daily price quotations for top grade of eggs on the Cleveland and New York markets, from October 1, 1929, to April 20, 1930, inclusive. This graph shows that the cold period during December was reflected in a temporary increase in egg prices on both markets. The general cold period during January was likewise reflected by a steadying of egg prices that were previously on a downward trend both in Cleveland and New York.

A line drawn across this chart at 10 degrees Fahrenheit or 10 degrees above zero, showing when the temperature was below this point, indicates the danger periods for high producing flocks, and the time when heat was especially needed in the laying houses. This chart indicates that heat was needed less than a total of three weeks during the past winter.

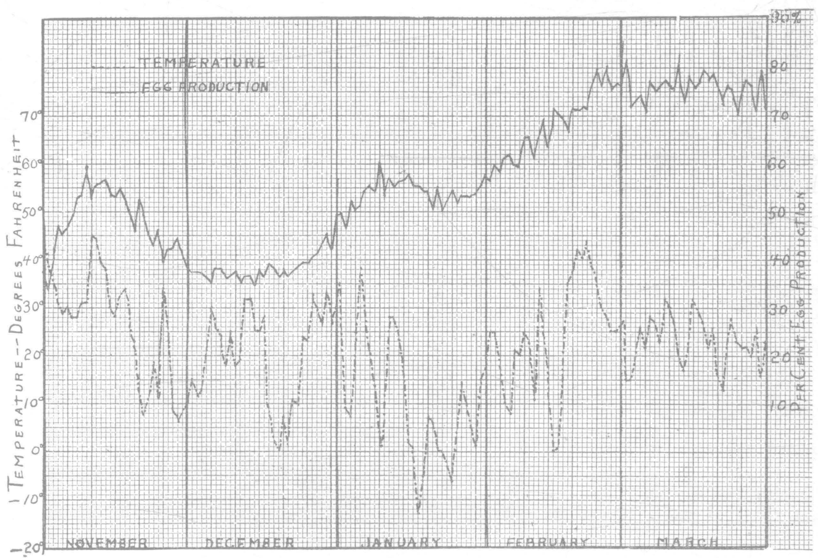


Fig.3.—Relation of lowest daily temperature at East Lansing, Mich., and daily egg production at the Michigan Egg Laying Contest, November, 1929, to March, 1930, inclusive. This graph shows that as the temperature went down during November, the egg production fell off, and that the cold spell during January was likewise followed by a slight decrease in egg production.

A careful analysis of egg production records in comparison with temperature charts shows that egg production is materially reduced by either extremely high or extremely low temperature. Many poultrymen can easily recall instances when the egg production of their flock was cut in half by a sudden drop in temperature from 40 or 50 degrees above zero to 15 or 20 degrees below zero.

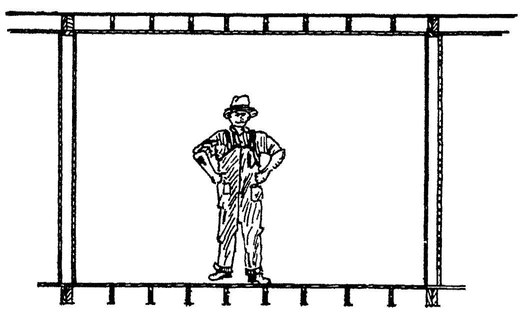
When markets are largely dependent on nearby sources for their high quality eggs, the decrease in production due to an extremely cold spell is often reflected in a temporary but substantial increase in the price of eggs.

The problem is not one of maintaining a constant temperature of say 60 degrees Fahrenheit, but is a problem of smoothing out the fluctuations of 30 to 50 degrees in 24 hours, so that temperature changes are not so violent, or rapid, and the birds are consequently able to adjust themselves to the changes.

Reasons for Difficulty in Maintaining Comfortable Temperature in Poultry Houses

1.—*Large Cubic Capacity*

Poultry houses are hard to keep at comfortable temperature, because of the large number of cubic feet of space contained in comparison to the size of the animal units housed. The early Ohio houses were criticized because they were extremely cold, but by twice reducing the height, so that at present the house is just high enough to permit the average man to stand erect in the lowest part (just in front of the dropping boards), the house has been made more comfortable during cold weather.



The house is still designed, however, for the convenience of the attendant rather than the comfort of the birds. If the poultry house was built on the same basis of relationship to the height of the birds as the rooms of our houses are to our height, we

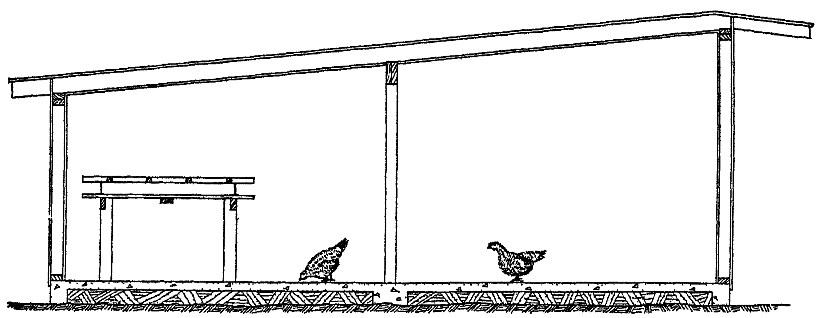


Fig. 4.—These illustrations show the relation of the height of the chicken to the height of the house, compared with the relation of the height of the average man to the height of the average room.

They also show graphically the large amount of air space in a chicken house in comparison to the size of the animal units housed.

would probably build our poultry houses about 30 inches high. Certainly, poultry houses of that height would not present a very complicated problem so far as maintaining a comfortable winter temperature is concerned. (See Fig. 4.)

2.—*Heat Losses Through Cracks and Openings*

Another reason for difficulty in controlling the temperature in poultry houses is caused by heat losses due to air passing into and out of the house. Every crack or crevice permitting air to pass out of the house also allows some heat to escape. Every time a door is opened, air passes out of the building, and with it some heat, particularly if there is a strong wind.

No building is ever airtight. In poultry houses, especially, there is a large amount of leakage through the walls, the windows, and other openings. The amount of this air leakage depends largely upon how well the building has been constructed and upon the type of construction.

Experiments have shown that there is enough leakage in the average residence to completely change the air in the rooms every hour. In poultry houses, where doors are frequently opened to the outside, or where the windows are loosely fitted and the construction is not especially tight, the air is probably changed at least three or four times an hour, depending on the wind velocity.

Since it is a very easy matter to supply fresh air and properly ventilate a poultry house by opening the windows, it is advisable to make the building as airtight as possible in order to conserve the greatest amount of heat during sub-zero weather, when it is most needed. It is an easy matter to get rid of surplus heat by opening the windows.

3.—*Effects of Conduction, Convection, and Radiation**

The problem of temperature control is further complicated by heat losses due to conduction, convection, and radiation, which may operate either separately or in combination, depending on conditions at the particular time.

Conduction.—In solid materials heat is transferred by a process known as conduction, the exact nature of which is not completely understood. The amount of heat conducted from one region to another is proportional to the temperature difference between the two regions in question. The ability to conduct heat varies widely among different materials, metals being, in general, far better heat conductors than non-metallic substances. It follows, therefore, that non-metallic materials are, in general, better insulators than metals. Gases, with two exceptions, are the poorest conductors of heat, but, as will be discussed later, heat transfer through gases is usually complicated by other factors besides conduction.

A simple illustration of the difference in conductivity of various materials can be had by placing an iron bar, a concrete block, and a stick of wood in the sun for some time. Obviously, all these things must soon be at the same temperature, since they are all under identically the same conditions. Yet if you touch them the iron bar will feel much hotter than the concrete block, and the concrete block will feel warmer than the wood. This apparent difference in temperature as judged by handling the different materials is accounted for by the difference in the conductivity of the different materials. Iron has a very high conductivity, and consequently transmits more heat units per minute than does wood, which has a very low conductivity.

Another very clear illustration of the transfer of heat by conduction, and also the difference in the conduction of heat by different materials, can be had

* Adapted from "Thermal Insulation of Buildings," Circular of Bureau of Standards, No. 376. United States Department of Commerce.

by heating the ends of a bar of iron and a stick of wood of the same length. The iron bar will soon become hot at the opposite end because it is a good conductor of heat, while the temperature of the opposite end of the piece of wood will show very little, if any, change in temperature because it is a poor conductor of heat.

Thermal conductivity is a property of the material itself, and does not depend on the size and shape of a particular piece of the material in question, provided the latter is of uniform structure. It is incorrect to speak of the conductivity of a wall or other structure; one should speak in terms of the conductivity of the materials of which the structure is composed.

The heat loss of a wall depends upon the conductivity, size, and arrangement of the materials of which the wall is composed. Heat loss through a single uniform material, as siding, is numerically equal to the conductivity of the material divided by the thickness of the wall. If the wall is composed of parallel layers of different materials, as siding plus insulating material, the heat loss through the wall can be calculated from the respective thicknesses of the layers and the conductivity of the materials composing them, less the reduction in loss brought about by a dead air space between the layers, as explained under "Convection" below.

Conduction plays an important part in the heat loss from poultry houses, especially those houses which are constructed with only a single thickness of siding and roofing boards, and which are not insulated. A very practical illustration of heat loss by conduction is provided by one of the long laying houses on the University plant. The two center pens in this house are insulated, while the end pens are uninsulated. In the winter the snow is often completely melted off the roof of the end pens when there is still four or five inches of snow on the roof of the center or insulated pens. The insulation reduces the conduction of heat through the ceilings, consequently the snow melts much slower. The rapid heat loss by conduction through the ceiling of the uninsulated pens accounts for the rapid melting of the snow and frost on the roof over those pens.

Heat which passes through the siding and roofing material by conduction is quickly taken away from the outside of the house by means of convection and radiation. The amount of heat lost by conduction can be greatly reduced by lining the inside of the building with a good insulating material.

Convection.—The transfer of heat in air is usually complicated by other factors besides conduction. Conduction is always present, but the heat transfer is ordinarily greatly increased by air motion, called convection, set up either automatically by reason of temperature differences or by means of the wind blowing. The former is called natural or free convection and the latter forced convection. The exchange of heat between the air in the poultry house and the *inside* surface of the wall of an uninsulated house is one of the simplest examples of natural convection. The air, on giving up its heat, increases in density and falls, giving place to warmer air from above and producing a continuous downward current.

The heat loss from the *outside* wall of the house to the outside air on a windy day is a familiar example of forced convection. An increase in the velocity of the wind produces a more frequent renewal of the layer of air in contact with the poultry house and increases the rate of heat transmission.

Air in motion makes for rapid transfer of heat due to convection; dead air, or air in a space where there is absolutely no motion, provides the *greatest possible insulation.* Placing the insulating material on the studs or rafters, as shown in the floor plans of the laying houses, makes a dead air space between the siding and the insulating material, and thus reduces heat loss because it reduces convection of heat from the insulation to the siding. The insulating material, too, absorbs heat much more slowly than does siding.

Radiation.—Everybody is familiar with the radiation of heat from an open fire, but it is not so generally recognized that radiation plays an important role in heat transfer at ordinary temperatures. Partition walls and all objects in a heated poultry house, for instance, radiate heat.

Some substances are transparent to heat rays and others absorb them. Air is almost perfectly transparent to radiant heat, while such materials as wood, hair, felt, and mineral wool—substances commonly used in insulating materials—are almost perfectly opaque to it.

However, heat radiated from objects within the house to the surface of the inside walls of the poultry house may be readily lost through the walls by means of conduction, unless the house is lined with a good insulating material, which, as explained above, is a poor conductor of heat.

Methods of Maintaining Comfortable and Even Temperature in Poultry Houses

High egg production during the winter is the goal of every poultryman, but it is impossible to maintain such production unless the flock is comfortably housed. The importance of controlling wide fluctuations and exceedingly low temperature in the poultry house during the winter cannot be over-emphasized. Every experienced poultryman appreciates the tremendous influence that temperature plays on the activity and feed consumption of the flock.

Some make the mistake of trying to maintain average room temperature of about 70° Fahrenheit in the poultry house. This is not necessary, however, for success with poultry. There is no need for worry when the house can be kept at a temperature which prevents freezing of the drinking water.

With Ohio conditions it is possible to maintain such conditions by two methods: first, by insulation of the laying house and restriction of ventilation, and second, by the use of artificial heat during very cold weather.

1.—*Control of Temperature by Insulation*

The insulation of poultry houses consists of lining the inside of the building with some good insulating material such as the commercial insulating materials, or with sheathing, in which case it is advisable to fill the spaces between the rafters and studding with sawdust, shavings, cut straw, or fine peat moss litter. The various types of construction for the walls, ceiling, and openings, and the relative amount of heat loss through each type, will be discussed on following pages.

In order to make the insulation of a building effective in the control of temperature, it is necessary to make the building tight so as to prevent air leaks around the windows and doors and through cracks, and to construct it so that the amount of ventilation can easily be controlled.

Ventilation Is Necessary.—The problems of ventilating the poultry house to maintain comfortable temperature and to control dampness are radically different; since temperature control is the more important problem, it will be considered first. Methods of correcting dampness in poultry houses are discussed on pages 18 to 23.

Poultrymen usually feel that the birds need a large amount of fresh air, but while their need is large, the supply will be ample even in a tightly closed house during zero or sub-zero weather. Experiments have shown that the air in the average residence is changed at least once every hour, even though the doors and windows are tightly closed. With the average construction found in poultry houses it is safe to assume that the air is changed at least three or four times an hour when the house is closed during zero weather.

The condition which influences the rate of change of air in a closed poultry house is the difference in temperature between the inside and outside of the house.

The whole problem of ventilating the poultry house to maintain a comfortable temperature may be summarized by saying that the windows should be kept open as much as is possible, and yet maintain a temperature high enough to prevent freezing of the water in the house. When this procedure is followed there is no need to worry about the birds not having sufficient fresh air.

In considering the construction of a poultry house it is important to consider the different types of construction from the standpoint of the amount of heat loss through them, so that available materials may be selected on this basis as well as the comparative price basis.

Heat Loss Through Different Types of Wall Construction.—Fig. 5 shows the relative amount of heat loss through various types of wall construction commonly used in poultry houses.

Walls with a single thickness of siding show the greatest heat loss, but by lining a building of this type of construction with any of the materials commonly used in lining poultry houses, the heat loss is reduced by more than one-half. *Additional thicknesses of either sheathing or insulating materials give very little added advantage unless separated by an air space,* as is shown by the small decrease in heat loss where both drop siding and sheathing were used on the outside and insulation board on the inside, in comparison to a single thickness of drop siding on the outside and insulation on the inside.

The type of construction showing the least amount of heat loss, and consequently one of the most desirable types of construction, is the use of ordinary drop siding on the outside and sheathing on the inside, with the spaces between the studs filled with sawdust, shavings, cut straw or peat moss litter.

The commonly used forms of masonry construction on which data are now available, show a relatively large amount of heat loss. The plans in this bulletin, therefore, recommend the use of insulating materials on the inside of masonry constructed houses. This insulation is much more effective when the building is constructed with an air space between the inside wall and the insulating material, than when the insulating material is placed directly against the inner walls of the building.

Heat Loss Through Different Types of Ceiling Construction.—Fig. 6 shows clearly how the heat loss through the roof is reduced by insulation. The insulation of the roof is especially significant because the warm air in a building rises to the ceiling and the greatest amount of heat loss in the building takes place at that point.

Heat Loss Through Different Types of Floor Construction.—Although the heat loss through flooring materials is very high, the actual heat loss through poultry house floors is not a very significant factor.

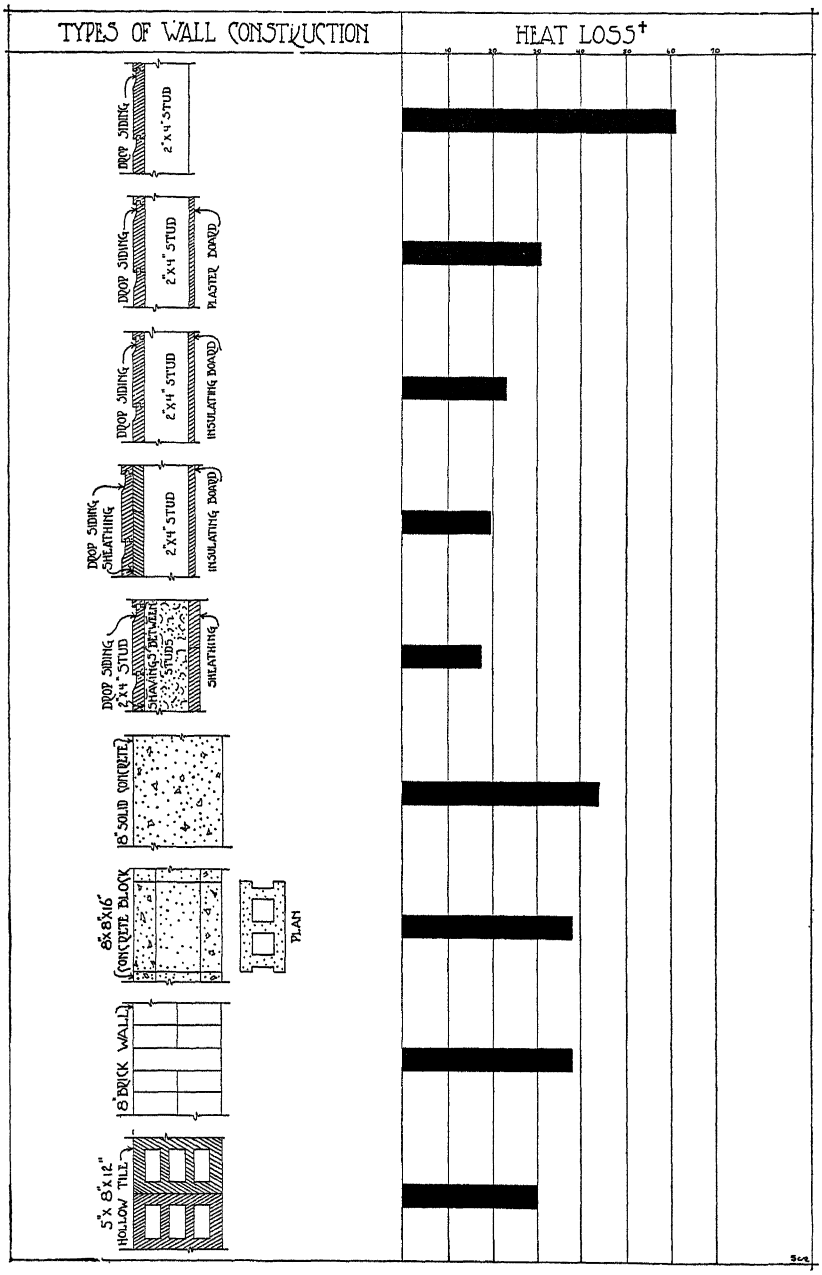


Fig. 5.—This chart shows graphically the relative amount of heat loss which occurs through different types of wall construction commonly used in poultry houses.

The use of sheathing on the inside of the studs, with the spaces between the studs filled with shavings, as shown above, provides one of the best methods of practical insulation for poultry houses.

With floors constructed of wood there is a greater heat loss when the building is set on posts than when it is built on a solid foundation wall. The temperature of the air under a building constructed on a wall will not change as rapidly as the outside temperature, because the heat does not escape as easily due to the walls.

The heat loss through concrete is relatively great (see Fig. 6), but floors constructed of concrete laid directly on tar paper on the earth do not allow much heat to escape because the ground underneath a concrete floor does not freeze in this section of the country. The temperature of the ground under a poultry house remains around 40° to 45° F. throughout the winter. In the winter the concrete floor, as a result of its great conduction of heat, may actually help to raise the temperature of the house in zero or sub-zero weather.

Floor are further eliminated as an important factor in heat loss from poultry houses by virtue of the fact that they are usually covered with a layer of litter, which acts as an insulator.

Heat Loss Through Different Types of Window and Door Construction.— The most serious heat loss in relation to the area exposed is through the windows. The amount of heat lost in this way is about twice as great as the amount of heat lost through an equal area of uninsulated roof (see Fig. 6.)

Heat loss through the back windows in the poultry house can be reduced to less than half by fitting the building with double windows or storm sash during the winter months. Since the back windows are not removed during the winter, the double windows in the back cause no inconvenience.

The front windows can either be provided with storm sash or double windows for use during zero or sub-zero weather, or a door can be made of a sheet of insulating board which can be dropped down over the windows during the night to reduce the heat loss. Either of these means will prove a great benefit in helping to maintain the temperature of the house above freezing during extremely cold weather. The heat loss through the doors can also be reduced if they are covered on the inside with a layer of insulating material.

*Value of Different Insulating Materials.**—Although air is a poor conductor of heat, its insulating value is small, because of the transfer of the heated air by convection and radiation. This fact should constantly be kept in mind when building the poultry house. To obtain the maximum amount of insulation, both the siding and the insulating material must be airtight. If there are any cracks left either in outside wall or insulating material, the value of the dead air spaces between studding and rafters is lost—in fact, the air is no longer "dead," but in motion, and air movement means heat loss. To get full return for the increased expenditure of insulating the house, this important principle should not be lost sight of.

A good insulating material is one having a large percentage of relatively small spaces containing air. Little convection can take place within such a material, and the solid portions effectively screen off the radiation so that the low conductivity of air is utilized to a greater extent than in an air space.

*Investigation has shown that the differences in the respective insulating values of various light fibrous or cellular materials are not very great. Of such materials less than 1½ inches of the poorest materials is equivalent in insulating value to 1 inch of the best.

Commercial insulating materials can be divided into two general groups: (1) fibrous materials, either in loose form or fabricated into soft flexible quilts

* Adapted from Circular 376 of the Bureau of Standards.

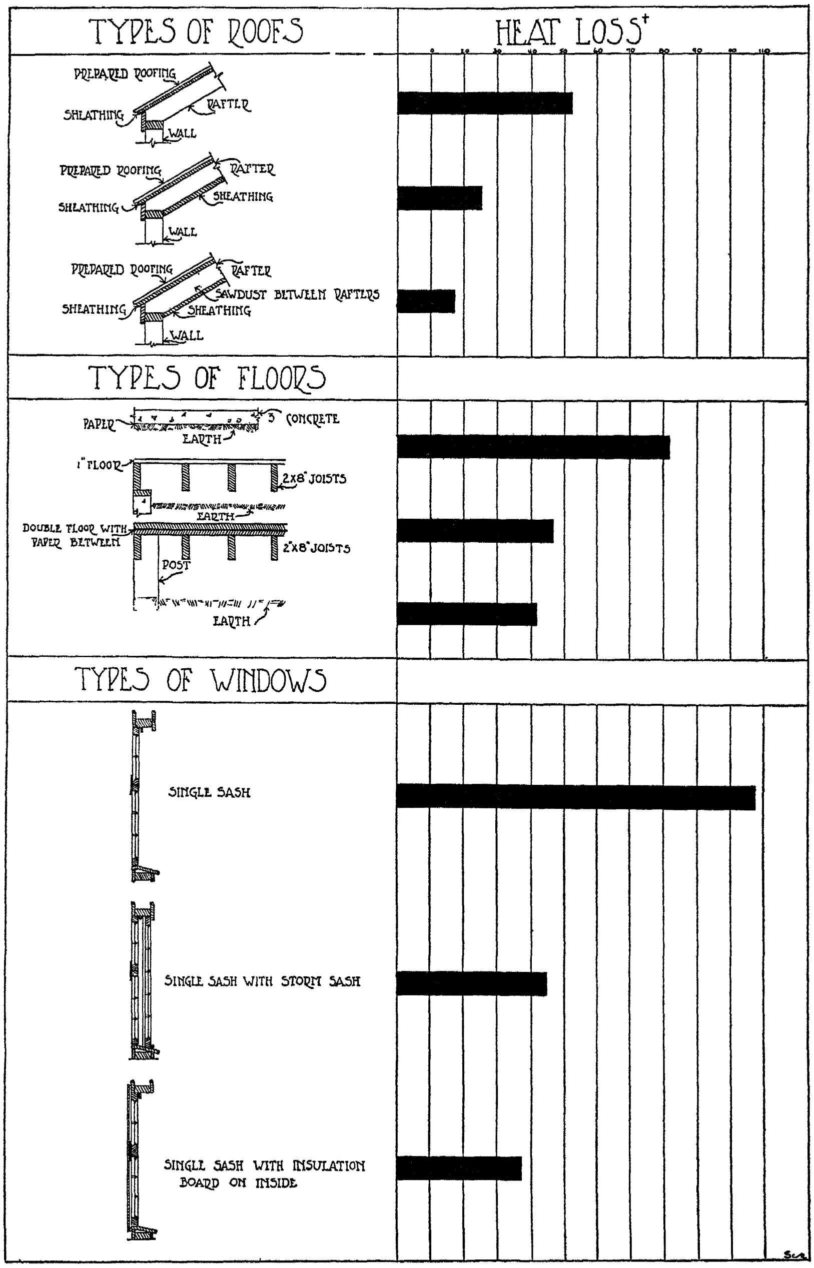
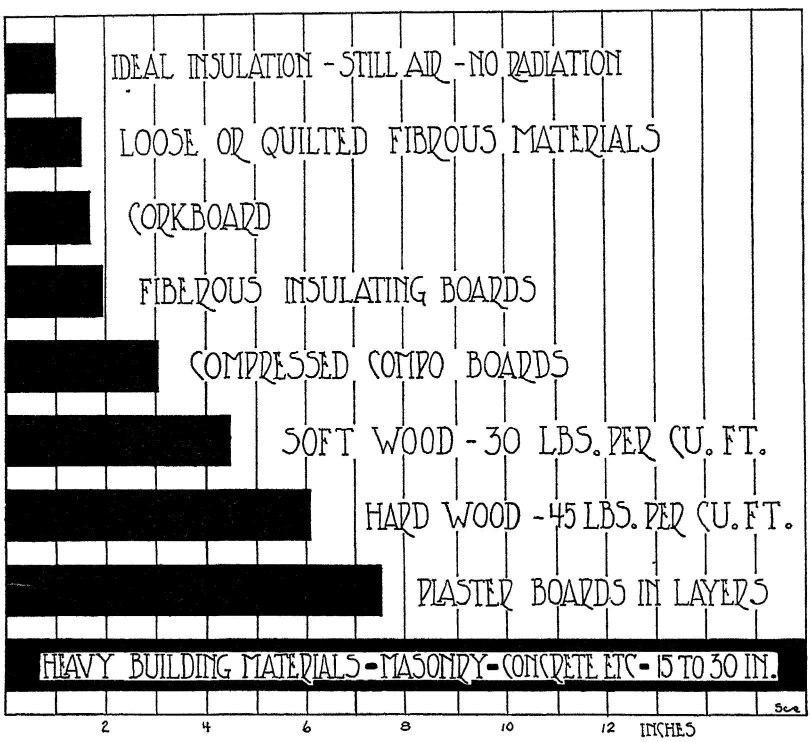


Fig. 6.—This chart shows graphically the relative amount of heat loss through different types of ceiling or roof construction, through floors, and through different window arrangements.

confined between relatively thin layers of paper or textile; and (2) more or less rigid boards in which the components are bonded together in some way. The differences in the respective insulating values of materials within each group are usually so small that the average purchaser can neglect them. In general, the lighter the material per unit total volume the better its insulating value per inch of thickness. Stiff, fibrous insulating boards having considerable structural strength are somewhat poorer insulators than lighter and looser materials. Dense, highly compressed wall boards made of wood or other organic fiber are not as good insulators as less compressed boards of the same general character. Heavy wall boards containing plaster in one form or another are relatively poor insulators, although they are very useful building materials and, like building paper, may be valuable in reducing infiltration of air through an otherwise porous wall.

Figure 7 shows the thickness of various materials having equivalent insulating values. The horizontal scale gives approximately the thickness in inches of various insulating materials required to furnish insulation equivalent to



THICKNESS REQUIRED TO EQUAL ONE INCH IDEAL INSULATION

Fig. 7.—This chart shows the thickness of various materials having equivalent heat insulating values. The horizontal scale gives approximately the thickness in inches required to furnish insulation equivalent to 1 inch of the best possible practical insulation, called ideal in the figure.

This chart also indicates that it takes 6 inches of hard wood to equal 2 inches of fibrous insulating board in insulating value; in other words, that insulating board has the same insulating value as three times its thickness of hard wood.

1 inch of the best possible practical insulation, called ideal in the chart—which is "still air, no radiation." It must be kept in mind, however, that the insulating value of air alone cannot be completely utilized in practice because of convection and radiation.

The use of insulation in poultry houses, besides helping to control the temperature has another advantage in that it largely prevents condensation of moisture on the inside surfaces of the ceiling and walls. This effect will be discussed further under the subject of moisture control, pages 18 to 23.

Protection of Insulating Material.—There has been considerable criticism of some of the insulating materials used in poultry houses because of the fact that the chickens eat the material. Several methods of preventing this have been found practicable. They are as follows:

(a) One of the manufacturers of insulating material recommends covering, with a gray cement paint, that section of the poultry house which the birds can reach. This paint is made by mixing equal parts (by volume) of Portland cement and fine, clean, sifted sand which is free from loam; add sour milk until a thick paint consistency is obtained. Do not use any water in the mix. Experience has shown that it is better to mix only small quantities of the paint at a time. Use one-half pail of material and stir it frequently when using to keep the heavier particles from settling to the bottom. Two coats of this paint should be used. Approximately 12 pounds of Portland cement, 12 pounds of sand, and 1 gallon of sour skimmilk will be required to cover with two coats a surface of 80 square feet. This method is somewhat cheaper than those suggested below.

(b) Paint the insulating material to a sufficient height with several coats of a heavy tar paint.

(c) Plaster the insulating material with ordinary plaster.

(d) Use tight tongue-and-groove boards on the parts of the building where the birds can reach, and insulating material on the rest of the building.

2.—*Control of Temperature by the Use of Artificial Heat*

The use of artificial heat in the poultry house during the winter months is for the sole purpose of keeping the flock healthy and free from colds, so that maximum mash consumption and normal egg production may be maintained. To achieve this end, it is not necessary to heat the house to room temperature; keeping the house warm enough so that the water will not freeze is sufficient. The sudden wide fluctuations and extremely low temperatures that occur during winter time invariably are followed by a drop in egg production in the average flock housed without artificial heat.

The use of artificial heat also makes it possible to provide more ventilation in the house, which is probably an advantage to the birds.

Brooder Stoves.—Some poultrymen use ordinary brooder stoves for heating poultry houses, fitting a strip of hardware cloth screen around the edge of the hover to keep the litter away from the stove. Others put the brooder stove inside of a metal box provided with openings at top and bottom, which permit the air to circulate around the brooder stove. The heated air passes out of the openings at the top of the box and the cold air comes in openings at the bottom. In other words, putting the brooder stove in a metal box provides a heating arrangement similar to the common type of heatrola used in many farm residences. This method of heating tends to raise the temperature

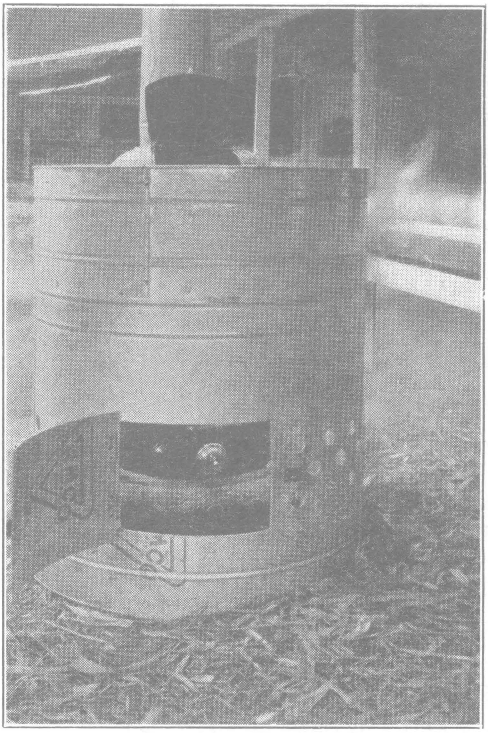


Fig. 8.—An ordinary heating stove with a metal jacket around it proves very satisfactory.

of the entire house, whereas the brooder stove alone with a wire screen around it provides maximum heat near the stove and only takes the chill off the far corners of house.

Hot Water Pipes in Concrete Floor.—There are several elaborate heating plants on the market for poultry houses which are very satisfactory, but many of the most successful plants in Ohio have been made by poultrymen. Some poultrymen have heated their houses by placing hot water heating pipes in the floor, thereby controlling two problems in poultry housing—first, the damp-floor problem, and second, the temperature problem. When the pipes are placed in the floor the heat is put in the most effective place in the house, and the floor is kept warm, thus preventing the moisture in the air from condensing on the floor.

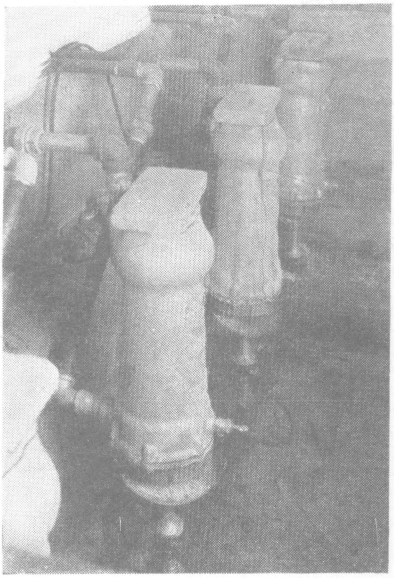


Fig. 9.—Small gas burners are used to heat the water for the heating system.

Some poultrymen have objected to placing the heating pipes in the cement floor because of the fear that the expansion and contraction of the pipes due to changes in the temperature of the water in them, will result in cracking the floors. If there is ¾ inch or more of cement over the pipes, observations of houses heated in this manner on farms in Ohio and also at the University poultry plant, do not bear out this contention. There is, however, a decided disadvantage in having the heating pipes in the concrete, if the pipes should develop leaks; but if the pipes are properly put together there is little danger of their leaking.

This method of heating the house is achieved by placing in the concrete floor 1¼-inch pipes lengthwise of the house at intervals of 30 inches. The pipes should be covered with about ¾ inch of cement. In new houses the floors should be given a pitch of 1 inch in 10 feet, with the high point at the end opposite the location of the boilers. This pitch is sufficient to get proper circulation of the heated water through the pipes.

Where this system of heating is installed in an old poultry house in which the floors are level, the best method is to place the pipes level on the floor and install a small electric pump to circulate the water. The cost of maintaining a pump for this purpose is insignificant. In placing the pipes on the floor of an old house they can be left exposed on top of the floor, but will be unhandy to clean around. If desired, the space between the pipes can be filled with sand and another layer of 1 inch of cement can be placed over the pipes and sand, on top of the original floor.

Hot Water Pipes in Board Floors.—Where such a heating system is installed in a house with a board floor it is advisable to notch the floor joist

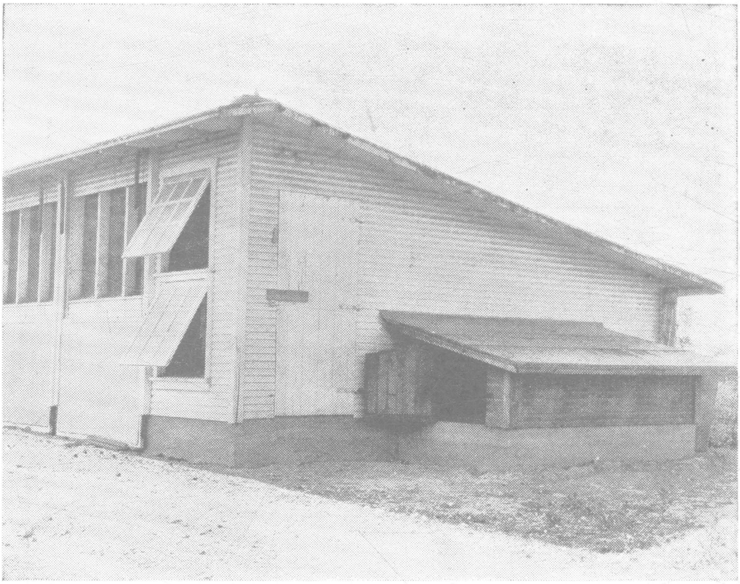


Fig. 10.—A small addition to the house, similar to this, is all that is necessary to house the heating unit for a poultry house. Fig. 9 shows the heating unit.

so that the pipes will be directly below the floor boards. It is also advisable to bank the foundation both inside and outside with dirt to prevent heat loss through the foundation.

Other Installations of Pipes.—There are other installations of hot water heating plants where the pipes are placed directly against the back wall of the building, and still others where the heating pipes are placed under the dropping boards. These installations have the advantage of being readily accessible in case there is any need for repairs. They supply heat to the house satisfactorily, but are not as efficient in helping to maintain dry floors as are the pipes placed in the floor.

One system of heating is as satisfactory as another. The type chosen should be on the basis of cost, ease of operation, and economy of operation and maintenance.

II.—*Control of Damp Floors*

Damp floors are considered by many to be the most serious problem in the winter management of poultry on Ohio farms. However, no one has yet shown that chickens cannot be kept on damp litter if other conditions are correct; in fact, some experiments carried on at one of the state experiment stations indicates that the control of extreme temperature fluctuations is of more importance than the control of damp floors in securing a high egg yield and maintaining the health of the flock.

But, since damp floors are considered such a serious problem, it is important to study all the factors which bring about the condition.

1. *Surface Drainage an Important Factor.*—Surface drainage frequently is the cause of damp floors. If the house is built on the side hill, a fairly deep ditch should be dug across the back to carry off the water. It should extend several feet on either side of the house, and be placed at least four or five feet from the rear wall, to carry the water around the ends of the house. If the

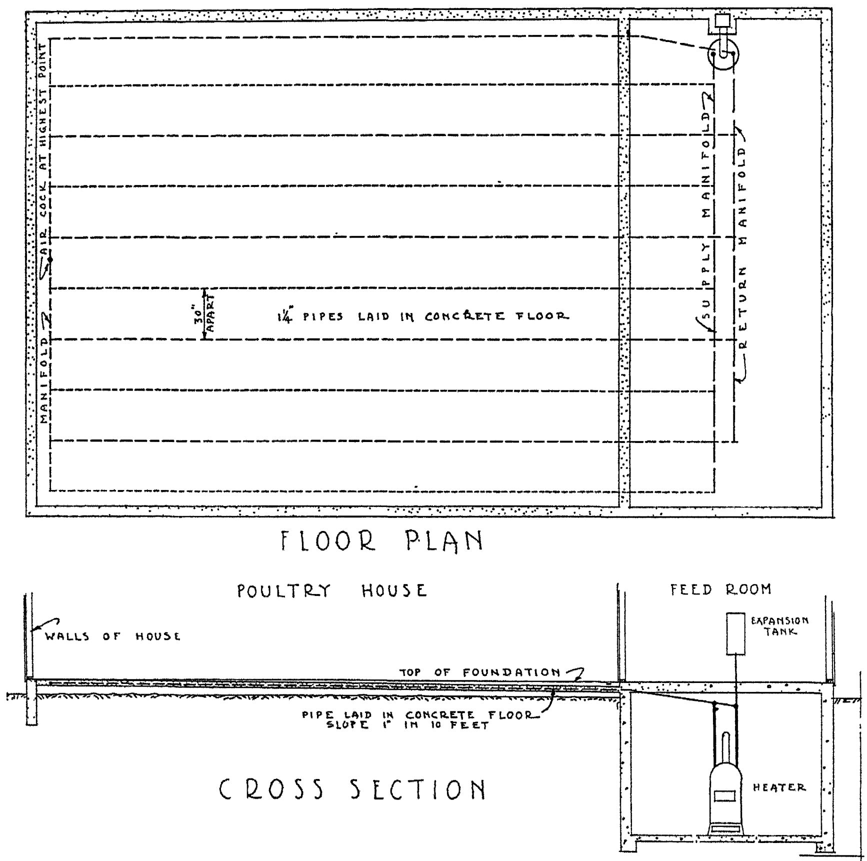


Fig. 11.—Poultry house with heated floor. The diagram shows how hot water pipes are placed the length of the house at 30-inch intervals. The floor is laid with 1-inch pitch to every 10-foot length to insure proper circulation of the water. The low end of the floor is at the heater.

house is too long for this to work well, large tile can be placed under the house as frequently as necessary to carry the water away.

In level country the foundation should be filled in with dirt or other material to bring the inside level at least four to six inches higher than the outside level before the concrete floor is laid.

If spouting is placed on the rear of the house to carry the roof water away, much water will be kept from seeping down the rear foundation, and the surface drainage problem thus greatly reduced.

2. *The Type of Feed Used.*—Feed has some influence on the amount of water consumed. Last winter in the feeding experiments at the University farm it was necessary to change the litter much more frequently in the pens where the birds were fed the all-mash ration than in the pens where the birds received a similar ration in the form of unground grain and meat-scrap. Records kept on two pens containing the same number of birds for a period of one week showed the following results:

	Total water consumed for a week	Total egg production for the week
Pen No. 7—All-Mash ration	509.5 pounds	302
Pen No. 8—Unground Grain and Meat-Scrap ration	302	296

(This comparison is not given as the basis for any conclusion on the efficiency of either system of feeding, but merely to point out a basic factor involved in controlling dampness in poultry houses.)

Any practice which increases the water consumption of a flock of hens, increases the problem of moisture control in the house.

3. *Leaks in the Roof.*—Leaks are a very common cause of damp floors. Unfortunately, roofs don't leak except when it rains and it is an easy matter to neglect fixing them until the next rain impresses the need. Leaky roofs should be repaired promptly, not only because of the resulting dampness, but because the type of lumber used in the average poultry house will soon rot out if allowed to remain wet.

Repairing Leaky Roofs.—Leaky roofs usually result from the improper construction of the original roof. With a roof that has as little pitch as the average poultry house, it is almost necessary to use a composition roll roofing or a built-up type of roof.

Ninety per cent of the trouble experienced with composition roll roofing comes from the fact that not enough attention is given to the way it is nailed down. If the roof is nailed in the cracks between boards, or in the tongue-and-groove of boards, the nails are not tight and the water seeps in around the nail head. With frequent freezing and thawing, the nail is soon raised up and a leak develops.

Careful attention should be exercised when the roof is laid, to see that all the nailing is done near the center of the boards. The nails should be driven down tight so that there is no possibility of the water seeping in around the nail head. It is for this reason that many prefer to use a smooth surfaced paper rather than one which contains some gravel, as they claim that the gravel will not permit the nail heads to sink into the paper and so make a water tight joint around the nail head.

On rainy days, the house should be marked on the inside to show the position of the leaks. Afterwards, when the roof has dried off, the parts of the seams which are leaking should be painted with a hot asphalt lap cement. A strip about 6 inches wide should be painted along the seam; this should be covered with a strip of muslin of equal width and the muslin painted again with the hot asphalt lap cement. Before doing this, however, it is wise to go over that section of the roof and see that all the nails are driven in tight. If they are, this method of repairing will keep the nails down.

The life of composition roofs can be greatly lengthened by regularly painting the entire roof with a hot asphalt cement. This should be done at least every three years.

4. *Condensation of Moisture From the Air.*—This is the common cause of a large amount of the moisture in the litter of poultry houses during the winter months. The moisture condenses on the floor, walls, and ceiling of the house because they are colder than the air inside the house. This is especially true of the uninsulated houses, where the inside of the building is almost as cold as the air outside of the building. In insulated houses the inside wall of the building is more nearly the temperature of the air inside the house, and relatively little condensation takes place, except on the windows and the floor.

Condensation is usually greater when the house is tightly closed and becomes warm, or when it gets warm following a cold spell and the air warms faster than the building. This means that in tightly closing the insulated house during zero weather to conserve the heat and control the temperature problem, we actually increase the condensation and our problem of damp floors.

Damp floors can be controlled, however, while the problem of extremely cold temperature can only be solved either by closing the house or installing artificial heat.

5. *Slopping of Water by the Birds when Drinking.*—This often causes the very damp condition found around the drinking fountains. Many poultrymen use a wide solid platform for the water fountain, which allows the birds to stand far enough from the pail so that the water drips from their beaks and wattles to the platform. The birds then track in this water and carry it into the litter. This cause of dampness in the poultry house can be controlled by using a narrow perch around the fountain or pail, close enough to it so that the water as it drips from the beaks will drop back into the pail.

6. *Carelessness in Filling Fountains.*—Some operators, when watering the birds and filling the fountains, fill them to overflowing, and thus cause much of the dampness in some houses.

7. *Snow and Rain Blowing into the House.*—This is another common cause of dampness during certain seasons of the year. The overhang on the front of the house is for the purpose of reducing trouble from this source, but care must be exercised when building the house to make the windows tight enough to keep out the rain and snow.

8. *Number of Hens in the Pen.*—The number of birds using fountains has a very direct influence on the amount of water consumed. Therefore, the fewer square feet of floor space allowed per bird or the larger the number of birds placed in the house, the more important the moisture problem becomes.

9. *Egg Production of the Flock.*—Egg production is one of the most important factors influencing the water consumption per bird. Since eggs are composed largely of water, a difference of 20 or 30 per cent in production results in a big difference in the amount of water consumed by the flock.

Every poultryman realizes that the problem of keeping the litter dry in a pen of old hens during the winter is a very simple one, compared to the problem of keeping the litter dry in a pen of high producing pullets. Old hens normally do not lay very heavily during the winter months, and consequently consume a small quantity of water in comparison with the pullets, which should be in heavy production at that season of the year.

10. *Ingredients in the Ration.*—These have some influence on the water consumption of the flock. Salt is one ingredient in the ration which when slightly changed greatly influences the water consumption of the flock. Molasses is another ingredient sometimes used in the poultry ration that has a very decided influence on the water consumption. In feeding experiments conducted at the University farm it was found that as the percentage of molasses was increased, the water consumption of the flock was likewise increased.

11. *Capillary Rise of Water Through the Floor.*—This is generally thought to be the most important cause of damp floors. Such conclusion is unquestionably erroneous, for with a concrete floor properly constructed and of good material, there is little danger of water coming up through the floor. A layer of tarred paper put under the floor further eliminates any possibility of trouble from dampness due to capillary rise of moisture.

Some housing experts have recommended the use of hollow tile under concrete floors to insulate the concrete from the heat of the earth during subzero weather, in order to permit the concrete to readily change its temperature with changes in atmospheric temperature, so that condensation would not occur on the floor.

However, houses on the University farm constructed with a layer of tile under the concrete floors have been just as troublesome so far as dampness is concerned as floors constructed on a layer of tar paper laid directly on the earth.

METHODS OF CONTROLLING DAMPNESS IN POULTRY HOUSES

The first step in the control of dampness in the litter is, of course, to eliminate the cause, if possible. There are some causes, however, which we do not wish to eliminate, such as dampness caused by the large water consumption accompanying high egg production, or dampness caused by natural condensation.

There are in general, three main ways of controlling the moisture problem.

1. *Cleaning and Changing Litter Frequently.*—Many poultrymen seem to think they should be able to get along for a month or two without cleaning their poultry houses. They do not object to cleaning the horse or cow stables daily or oftener, and might just as well get accustomed to changing the litter in the poultry house every week or ten days during the winter season.

The problem of changing the litter in a poultry house is not so serious when the litter on the floor is only two or three inches deep. There seems to be no justification for using ten to twelve inches of litter, as many poultrymen have done in the past, and it presents quite a labor problem when the house must be cleaned.

Solving the damp floor by frequently cleaning the house may add to the cost of operation through increasing the cost of litter and labor, but the better results secured will more than return this added cost.

2. *Ample Ventilation.*—A large amount of the dampness in poultry houses can be eliminated by ventilation. But, if sufficient ventilation is provided during cold weather to keep the house dry, the house will be too

cold. Experiences at the University poultry plant, coupled with the experiences of many poultrymen throughout Ohio, prove that it is more important to keep the house warm during cold weather than it is to keep it dry.

However, it is doubtful if a ventilating system can be devised which will keep the poultry house dry when birds are in heavy production, and at the same time keep it warm during zero weather, without the use of artificial heat.

Ventilation helps to control the moisture problem by virtue of the fact that air expands when heated, and as it expands its moisture carrying capacity is increased. Consequently, when cold air is brought into the house and heated, it can carry out more moisture than it brought in, even though it might be moisture laden at the temperature at which it is brought into the house. If sufficient air is taken through the house to carry out all the moisture expelled by a flock in high egg production, the temperature inside the house will be practically the same as the outside temperature. Artificial heat seems to be the solution to the problem.

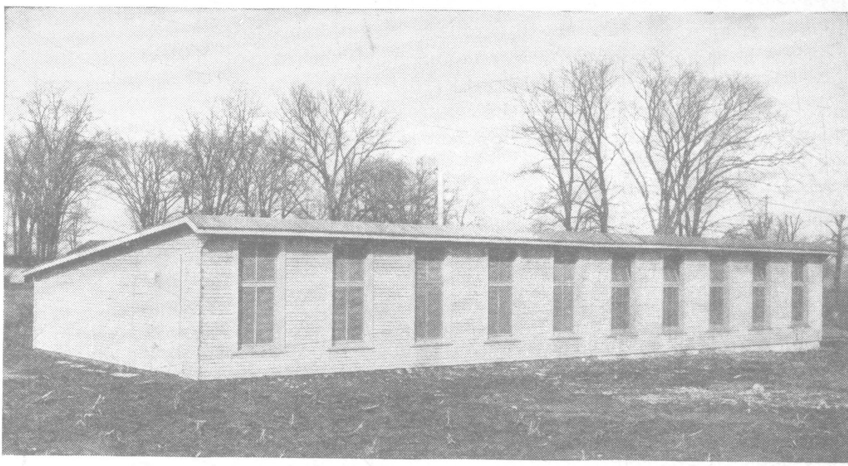


Fig. 12.—The new insulated Ohio type poultry house.

The windows should always be opened during the daytime when the sun shines, or at any time when the temperature inside is above freezing, as ventilating in this manner will help to control the moisture problem. The amount the windows are opened, therefore, depends on the temperature inside the house; a good policy is to open the house as much as possible and yet maintain an inside temperature above freezing. This probably means that in zero weather it will be necessary to close the house up tight.

3. *Artificial Heat.*—The value of artificial heat to control the temperature problem in poultry housing is easily appreciated, but its value in helping to overcome the moisture problem is often overlooked.

Aside from the direct drying effect of the heat itself, perhaps the most valuable part that it plays in moisture control is that it raises the temperature, and consequently the moisture carrying capacity of the air passing through the house; also, by raising the temperature in the house it increases the amount of ventilation that it is possible to supply and yet maintain a comfortable temperature.

In unheated houses it is necessary to close them up tight during zero weather to maintain a comfortable temperature, which results in an accumulation of moisture. The use of heat during such weather means that the house can be kept comfortable and yet have the windows open a little, permitting the normal loss of moisture through ventilation.

The matter of different types of heating systems has already been discussed on pages 15 to 17, but it might well be emphasized again that the installation of heat in the floor of the poultry house keeps the floor at a higher temperature than the air in the house, and consequently prevents condensation of moisture on the floor.

III.—*Proper Control of Ventilation and Prevention of Drafts*

The purpose of ventilation is at least three-fold: (1) to supply the oxygen requirement of the birds; (2) to carry off the moisture in the house; (3) to keep the birds comfortable.

The success of any ventilation system, therefore, depends on its effectiveness in producing a movement of air which will be sufficient to supply the proper amount of oxygen to the birds, keep the litter dry, remove objectionable odors, afford satisfactory dilution of air, and at the same time maintain a comfortable temperature in the house. This is, perhaps, more than any present system of ventilation can perform perfectly without the use of artificial heat, but sets the ideal toward which we must work.

Results of Federal Experiments

Investigation of the problem of ventilation of farm buildings by the United States Department of Agriculture has led to the following conclusions, which have materially affected the designing of dairy barns and should have some effect on the designing of poultry houses.*

1. Since the amount of heat given off and the ventilation requirements of different animals vary, the animal unit must be considered in the design of a ventilation system.

2. Carbon dioxide as ordinarily encountered in stable air does not settle to the floor. The evil effects of bad ventilation are not caused by carbon dioxide as found in the average stable.

3. There must be a constant removal of moisture from the occupied stable or the amount of moisture in the air will increase. Damp walls may be due to improper ventilation, poor construction, insufficient production of heat, or lack of conservation of heat.

4. A large volume of air space per head is not a substitute for ventilation, as purity of air is not dependent upon volume of air space. However, the volume allowance per head is important with regard to maintenance of stable temperature and varies according to climatic conditions.

5. Insulation requirements vary according to the temperatures to be expected in the different sections, amount of air space which the animal must heat, the amount of ventilation desired, and the method of securing it. The amount and choice of insulating material required will depend upon the relative efficiency and cost of the various materials available. Tight construction to prevent excessive leakage of air is essential to effective insulation.

6. Whenever barn walls are tightly built to save heat, ventilation becomes necessary. Storm sash, storm doors, vestibules, and feed rooms may be used as effective forms of protection against cold.

7. It is possible to maintain a comfortable temperature in a well built barn and yet have an appreciable circulation of air. The temperature in a stable filled with stock can be controlled by temporarily or partly closing the

* Ventilation of Farm Barns. Technical Bulletin 187, United States Dept. Agriculture.

ventilation system. Stable temperatures within certain limits appear to affect both the quantity and quality of milk.

8. Wind velocity and direction have an effect upon the amount of ventilation.

9. Back drafting may be due to poor design or poor position of ventilator or intake.

10. Outtakes near the floor are more favorable to the maintenance of desirable stable temperature than ceiling openings.

11. Under average conditions, outside temperature is usually the dominant factor in barn ventilation.

12. The moisture content of the air in a well built stable is usually controlled by the amount of ventilation.

13. Horizontal runs and abrupt turns in outtake flues should be avoided. An airtight flue with proper insulation is necessary to greatest efficiency. Lack of insulation may cause excessive drip from flues. This factor should be given consideration especially in the northern zone.

14. The bases of ventilator heads should be equipped with suitable doors, which may be opened or closed as required. The efficiency of an outtake flue is affected by an open base.

15. Windows as intakes require frequent adjustment and prevent uniform regulation of the ventilation. Their use for such purpose is undesirable in cold sections. However, during mild weather they are an advantage as they provide a large area of opening.

16. Warm air furnace registers are unsuitable for use as intake valves in barn ventilation.

17. Open hay chutes interfere with ventilation, and should not be used as foul air shafts.

18. Flue sizes proportioned to local temperatures may be obtained by a formula that has been developed as a result of these tests.

Animal Heat of Poultry a Factor in Ventilation

The heat given off by chickens must be employed in maintaining the poultry house temperature and also as the motive power in producing circulation of air. While good ventilation of pure air is the chief aim of any ventilation system, the comfort of the chickens must also be considered. An insulated poultry house cannot be kept warm if the allowance of air space per chicken is too great, as is the case with an extremely high house, or if the house is but partially filled with chickens. (See Fig. 5.)

It is important that provision be made so that the hen may be kept comfortable at all times, as her condition affects egg production. Comfort of the body is dependent on the cooling power of the air, which in turn is dependent on temperature, humidity, and air movement—all factors affected by ventilation. These factors all affect the bird. For instance, within certain limits, as the air gets cooler there is a definite loss of body heat by the hen, which must be replaced by the heat regulating mechanism of the body.

Chickens are most efficient when not subjected to any strain which tends to weaken their body resistance and make them more susceptible to germs. The continual breathing of damp, stale air in ill ventilated poultry houses undoubtedly lowers the vitality of the hen. In a house without ventilation the air becomes stagnant. Heat and moisture given off by the chickens is not removed, and there is an increase in temperature and humidity, a condition which interferes with the normal heat regulation of the body. Habitual exposure to such conditions may lead to lowered vitality, and may exert some influence upon the susceptibility of the chickens to respiratory troubles.

The poultryman tries to induce his flock to eat as much feed as can economically be converted into eggs. Hence it is desirable that the temperature should be low enough to maintain the maximum appetite of the birds and yet not so low as to cause wasteful oxidation for simple heat production. Tests have shown that egg production is affected by sudden changes of temperature and by extremely low temperature, which may be avoided in an insulated and well ventilated poultry house where it is possible to maintain a comfortable temperature and yet have some air circulation.

Poultry Require More Oxygen Than Other Animals.—Oxygen, which constitutes about one-fifth of the air by volume, is the element upon which animal life is dependent for its existence. In the process of respiration the lungs draw in and expel air; a portion of the oxygen inhaled unites chemically, while in the lungs, with impurities of the blood, and thereby cleanses it. (It is interesting to note that *poultry require more oxygen per pound of body weight than other farm animals.*) Some of the resulting products of this chemical reaction are exhaled in the form of gases and vapors, the two most important being carbon dioxide and water vapor.

While carbon dioxide is heavier than air and consequently will eventually go to the floor, yet when it is exhaled by the bird at a temperature of about 103° Fahrenheit it goes to the top of the building. Consequently, *except when the windows are tightly closed,* the carbon dioxide probably passes out of the house almost immediately. This problem is further simplified by the fact that the fresh air, because it is colder and heavier than the inside air, settles to the floor as it enters, and reduces any danger from carbon dioxide.

However, in poultry houses there is no danger of a lack of oxygen or an over supply of carbon dioxide; first, because even in the best constructed poultry houses, there is enough air leakage around the doors and windows when tightly closed to supply the necessary oxygen; and second, because the air volume of a poultry house is so large compared to the size of animal units housed, that the oxygen and carbon dioxide supply present no problem.

Relation of Air Moisture and Ventilation.—Moisture is present in the air as a gas, its amount depending largely on weather conditions. The higher the temperature, the more water vapor the air will carry. The air is said to be saturated (or at the dew point) when it contains the maximum amount of water vapor which it can hold at that temperature. This property of air which enables it to carry more water vapor as the temperature is increased is of fundamental importance in ventilation and moisture control in poultry houses. When air below saturation is brought into contact with water, there is always a tendency for some of the water to vaporize, increasing the moisture content of the air. It is this property of air which enables it to pick up the moisture in the litter, that makes ventilation such an important factor.

The water vapor which is exhaled by the birds and the moisture from their excrement add to the problem of controlling dampness. If the house is not ventilated, the moisture from the breath and excretions of the birds is retained in the air; when the temperature falls, the moisture congeals on the ceiling, side walls, and window panes of the house. Fresh air, entering the house, helps to absorb and dry up the moisture.

The science of poultry house ventilation has only recently approached a satisfactory stage. The difficulty has not been one of providing satisfactory mechanical equipment, but rather one of learning what conditions are necessary for good ventilation and control of other factors affecting the comfort of the hen.

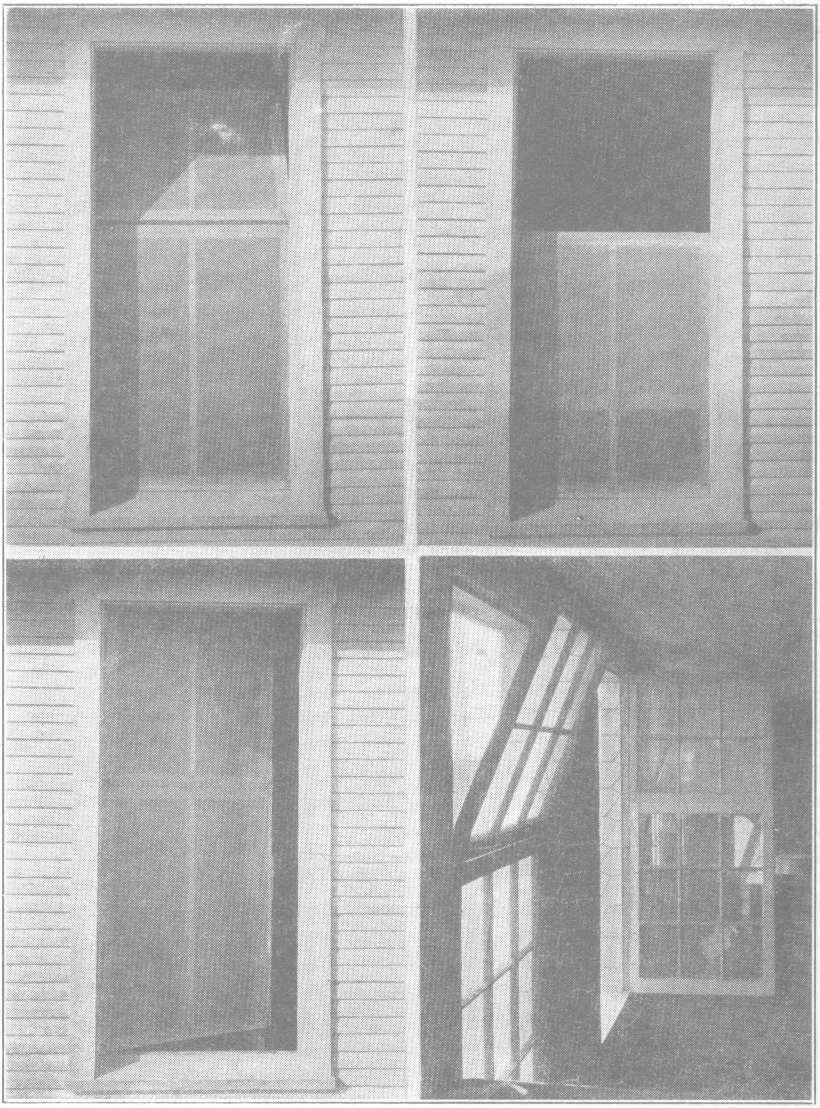


Fig. 13.—The New Ohio Type Window Arrangement

(Illustrations read from upper left to lower right.)

(a) shows the top sash tipped back part way for ventilation.

(b) shows the top sash folded all the way down, permitting the direct rays of the sun to enter the house in addition to providing ventilation

(c) shows how the entire window swings to the side, permitting the sun to enter the house through the entire window.

(d) shows the window arrangement from the inside of the house.

This picture shows a casing around the window as suggested in the alternate jamb detail in Fig. 27

Methods of Ventilation

The three general types of ventilation equipment used in poultry houses are (1) windows, (2) wall ducts, and (3) automatic intakes for the inlets, and windows or roof ventilators for outlet. Unquestionably, well designed ventilating systems, especially the automatic type, are much easier to operate than windows, but the cost of such equipment in many cases is almost prohibitive.

Windows as Ventilators.—Windows can be used for ventilation effectively when they are properly located and properly installed. Perhaps the greatest drawback to the effective use of windows for ventilators is the effort required to operate them. If the windows are hard to open and close they will not be used; in fact, poultry houses with the windows nailed in throughout the year are not uncommon on many Ohio farms. Obviously, more ventilation is needed in the summer than during the winter, yet if the windows do not open easily they will remain closed even during the hot summer months.

The windows on the new Ohio type house are composed of two sash; the top sash is two-thirds as large as the bottom sash. The top sash is hinged to the bottom sash and consequently can be turned back at any angle—a slight amount during cold weather, and opened up to give more ventilation when the weather permits. The top sash can be dropped all the way down when the weather is suitable, and on nice days the whole sash can be swung around inside the house so the entire window is open. The window itself is thus protected from the sun and also from danger of breakage (see Figs. 13 and 27).

This arrangement of the windows makes it possible to get the maximum amount of light into the house and also provides an efficient and workable method of ventilating the house. It is probably advisable to provide the windows with side shields which direct the incoming air towards the ceiling: this prevents cold drafts blowing directly on the birds.

If windows are used as intakes, the formation of frost cannot be avoided during cold weather, and if the temperature is not quite low enough to form frost the moisture then condenses on the panes, runs down the sash, and may have a tendency to rot the sills and frames unless they are covered with metal.

The most serious objection to windows as ventilators is that it is difficult to control the temperature and amount of ventilation because of the variation of the direction of the wind, which makes frequent adjustments of the windows necessary. Particularly during periods of high wind velocity the volume of air passing through the windows is greatly increased, and must be taken into consideration in determining the extent to which the windows are opened. The difference in temperature between the outside air and that in a well built poultry house is sufficient in cool weather to induce ample circulation without the aid of wind.

During zero weather it is necessary to close the average insulated poultry house as tight as possible in order to maintain a comfortable temperature. At such times the windows and doors will be closed, and some poultrymen think that under such conditions there is not sufficient ventilation; but, as a matter of fact, when the house is closed tightly and there is wide difference between inside and outside temperatures, there is sufficient ventilation through the cracks around the windows and doors.

Windows have one decided advantage in that they provide large openings which, during mild and warm weather, will give good ventilation. It is necessary to have different intakes and outlets in a house in order that they may provide a more complete circulation of air within the house. Yet one open window may in many cases serve both as an inlet and an outlet. That is, the bottom part of the window will serve as an inlet for the cold air coming into the house, and the top part as an outlet for the warm air. In other cases one window may serve as the inlet and another window as the outlet.

Poultry houses unquestionably can be ventilated by use of the windows. But such a ventilating system entails more careful attention, more exacting judgment, and more frequent adjustment to get the best results. During the next few years much time and effort will be spent in an effort to design a simple and inexpensive ventilating system that will be suitable for poultry houses. Ventilating systems now on the market are very satisfactory but expensive, and more study on this problem will doubtless lead to changes and improvements and also to cheaper designs.

Operation of Windows to Control Ventilation.—It is advisable to get the maximum of ventilation into the poultry house and yet control the temperature. As discussed earlier in the bulletin, temperature control is probably the paramount problem of poultry housing, with moisture control a close second. Poultry house windows, therefore, should be opened as much as it is possible to open them and yet maintain a temperature of at least 25 to 30 degrees. When the outside temperature is above freezing there is no reason why the windows can not be opened wide in order to admit as much sunlight as possible into the house. If the outside temperature goes below freezing the windows should be closed sufficiently to raise the temperature of house above freezing.

IV.—*Admission of Large Amount of Direct Sunlight*

The constantly increasing demand for larger numbers of eggs, and more hatchable eggs, has resulted in numerous experiments to determine the part that sunlight plays in the health and productivity of the chicken. Consequently, data have been collected by the various experiment stations throughout the country, which invariably show that the ultraviolet rays stimulate egg production, increase hatchability, produce better shell texture, and maintain the bird in better health.

Use of Glass Substitutes

The ultraviolet rays do not pass through ordinary window glass, and in order to be sure that the birds get the benefit of these rays, it is necessary to replace the glass with a glass substitute having a wire base, which will

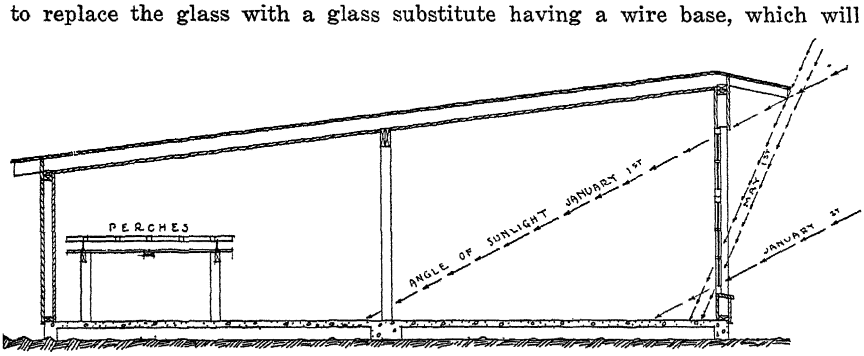


Fig. 14.—This chart shows graphically the angle of the sun at noon January 1 and May 1, and illustrates the fact that more sunshine gets into the poultry house at noon during the winter months (when it is most needed) than during the summer. Illustration also gives some idea of the effectiveness of the new window arrangements in letting the sun's rays into the house.

permit the ultraviolet light to pass through it; or else to get the birds into the direct sunlight. Recent investigations carried on by the United States Bureau of Standards show that a good glass substitute made with a wire base will permit approximately 40 per cent of the ultraviolet light to pass through it, and will stand all conditions, except the extreme heat of the summer sun.

Many poultrymen are now using this material on frames in place of windows in poultry houses. The frames are much lighter in construction than ordinary windows, and the corners do not sag and fail to fit after a year's use as is true with many windows. Where glass substitutes are used in place of window glass, ultraviolet light is admitted into the house even when windows are closed due to inclement weather.

The windows should be arranged so that they are easy to open and close, and made so they are properly protected in either position. The type of window recommended in this house has been adopted only after careful study and experience with many types of windows. When weather conditions permit, the windows should be kept open to permit the direct rays of the sun to enter the house. The glass substitute permits some of the ultraviolet light to enter when weather conditions make it necessary to keep the windows closed. The windows are illustrated in Figs. 13 and 27.

When open, the window is protected from the direct summer sun, an important factor in the life of glass substitutes. The windows are also in a position where they will collect the minimum amount of dust and yet are protected from injury.

V.—*Ample Feeding Space and Water Supply*

The feed consumption of the flock is a very important problem with the successful poultryman. Healthy flocks, well housed, and on good rations, often fail to be profitable because the poultryman lacks the ability to stimulate the feed consumption sufficiently to yield a profitable production.

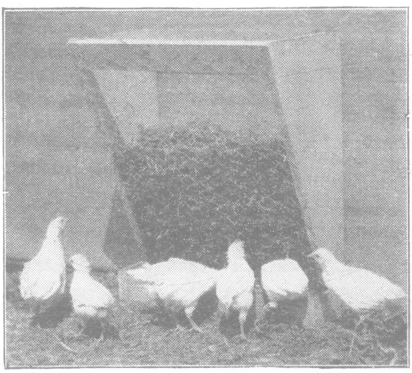


Fig. 15.—Wire netting chick feeder for chopped alfalfa, clover, or soybean hay. When used for older birds it is elevated four inches off the floor. (Courtesy Ohio Exp. Station.)

A prime essential in securing the maximum food consumption of the flock is ample feeding and drinking facilities. Even in carefully selected flocks there are always some timid and backward birds that will not get enough feed unless there is sufficient feeding space so that the birds will not crowd around the hoppers.

The Ohio laying mash hopper is 4 feet long and the birds can eat from either side, making 8 feet of feeding space per hopper. Allowing 5 birds per foot of hopper space, each hopper will accommodate 40 to 50 birds. This means that at least 6 mash hoppers should be provided for each 25 by 30-foot unit of the Ohio Multiple Unit Laying House. (See Fig. 32.)

The importance of an ample supply of water for the laying flock cannot be over emphasized. The ordinary pail with water stand described on page 70 provides a very satisfactory drinking arrangement. At least two such fountains should be used in each unit of the Ohio laying house.

VI.—*Properly Installed Artificial Lights*

The use of artificial lights to increase egg production, at least during the season of high prices, is fundamentally sound and a common practice on Ohio farms.

There is, however, a great waste of light on the part of farmers in lighting their poultry houses due to a lack of understanding of the proper installation of the equipment. In some sections of the state where gas wells are common the farmers are using gas lights in their poultry houses. In these sections, however, gas is so cheap that the houses usually are amply provided with light, and cost is no factor. In most sections of the state where electric lights are used the amount of current necessary to properly light the house could be considerably reduced if the lights were properly installed.

Roosts Should Be Lighted.—Lights should be arranged so as to give the maximum amount of light on the floor, but the roosts must also be lighted; otherwise, the birds will fail to get off the roosts. Recent experiments at

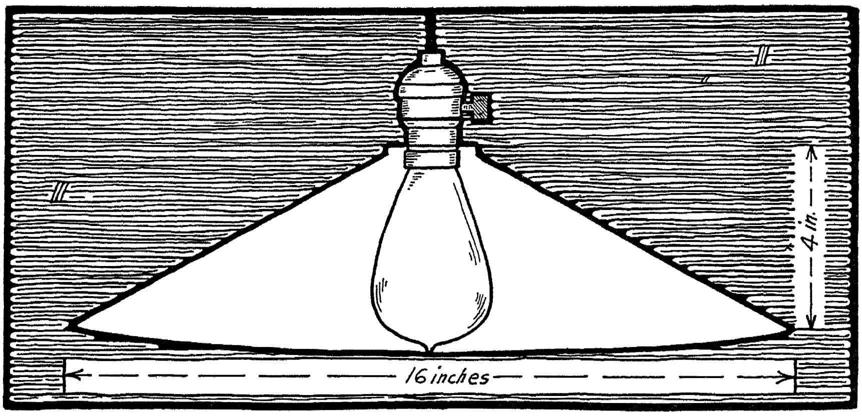


Fig. 16.—A lamp reflector of proper dimensions.

Cornell University show that one 40-watt bulb is sufficient for each 200 square feet of floor space. Experiments at the same institution also indicate that the lights should not be placed more than 10 feet apart in the house, and that in order to break up the shadows it is advisable to place the lights in the center of the distance between the purlin posts in the middle of the house. The exact location of the lights should be determined by placing them half way between the front edge of the dropping boards and the front of the house.

Reflectors.—The lights should be equipped with reflectors in order that the best results may be secured in intensifying the light on the floor. Reflectors increase the efficiency of the lights by reflecting the light rays that normally would go upward, and directing them toward the floor. The most efficient reflectors should be 16 inches in diameter, cone shape, with the cone 4 inches high at the center (see Fig. 16).

Suspending lights with this type of reflector from a plug half way between the front of the dropping boards and the front of the house, and then adjusting the length of the cord so that the light reaches every part of the

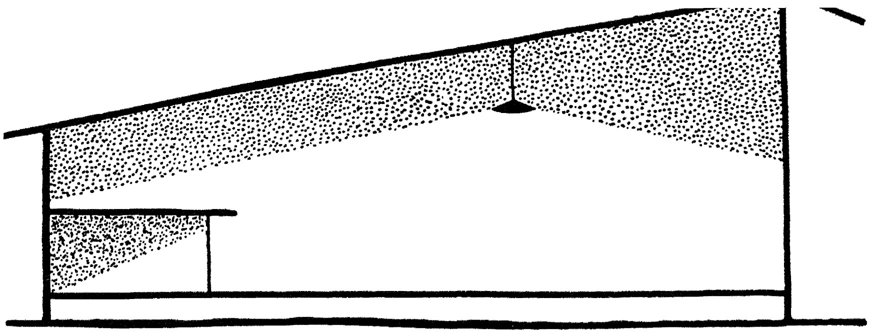


Fig. 17.—Lighting units with proper reflectors intensify the light on the floor and dropping boards. Place them 10 feet apart, 6 feet from the floor, and half way from the front of the dropping board to the front of the house.

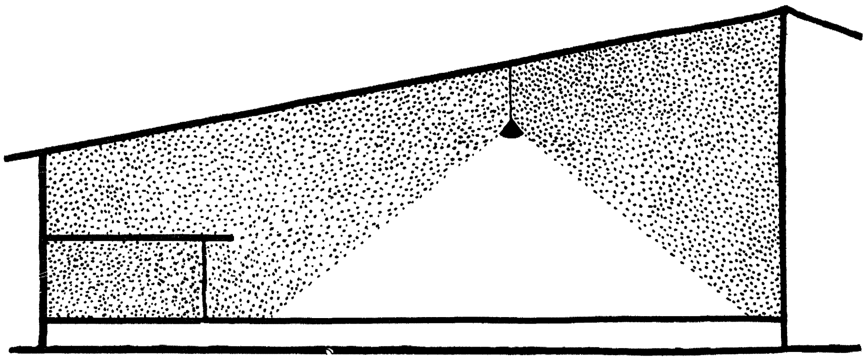


Fig. 18.—The result of using a wrong type of reflector. The light is intense on the floor, but the dropping boards are in semi-darkness.

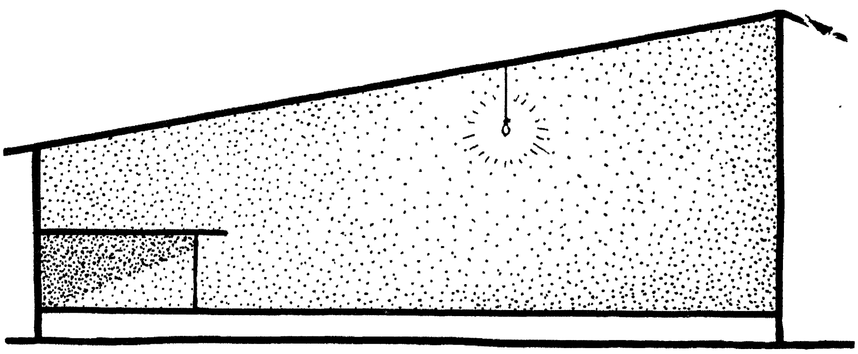


Fig. 19.—A light without a reflector produces semi-darkness in the entire pen.

dropping board, places the light in position to give the greatest efficiency. With the lights arranged in this manner the dropping boards are lighted enough to keep the birds off the roosts, and yet the main part of the building where the hoppers are located is the most brilliantly lighted part of the house.

Dimming the Lights.—The lights can be wired with two circuits, using one set of bulbs with very low power and another of 40-watt power; thus turning the bright lights off and the dim lights on will produce semi-darkness and cause the birds to go to roost. Another system that is sometimes used is one in which a resistance coil is introduced in the circuit; by increasing the resistance in the coil, the lights are dimmed and semi-darkness produced, with the result that the birds go to roost.

VII.—*Selection of Good Building Material, and Proper Construction of Foundation, Floors and Roofs*

Economy of Construction

Old buildings or second-hand lumber can often be utilized in poultry houses, but this does not mean that it is ever economical to use anything but sound timber and boards. In many cases there are buildings already on the farm which with small expense for material can be made into efficient poultry houses, by laying a moisture proof floor, insulating the ceiling and side walls, and putting in properly arranged windows.

In building a new house it is advisable to give some consideration to the kind of materials to be used, as often the material representing the lowest initial cost may prove to be the most expensive over a period of years. It is especially important to consider the lasting qualities of different species of wood. These are discussed below.

*Decay Resistance of Various Woods.**—Wood kept constantly dry or continuously submerged in water does not decay regardless of species. Moisture and temperature are the principal factors which affect the rate of decay. When exposed to conditions which favor decay, wood in warm humid areas of the United States decays more rapidly than in cool or dry areas.

Dampness favors the growth of the fungi which destroy wood. Untreated wood decays in contact with the ground, or in any situation where it can collect moisture and remain damp, or where it is alternately wet and dry.

Leaks from roofs, drips from water fountains, or water pipes, or other abnormal conditions due to improper design or construction, or lack of repair in houses sometimes causes decay, but the remedy is to improve conditions rather than select wood of higher durability.

When not too close to the ground, the siding of the poultry house, kept in reasonably good repair, should last a long time regardless of species. Although exposed to rain, the water usually runs off quickly, and except where defective conditions allow the water to collect in cracks or crevices, the wood does not stay wet long enough for fungi to do much harm. Decay resistance in the siding of insulated houses is not of major importance, although the use of durable wood for this purpose is safe and conservative.

The use of good decay-resistant material in uninsulated houses is more important, because the moisture which condenses during the winter months on the ceiling and side walls will tend to increase the development of decay-producing fungi.

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* Adapted from material published by U. S. Dept. Agr. Forest Products Laboratory, Madison, Wis.

The cornices, window frames, sills, and sashes and the exterior trim of the building should be made of the most decay-resistant materials, as these are the parts of the poultry house that cause the most trouble.

The natural decay resistance of the heartwood of all common native species of wood is much higher than that of the sapwood. When untreated, the sapwood of practically all species has low decay resistance and generally short life under decay producing conditions. The decay resistance of heartwood is greatly influenced by differences in the character of the wood, the attacking fungi, and the conditions of exposure. Therefore, wood from the same species or even from the same tree, and used under similar conditions, will vary greatly in lasting qualities, depending on whether heartwood or sapwood is used.

General comparisons of the relative decay resistance of different species must be estimated. The following classification of the different species on the basis of decay resistance when used under conditions favoring decay, gives some idea of the merits of the various species.

1. *Very high decay-resistant species:*
   - Catalpas
   - All cedars
   - Chestnut
   - Southern cypress
   - Junipers
   - Black locust
   - Red mulberry
   - Osage-orange
   - Redwood
   - Black walnut
   - Pacific yew
2. *High decay-resistant species:*
   - Dense Douglas fir
   - Honey locust
   - White oak
   - Southern pine
3. *Medium decay-resistant species:*
   - Douglas fir
   - Red gum
   - Western larch
   - Chestnut oak
   - Southern yellow pine
   - Tamarack
4. *Low decay-resistant species:*
   - Ash
   - Beech
   - Birch
   - Hemlock
   - Sugar maple
   - Red oak
   - Spruce
5. *Very low decay-resistant species:*
   - Aspen
   - Basswood
   - Cottonwood
   - True firs (not Douglas fir)
   - Willows

PRESERVATION OF LUMBER

Coal-Tar Creosote.—Coal-tar creosote, which is a brownish-black heavy oil, practically insoluble in water, is in general use for preserving fence posts and other farm timber. Satisfactory penetration of many species of wood can be secured with it, and excellent results have been obtained by its use. It is considered about the most effective preservative against decay so far developed for farm timbers exposed to the weather. It may also be used for inside work wherever its color, odor, and other properties are not objectionable.

Coal-tar creosotes vary considerably in quality; but satisfactory results may be obtained from any good grade, provided a sufficient amount is put into the wood and a good penetration is secured. Creosotes containing a high percentage of oils which boil at a low temperature are not so suitable for use on the farm as those which contain a lower percentage of these oils, because a considerable portion may evaporate during treatment. In some cases as much as one-fifth of the oil used has been lost in this way. This loss of oil by evaporation may be largely offset, however, by the lower price at which the low-boiling creosotes may usually be obtained. The increase in price which can be economically paid for the higher boiling creosotes will in general not be more than 25 to 35 per cent.

Creosote Mixtures.—Coal-tar creosote is so destructive to fungi that it can be diluted with less effective oils and still give very satisfactory results. It is better to use straight creosote, but where the cost of creosote is almost prohibitive economy may result from using it mixed half and half with a suitable, cheaper oil. Water-gas tar, water-gas-tar creosote, and gas oil are suitable, provided they are clean and of good quality. Coal tar, fuel oil, and crude petroleum are likely to reduce the penetrating properties of the creosote and should be avoided if more suitable oils are available. They can be used successfully, however, with woods which are easy to penetrate, provided sufficient care is taken during treatment to insure deep penetration. Spent crank-case oil can probably be used successfully for mixing with creosote, but no experimental evidence concerning its use is available.

In mixing oil with creosote it is best, after stirring the oils together very thoroughly, to allow the mixture to settle and then to use only the liquid portion. Any sludge which separates out should be discarded.

Paint, Linseed Oil, Whitewash.—Good results in preventing decay cannot, in general, be expected from paint, linseed oil, whitewash, or similar materials when used on fence posts or other timbers in contact with the ground. They do not penetrate the wood deeply, and as a rule are not poisonous to wood-destroying fungi. It is sometimes believed that they can prevent decay by preventing the entrance of fungi or moisture into the wood, but this belief is not well founded. Wood is seldom painted on all sides, so it is usually possible for fungi to enter through an unpainted part. Furthermore, whenever the painted film cracks or peels off, fungi can enter. Experiments have shown, also, that paint films do not prevent moisture changes, but merely retard them. It is quite common to see wood decaying beneath a coat of paint. Because of appearance, however, paint is commonly used on poultry houses to make them conform in color to the rest of the farm buildings.

The sills and foundation timbers which come in contact with the ground or with stone or concrete foundations, where they do not dry out rapidly, should be treated with creosote since it is a much better preservative.

Experience has shown that in any timber structure where the wood comes in contact with wood, stone, or other material, decay is liable to occur more rapidly at the point of contact than in other parts of the structure. If it is impracticable to treat the timber for the whole structure, it will frequently be profitable to give a good brush treatment of creosote to the joints and other points where decay is usually most severe.

Storage of Lumber on the Farm.—It is important, in the case of lumber and sawed timbers of all sorts, to pile it so that it will not decay during seasoning. All sawed lumber and timber during seasoning should be piled upon skids or sills at least a foot above the ground. The layers of boards or timbers should be separated by narrow stickers or crossers about 1 inch thick. The stickers should be lined up vertically over the skid timbers, and they should be spaced closely enough along the length of the pile to prevent the bending of the boards. The piles should be sloped lengthwise, so that rain water can run off quickly if it is necessary to store it out-of-doors. It is always best to store lumber in a dry place in a building.

Farmers having trees from the home woodlot sawed for the construction of poultry houses, will do well to follow these suggestions in storing or seasoning of lumber. The writer well remembers seeing a pile of over 5,000 feet of black walnut sawed lumber on an Ohio farm that was absolutely worthless as a result of careless storage.

Foundation of the Poultry House

The permanency of a building is jeopardized when it is placed on a weak foundation. Considerable attention, therefore, should be given to building a proper foundation.

Depth of Foundation.—The foundation of the poultry house should be at least 6 inches thick, and extend at least 12 to 18 inches below the surface of the ground. If the soil is firm and does not show any tendency to cave in, it will not be necessary to build a form beneath the surface of the ground, but if the sides of the excavation fall in the trench, it is wise to dig it a little wider than is necessary for the wall, and then construct a form the full depth of the trench.

The Forms.—The forms can be constructed of the regular 1-inch material used for roofing, and the frame of the form can be made of 2 by 4-inch material which will later be used for studs in the building.

Cement Mixture.—In making the cement, the strength is largely dependent on the quality of the materials used. The sand should be clean and well graded, ranging in size from very fine particles (exclusive of dust) up to particles which will just pass through a screen having meshes ¼ inch square. Pebbles or crushed stone should also be clean and assorted in size from ½ inch to 1½ inches. The material should be accurately measured in a pail, box, or other convenient container which will give uniform proportions to each batch. Mixing may be done either by hand or by machine. In either case, mixing should be carried on until each pebble is covered with cement and mortar.

The foundation of the house should be made of a mixture containing not more than 5 gallons of water for each sack of cement. For the first trial batch, use 1 part cement, 2½ parts of sand, and 3½ parts of pebbles. If the mixture resulting from these proportions is too stiff for placing, reduce amounts of pebbles and sand until the right workability is obtained. If, on the other hand, the above proportions give a sloppy mixture, add pebbles and sand until a proper plasticity is obtained. Under no circumstances add more than 5 gallons of water for one sack batch unless the sand and pebbles are absolutely dry, in which case up to 6½ gallons of water may be safely used.

Making a Concrete Floor.—Concrete floors are very satisfactory for poultry houses because they are permanent, sanitary, and rat proof. The poultry house should be filled so that the level of the earth on which the concrete is to be placed is at least three or four inches above the outside level of the house. A layer of one thickness of tar paper should be placed on the ground before the concrete is poured. This prevents the possibility of capillary rise of water through the floor.

A mixture containing not more than 4½ gallons of water to a sack of cement is considered best when ordinary sand and pebbles are used. In case of dry pebbles, up to 5½ gallons of water may be used to a sack of cement. The amount of sand and pebbles used should be varied according to the condition of the mixture, adding more sand and pebbles if it is too sloppy, and reducing the amount if it is too stiff.

The full thickness of concrete can be placed in one operation. Most of the finishing should be done with a wooden trowel to produce a smooth, dense surface. The final finish may be made with a light trowel, which produces a smooth, durable, sanitary surface. The floor should be kept wet for several days after laying, in order to permit proper hardening of the concrete.

It is not necessary to make the poultry house floor more than 2 or 3 inches thick if good materials are used. In fact, where extreme care is used in making concrete, thinner floors give excellent results.

Floor Drains.—There is probably no more satisfactory method of thoroughly cleaning a poultry house than the use of water under pressure. If water is allowed to stand on a concrete floor overnight, all the dirt can easily be removed. To facilitate washing out the building, it is advisable to put a drain in the floor of each pen and build with a slight slope to that point.

Concrete Dropping Boards.—On many farms, there is an excess of fence boards and similar material for which there is apparently no use. Many poultrymen have used such material for making dropping boards. The fence boards are first joined together, then covered with newspapers, and a few roofing nails driven in the surface (allowing them to stick up ½ inch). The whole surface is then covered with about 1 inch of cement. Such dropping boards have proved very satisfactory, but are somewhat heavy to move when the dropping boards are made in sections.

Suitable Roofs for Poultry Houses

The designing of a satisfactory roof for the Ohio type poultry house has been a constant problem for several years. The general style of the house, with its wide roof and relatively small pitch, has complicated the construction of a leak proof roof. The use of roll roofing paper has never been satisfactory; first, because it was almost impossible to keep it from wrinkling; and second, because of the tendency for the water to seep in around the nail heads and by freezing and thawing gradually lift the nail and produce a leak in the roof. Metal roofs have also been tried with unsatisfactory results, due to the great amount of moisture condensation on the underside of roof in cold weather.

Several years of close observation of the results secured from different types of roofing has led to the recommendation of the use of built-up type of roofs on the Ohio poultry house.

Built-up Roofing.—This type of roofing is well known from its use on large and more permanent city buildings which have low pitched roofs, but the use of built-up roofs on poultry houses has been an innovation of recent years.

Ideal roofs for poultry houses are ones without seams or exposed nails; simple and economical to apply; proof against wind; durable, with a minimum amount of care and expense in maintenance; and, most important of all, effective in the prevention of leaks. A built-up roof is one made by laying several thicknesses of roofing paper over wood sheathing, the first layer being nailed down and each layer thereafter being cemented down with hot asphalt compound. The construction of a built-up roof suitable for poultry houses can probably best be explained through studying the different steps shown in Fig. 20, where an old composition roof is being used as the felt base for a new built-up roof.

It is important that tongue and groove boards or shiplap be used for the sheathing, so as to prevent wind getting in through cracks and working the roofing loose. The first layer of roofing paper, or base sheet, is heavier than the following layers, usually weighing 60 pounds to the square. It is run at right angles to the sheathing, and secured to the roof boards with nails (tin-cap spacing nails) driven flat along the seams about 3 inches apart. In addition, two rows of nails are run parallel to the laps through the center of the sheets, these nails being about 6 inches apart and 12 inches from either edge. This is shown in Fig. 20, *c*. The reason for nailing the base felt to the boards

FIG. 20.—STEPS IN MAKING A BUILT-UP ROOF (**Read from upper left to lower right**).

a. The asphalt comes in large metal drums which must be cut open and the asphalt split into chunks to place in the cooker.

b. The chunks of asphalt are heated in the cooker to 350° F. Note spigot at end of cooker to draw off melted asphalt.

c. The first layer of roofing is nailed on the edge, using roofing nails with large caps at about 3-inch intervals, and 12-inch intervals in center.

d. The first half strip has been laid and metal edge is being nailed on roof.

e. The first full roll of roofing is being laid, covering the half strip and metal edge. Note chalk marks to guide laying of paper.

f. Several layers of roofing have now been laid, each lapping the previous one half the width of roll.

rather than cementing it with hot asphalt is that it makes the roofing less subject to strain or buckling due to changes of temperature.

Where the old roof on a poultry house is being converted into a built-up type of roof, the original paper roof serves as the heavy base felt. The nails already on the seam should be hammered in tightly and additional nails with large tin caps should be put into the roof as discussed above.

The metal edge shown in Fig. 20, *d*, is an L-shaped galvanized iron or heavy tin strip, nailed down around the edge of the roof. Some roofing manufacturers recommend a narrower strip of roofing felt bent over and nailed down around the edge of the roof; either method is satisfactory. The same illustration shows the first strip of felt paper cemented down with hot asphalt.

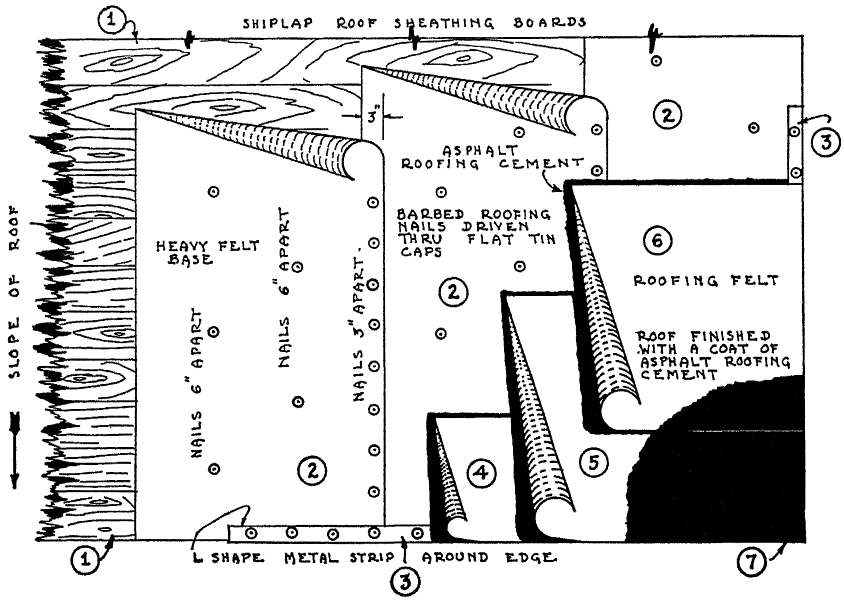

Fig. 21.—This shows another method of making built-up roof. The felt base (2) is applied at right angles to sheathing; roofing (4, 5, 6) is put on as described in Fig. 20, but at right angles to heavy base felt. Asphalt (7) is applied over entire roof.

It is the starting strip, and is one-half the width of a full sized roll of paper. This felt is of lighter weight than the base sheet, usually weighing about 15 pounds to the square. In laying the felt, the roll is started at one end of the roof, only enough hot asphalt being applied on the roof surface to be covered by the width of the paper. As the hot asphalt is mopped on, the felt paper is unrolled, the roll kept closely following the mop. It requires about 25 pounds of asphalt to cover a square of roof.

The next layer of felt is a full width layer. It is started from the bottom of the roof, as will be noted in the illustration, *(e)*, and completely covers the original one-half strip of felt. It will be noticed that each layer overlaps the preceding layer a little over half way, so that when the job is finished there will be three thicknesses of roofing felt, one layer nailed down and two layers cemented down. A coat of hot asphalt is applied over the entire roof surface after the laying of the paper is completed.

The Following Articles Are Needed in Laying a Built-up Roof:

A 50-gallon capacity kettle for heating the asphalt. The asphalt must be heated to about 350 degrees, or until it pours readily. Usually it takes about one hour to heat.

2 buckets with covers
1 bucket of water on roof in case of fire
1 mop especially made for applying hot asphalt
1 knife for cutting felt
Hammers
Canvass gloves
Kerosene in case of burns

Roofing Materials for 1 Square of Roof:

1 square 36-inch roofing felt, weighing about 60 pounds per square, for base coat, to be nailed down.

2 squares 36-inch roofing felt weighing about 15 pounds to the square, for coats to be cemented down with hot asphalt.

2 pounds 1-inch galvanized nails.

½ pound 1-inch or 1¼-inch flat tin disks or caps.

About 75 pounds of roofing asphalt.

Precautions and Suggestions.—Built-up roofs are better adapted for comparatively flat roofs than for steep roofs. If the hot asphalt is applied too freely, it will run off the roof during hot weather.

The material used in making the mop for applying the hot asphalt must be of a quality to resist the high temperature at which the asphalt is applied.

Kerosene should be kept available for use in case of burns.

Roofing supply houses are usually glad to supply special cookers for melting the asphalt. Discuss your roofing problems with the local roofing supply house, and get further suggestions on the application of the built-up type of roof.

Remodeling Poultry Houses

The latest poultry house, like the automobile of today, offers many improvements over those in use five years ago. Since environment is such an important factor in securing high egg production, the poultryman should take advantage of every new development in housing.

High Ceilings.—The major criticism of the older Ohio type poultry houses is the fact that they are so hard to keep warm, due to high ceilings and open fronts. Many of these houses have been made satisfactory by constructing a false ceiling just high enough for good head room, from the front of the dropping boards to the front of the house. This false ceiling consists of 2- by 4-inch pieces, 2 feet apart, with chicken wire stretched over the 2- by 4's so that the space between the wire and the ceiling proper can be filled with straw. Another method is to use insulation material making a tight false ceiling.

The sides of the building can also be insulated, thus giving the old house all the advantages of the modern insulated house. This method of remodeling applies to all types of houses with high ceilings, including the semi-monitor type.

Narrow Houses.—Narrow poultry houses can be made more satisfactory and the capacity economically increased by widening the house. High houses can best be widened by adding to the back, while low houses can best be extended in the front. The plan of the front should be made to conform as nearly as possible to the plan shown in this bulletin.

Dark Houses.—Many of the poultry houses found on farms today do not have sufficient light. By duplicating the front of the modern poultry house, they could be made into comfortable, satisfactory houses.

Baffles.—The front of the old Ohio house can be improved by arranging doors to close the permanent baffles at the top of the front during extremely cold weather.

The distribution of light and control of ventilation can be improved by replacing the removable bafflers with frames covered with a good glass substitute. Ventilation can be controlled by tipping or removing these windows.

Concrete Floors.—The sanitation of many farm poultry houses could be improved by the use of a concrete floor. It is necessary to remove from 5 to 6 inches of dirt to properly clean a poultry house with a dirt floor. Therefore, if labor alone is considered, the concrete floor will soon pay for itself.

Two-Story Poultry Houses

With the newer knowledge of nutrition which does not require that the birds be kept on range, a number of poultrymen are taking advantage of the cheaper housing cost per bird which can be obtained by building a two-story poultry house.

The advantage of a two-story house is that the same roof and foundation will give double the housing capacity of a single story building without the additional cost. It also makes a more compact building and the labor requirement is reduced. However, the advantages of a two-story house are not sufficient to warrant its use on the average farm. Where land values are extremely high or the amount of land available is restricted, the two-story poultry house may be justifiable.

With a two-story poultry house, it is desirable to use 2- by 6-inch studs and place the second floor just high enough for good head room. The window and dropping board arrangement for both upper and lower floors should be similar to that used in the ordinary shed roof house. It is desirable to use a gable roof on a two-story house, with asphalt shingles or some more expensive type of roofing material than is commonly used for poultry houses.

Poultrymen desiring to construct the two-story house can readily have the plans for the shed roof house adapted to the two-story proposition.

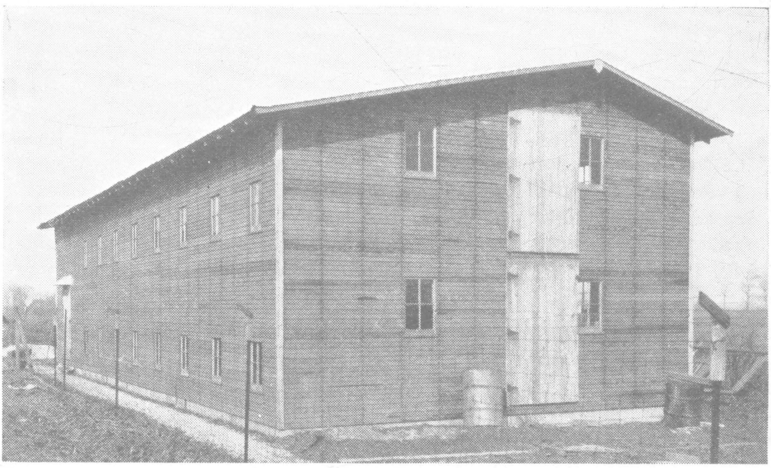

Fig. 22.—A well designed two-story poultry house.

Shed Roof Laying House, 25 by 30 Feet

(Frame construction)

This house has been designed to accommodate 250 Leghorns, or 200 of the heavier breeds, although many poultrymen are keeping more than this number of birds in the house with success.

One advantage of all the houses shown in this bulletin is that they can be built in any multiple of the lengths shown; consequently, new units can be added on at any time. When more than one unit of the house is built, the labor can be reduced by constructing a feed room in the center, or at one end of the laying house. The feed room should be at least 10 feet and preferably 20 feet long, and the same width as the house. Such a room will provide ample floor space for mixing the mash, and storage bins for grain, shell, meat scraps, etc.

A cellar constructed under the feed room provides an ideal place for storage of root crops and eggs. Many poultrymen use such cellar rooms for incubation during the hatching season, and for crate fattening the broilers or storage of eggs during the summer.

Foundation Plan.—Fig. 23 gives a ground plan of the house. The bolts are placed in the concrete foundation for the purpose of fastening the sills to the foundation. The bolt heads are placed downward 2 inches in from the outside edge of the wall so as to be in the center of the 2″ × 4″ sill. The top of the bolt comes about 3 inches above the top of the foundation.

It is desirable to place a floor drain in the house in order that it may be flushed out from time to time. Surface water can be prevented from entering the house by having the floor slightly higher than the outside ground level. The house should be filled in with dirt, gravel, or other material, and then a layer of tar paper should be placed on the ground before the cement floor is poured. This paper breaks up the rise of any capillary water. (See pages 10 and 17 on construction of floors.)

Floor Plan.—Fig. 23 shows how the dropping boards should be made, with the boards running from the back toward the front of the house, to eliminate the possibility of the hoe catching behind warped boards when cleaning the droppings off. Fig. 23 also shows the arrangement of nests on the ends of the building. Note also how the windows in the front of the house swing around against the wall inside house, between the windows, where they are protected from the sun and from breakage.

End View.—Fig. 24 gives a cross section through the house showing the height of the front and rear studs, and length of rafters.

A driveway door, to enable the poultryman to drive in the house with a wagon or a manure spreader, may be provided by replacing the small door on the end with a large sliding board. In either case, it is wise to have a hinged door on the inside of the house, screened with 1-inch mesh poultry netting, so that the regular door may be left open during the summer, and the screen door used to provide plenty of ventilation.

Windows are sometimes placed in the ends of the house, but they must be so located that the nest on the walls do not cover them. Note the overhang in front of the house. This overhang prevents driving rains or snows from entering the top of the house when the top windows are lowered. The overhang also adds to the appearance of the house.

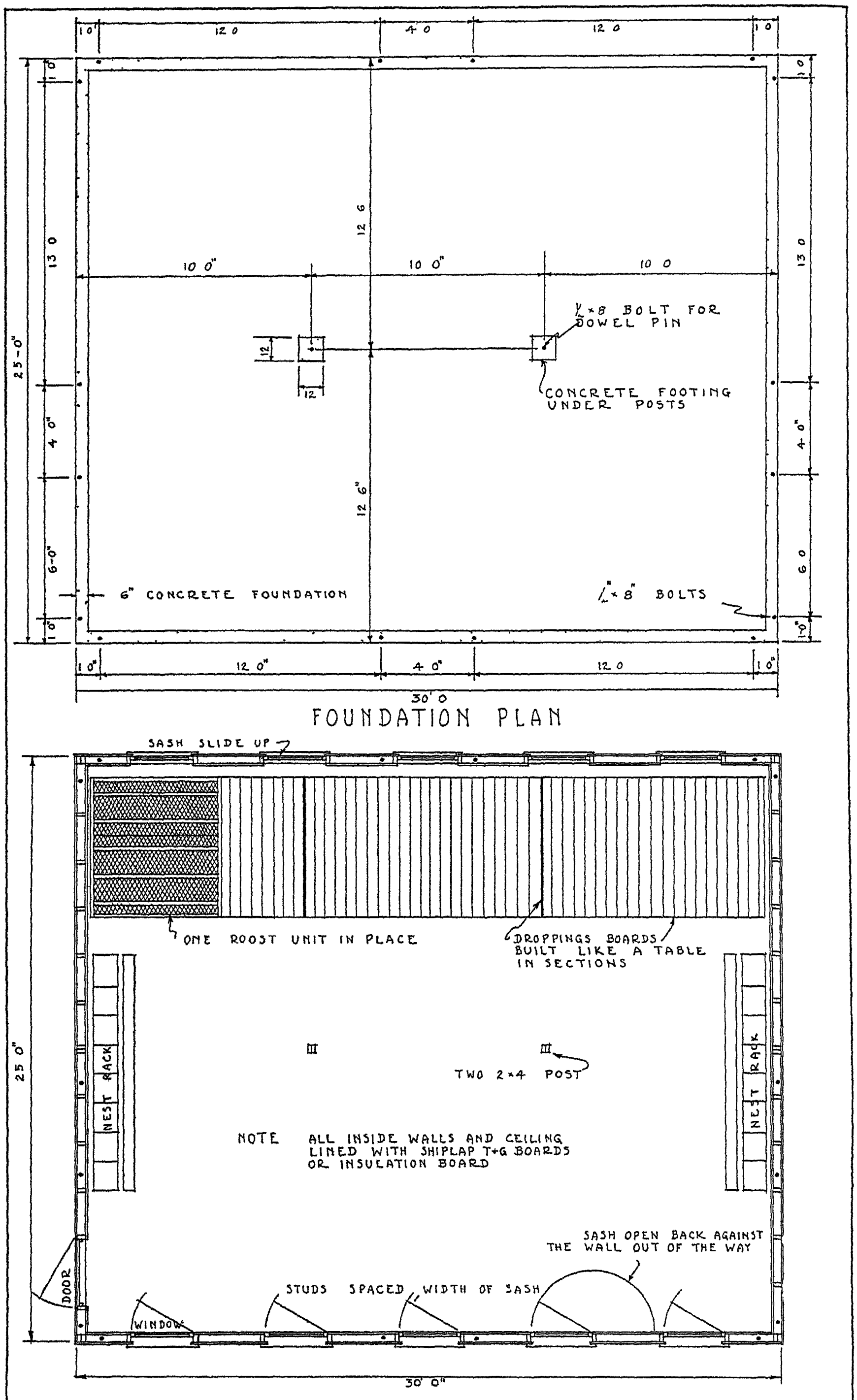

Fig 23 —Floor plan of 25- by 30-foot laying house

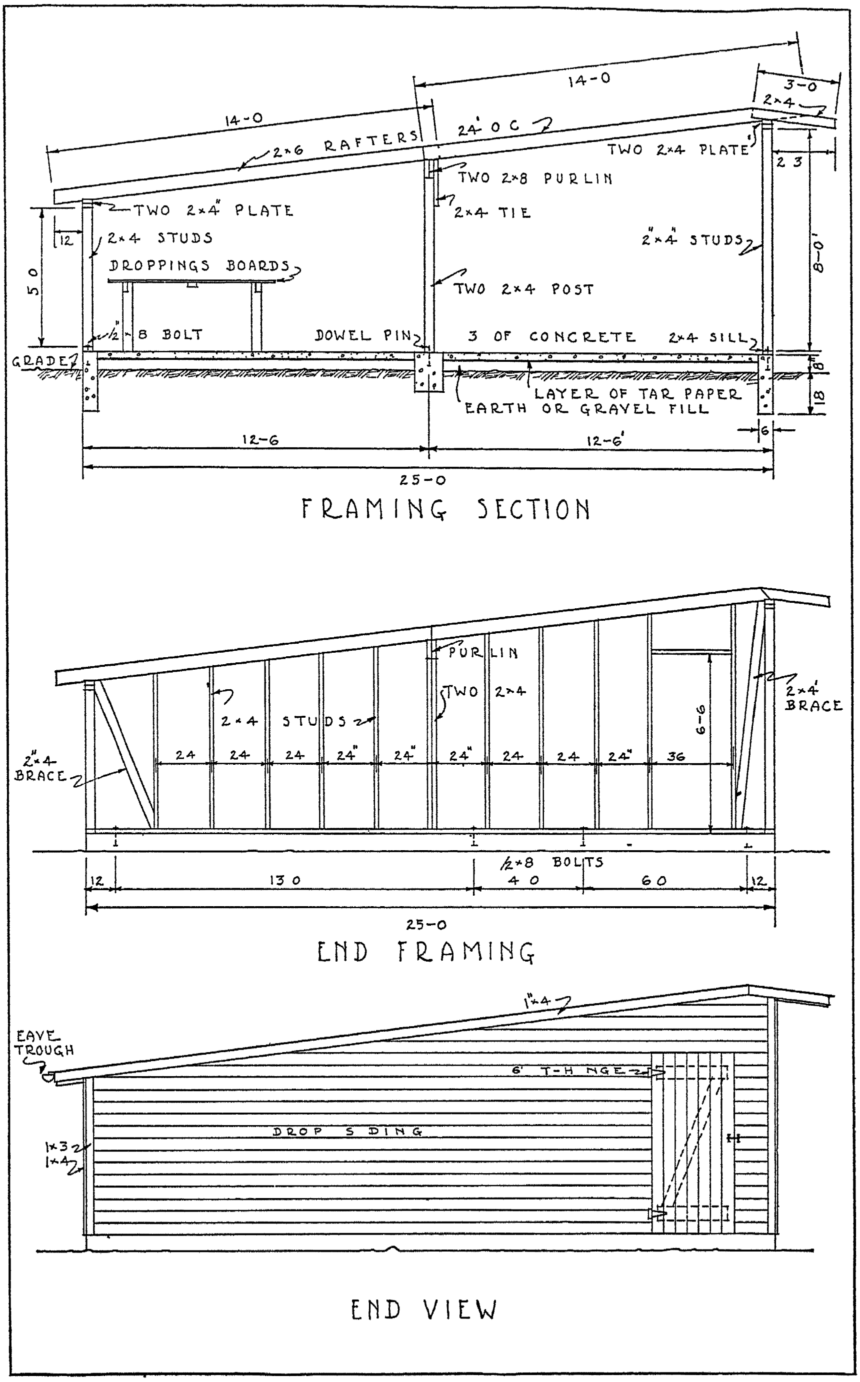

Fig. 24 —End view, showing length of studs, rafters, and lookouts.

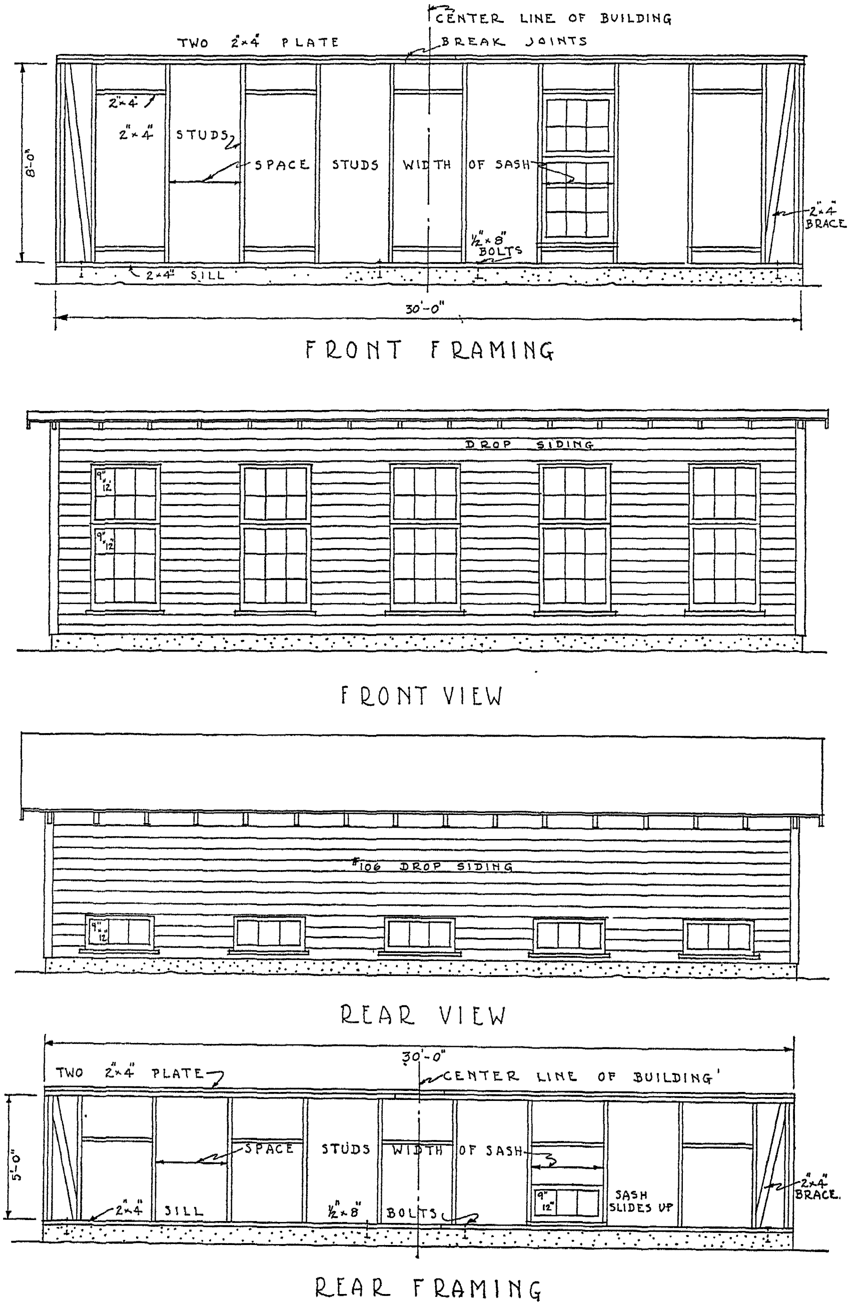

Fig. 25.—The position of the studs in the front and rear walls is the same. The studs are spaced the width of the sash apart. The middle of the center sash is in the center of the building.

Front and Rear Framing.—The front and rear framing of the house is shown in Fig. 25. In marking out the position of the studs begin at the center and work out. Place the studs the width of the glass window sash, allowing a small amount for "play" to permit the windows to work easily. Place the center of a window on the center of the front of the building, and then set a stud on each side of the window and the remainder of the studs the required distance each way from the first window. The end studs and plate are doubled, making them 4" × 4".

In erecting the front wall, it is a good plan to do all the work that is possible on the ground. This is best accomplished by nailing the sills, plates, and stud together on the ground, and then raising the entire wall as the unit into its position. The holes for the bolts should be bored in the sill before nailing it to the studs. It will require four to six men to raise the wall by this method. When fewer men are available, the front can be raised in sections.

It is advisable to cover the sash in the front part of the house with a good glass substitute. The frames, being much lighter, will not warp out of shape, and consequently always fit better. The rear studs are placed in the same position as the front studs, allowing for a window in every other space between the studs. The sill is made of one 2" × 4" bolted to the foundation. The end studs and plate are made of 2" × 4" material doubled to give greater stiffness to the building. It is a good plan to construct the rear wall on the ground, and raise it into position in the same manner as the front wall.

The siding is allowed to run past the studs ¾ inch to form a casing for the rear windows. The five windows in the rear of the house come underneath the dropping boards. This brings the light into the house from both the front and the rear, thus inducing the birds to scratch in all directions, since the hen always faces the light when she scratches. With this arrangement, the litter is kept evenly distributed over the entire house. Providing plenty of light underneath the dropping boards tends to discourage the hens from laying on the floor. The rear windows are opened by raising the sash between the studs. This allows the air to circulate freely into the house and tends to keep the house much cooler in summer weather.

Roosts.—A detailed plan of the roosting arrangement is shown in Fig. 26. The perches are shown in 6-foot sections, resting on four ½" × 6" lag screws; 1½-inch mesh poultry netting is nailed to the underside of the perches; however, if the dropping boards are built in 10-foot movable sections, the length of the perches should conform to the length of each dropping board table. The construction of the dropping board table also is shown in Fig. 26.

Double Wall Construction.—This house is constructed with double walls throughout, which will reduce the heat loss, and consequently protect the birds from rapid changes in temperature. Insulation material may be placed on the inside of studding, as shown in the drawings. To prevent making a hiding place for rats and mice, it may be advisable to place the insulation material on outer side of studs and rafters. With this type of construction do not use anything for sheathing smaller than 8 d. common nails.

Windows.—The arrangement of the windows is shown in Fig. 27. The insulation is allowed to come flush with the edge of the studs but the siding is allowed to extend ¾ inch over the edge of the studs. The windows are made in two sections; the top section is made of a 6-light 9" × 12" sash which is hinged on the bottom to the top of a 9-light 9" × 12" sash. The lower sash is in turn hinged to the side of the house. With this arrangement, the top

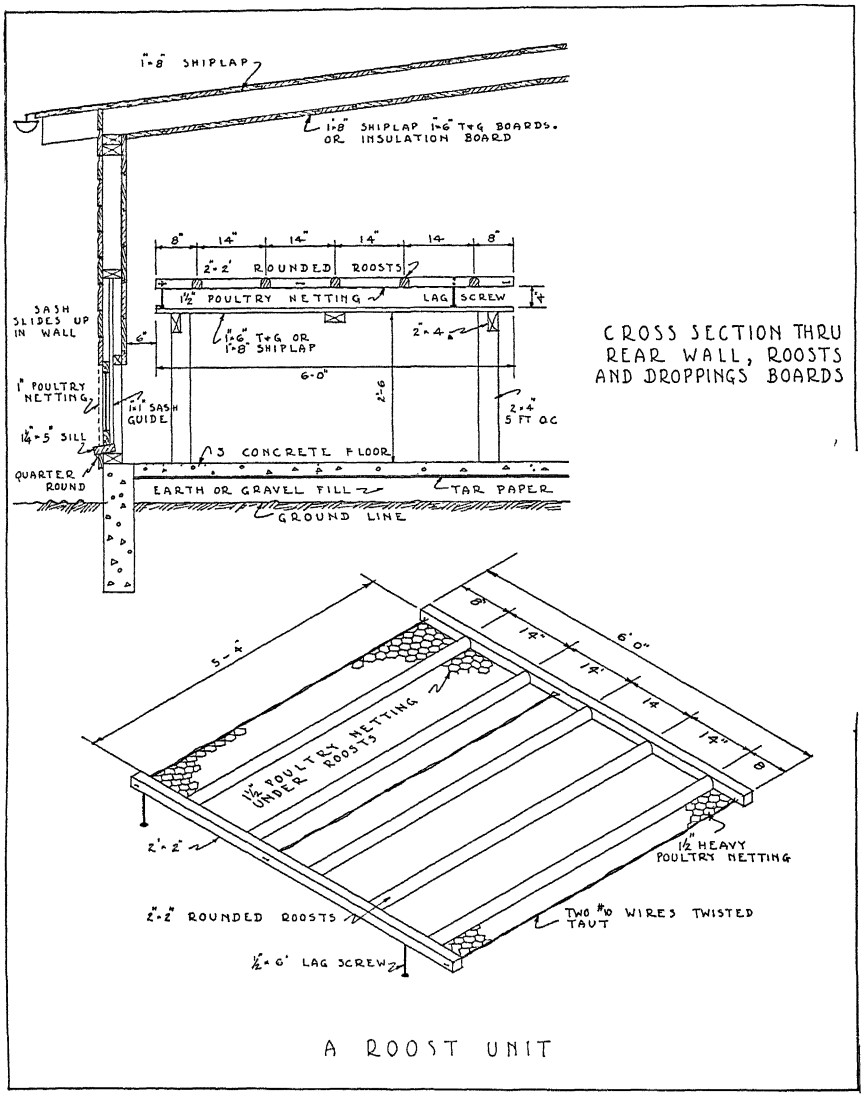

Fig. 26.—The dropping boards are a table-like arrangement not attached to the house. This table is usually placed about 4 inches from the back of the house, but during the summer can be moved farther away and thus promote circulation of air around the roosts.

The perches are made of 2" × 2" material with rounded tops. The end pieces are 2" × 2" material but not rounded. Use 16d nails in nailing end pieces to perches. Double No. 10 wire made taut by twisting is used across the front and rear to keep the edge of the poultry netting from sagging. The perches are supported by 4 lag screws. Poultry netting is fastened to the under side of the perches; 1½" mesh wire gives the best results.

Illustration shows perches 5' 4" long. These are intended for use where the dropping board platform runs the length of the house. If the dropping board platform is made in movable sections as recommended in this bulletin, the length of the perches must necessarily conform to the length of the individual tables.

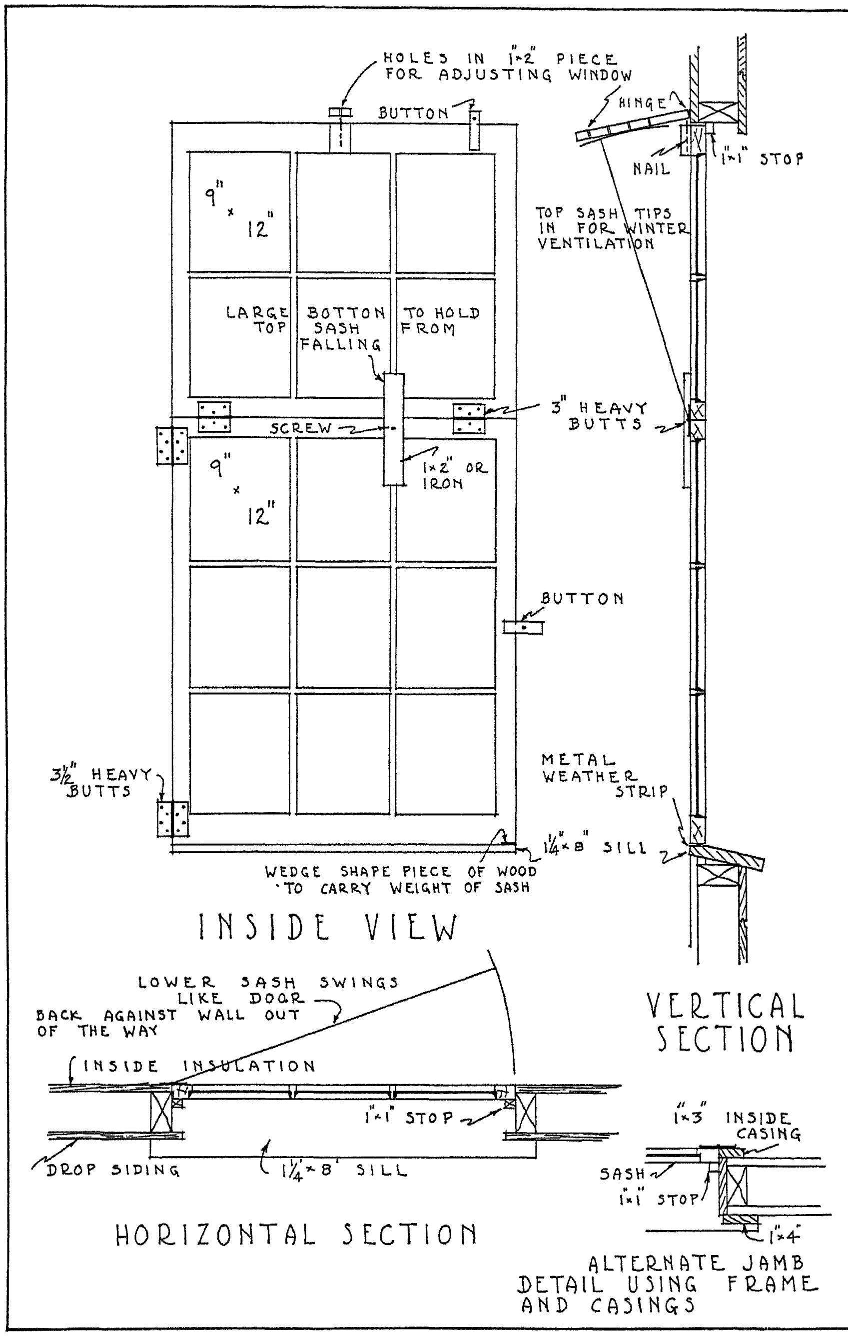

Fig. 27.—In this window arrangement, the top sash is hinged to the bottom sash, which in turn is hinged to the building. A metal weatherstrip should be used between the sill and the lower sash.

window may be tilted back at any angle to allow for the desired amount of ventilation, or can be folded down, leaving the top section entirely open. In fine weather, the bottom and top sash can be swung to the side, opening the entire window space for the admission of direct sunlight (also see Fig. 13).

A small stick with holes in it is hinged to the top of the window sill and a nail on the top of the window provides an arrangement for giving any desired amount of opening of the top sash.

Bill of Material for
25- by 30-foot Shed Roof Laying House
(Frame construction)

Concrete

The amounts given below are based upon a dry sand, well graded in size from fine to ¼ inch and the stone from ¼ inch up to 1½ inch. A reasonable amount has been added for waste.

FOUNDATION AND POST FOOTINGS { 4½ cubic yards 1:2½:3½ mixture; 6½ gal. of water per sack of cement }

Portland cement	26 sacks
Sand (fine aggregate)	2½ cubic yards
Stone (coarse aggregate)	3½ cubic yards

FLOOR, 1 COARSE { 6½ cubic yards, 1:2:3 mixture; 5½ gal. of water per sack of cement }

Portland cement	45 sacks
Sand (fine aggregate)	3⅓ cubic yards
Stone (coarse aggregate)	5 cubic yards

Dimension Lumber

(1200 B.M. ft.)

Use	No. Pieces	Size Inches	Length Feet
Front sill and plates	3	2 × 4	16
Front sill and plates	3	2 × 4	14
*Front studs	14	2 × 4	8
Front wall brace	2	2 × 4	8½
Front window headers	10	2 × 4	3
Rear sill and plate	3	2 × 4	16
Rear sill and plates	3	2 × 4	14
*Rear studs	14	2 × 4	5
Rear wall brace	2	2 × 4	5½
Rear window headers	5	2 × 4	3
Rear window headers	5	2 × 2	3
End sills	2	2 × 4	16
End sills	2	2 × 4	9
End studs	12	2 × 4	14
Door header	1	2 × 4	3
End wall brace	2	2 × 4	8½
End wall brace	2	2 × 4	6
Purlin	2	2 × 8	16
Purlin	2	2 × 8	14

* These studs are the frames for the window, and therefore must be straight

Use	No. Pieces	Size Inches	Length Feet
Post	4	2 × 4	6½
Post ties	2	2 × 4	2
Rafters	32	2 × 6	14
Lookouts	16	2 × 4	3
Droppings platform, frame	3	2 × 4	16
Droppings platform, frame	3	2 × 4	14
Dropping platform, posts	18	2 × 4	2½
Roosts	10	2 × 2	6
Roosts for stationary platform (rounded)	25	2 × 2	5⅓
Or: Roosts for movable platforms	15	2 × 2	10

Miscellaneous Lumber

1,000 feet B.M. fir drop siding—Pattern No. 106
1,100 feet B.M. 1″ × 8″ shiplap roof sheathing
200 feet B.M. 1″ × 6″ tongue and grooved dropping board—6 ft. lengths
1,400 sq. ft. Insulation board for lining inside of house
200 linear feet 2″ × 2″ for nailing strips insulation board
5 pieces 1¼″ × 8″, 3 feet long, white pine window sills
5 pieces 1¼″ × 5″, 3 feet long, white pine window sills
125 linear feet 1″ × 1″ window and door stops
30 linear feet ¾″ × ¾″ quarter round to go under window sill
64 linear feet 1″ × 4″ verge board
1 piece 1″ × 6″, 14 feet long, door braces
30 linear feet 1″ × 4″ corner boards
30 linear feet 1″ × 3″ corner boards

Hardware, Roofing, Sash, Etc.

10 rolls prepared roofing with nails and cement (not slated covered roofing)
800 sq. ft. tarred felt paper for floor
5 9-light 9″ × 12″ sash
5 6-light 9″ × 12″ sash
(Note: Sash may be glazed with ordinary glass or covered with glass substitute)
5 3-light 9″ × 12″ cellar sash
29 linear feet 1½″ mesh poultry netting, 6 ft. wide, for roosts
38 linear feet 1″ mesh poultry netting, 3 ft. wide, for windows
5 pairs 3½″ butts with screws, for windows
5 pairs 3″ butts with screws, for windows
5 2″ butts with screws, for window adjusters
1 pair 6″ T-hinge with screws, for door
1 door latch
250 ft. No. 10 wire, for roosts
20 ½″ × 6″ lag screws, for roosts
13 ½″ × 8″ bolts with nuts and washers
2 lbs. poultry netting staples
20 lbs. 6d common nails
20 lbs. 8d common nails
20 lbs. 10d common nails
20 lbs. 20d common nails
20 lbs. 1½″ galvanized roofing nails with 3/9″ head, for insulation board

Shed Roof Laying House, 20 by 30 Feet

(Frame construction)

This house is built to accommodate 200 Leghorns or 150 birds of the heavier breeds. The plan shown in Fig. 28 is for a one-unit house 30 feet long, but the house can be built in any number of units desired. Where several units are constructed, it is desirable to have a feed room at one end, or in the center of the house. This house is similar to the 25- by 30-foot house, except in width. The floor plan is also shown in Fig. 28.

The front wall framing in this house is the same as in the 25- by 30-foot house shown in Fig. 25, except that the studs are 7′ 6″ instead of 8′ 0″.

The five front windows are the same size as those used in the 25-foot house, and are hinged for ventilation in the same manner as the other house.

The roosts are made with four perches instead of five as used in the 25-foot house; the dropping boards are likewise a foot narrower.

Bill of Material for

20- by 30-foot Shed Roof Frame Laying House

Concrete

The amounts given below are based upon a dry sand well graded in size from fine to ¼ inch, and the stone from ¼ inch to 1½ inches. A reasonable amount has been added for waste.

FOUNDATION AND POSTS FOOTINGS { 4 cubic yards 1:2½:3½ mixture; 6½ gal. of water per sack of cement

Portland cement	23 sacks
Sand (fine aggregate)	2¼ cubic yards
Stone (coarse aggregate)	3 cubic yards

FLOOR, 1 COARSE { 5 cubic yards, 1:2:3 mixture; 5½ gal. of water per sack of cement

Portland cement	36 sacks
Sand (fine aggregate)	2⅔ cubic yards
Stone (coarse aggregate)	4 cubic yards

Dimension Lumber

Use	No. Pieces	Size Inches	Length Feet
Front sill and plates	3	2 × 4	16
Front sill and plates	3	2 × 4	14
*Front studs	14	2 × 4	7½
Front wall brace	2	2 × 4	8
Front window headers	10	2 × 4	3
Rear sill and plates	3	2 × 4	16
Rear sill and plates	3	2 × 4	14
*Rear studs	14	2 × 4	5
Rear wall brace	2	2 × 4	5½
Rear window headers	5	2 × 4	3
Rear window headers	5	2 × 2	3
End sills	4	2 × 4	10
End studs	10	2 × 4	14
Door header	1	2 × 4	3
End wall brace	2	2 × 4	8½
End wall brace	2	2 × 4	6

* These studs are the frames for the windows and therefore must be straight.

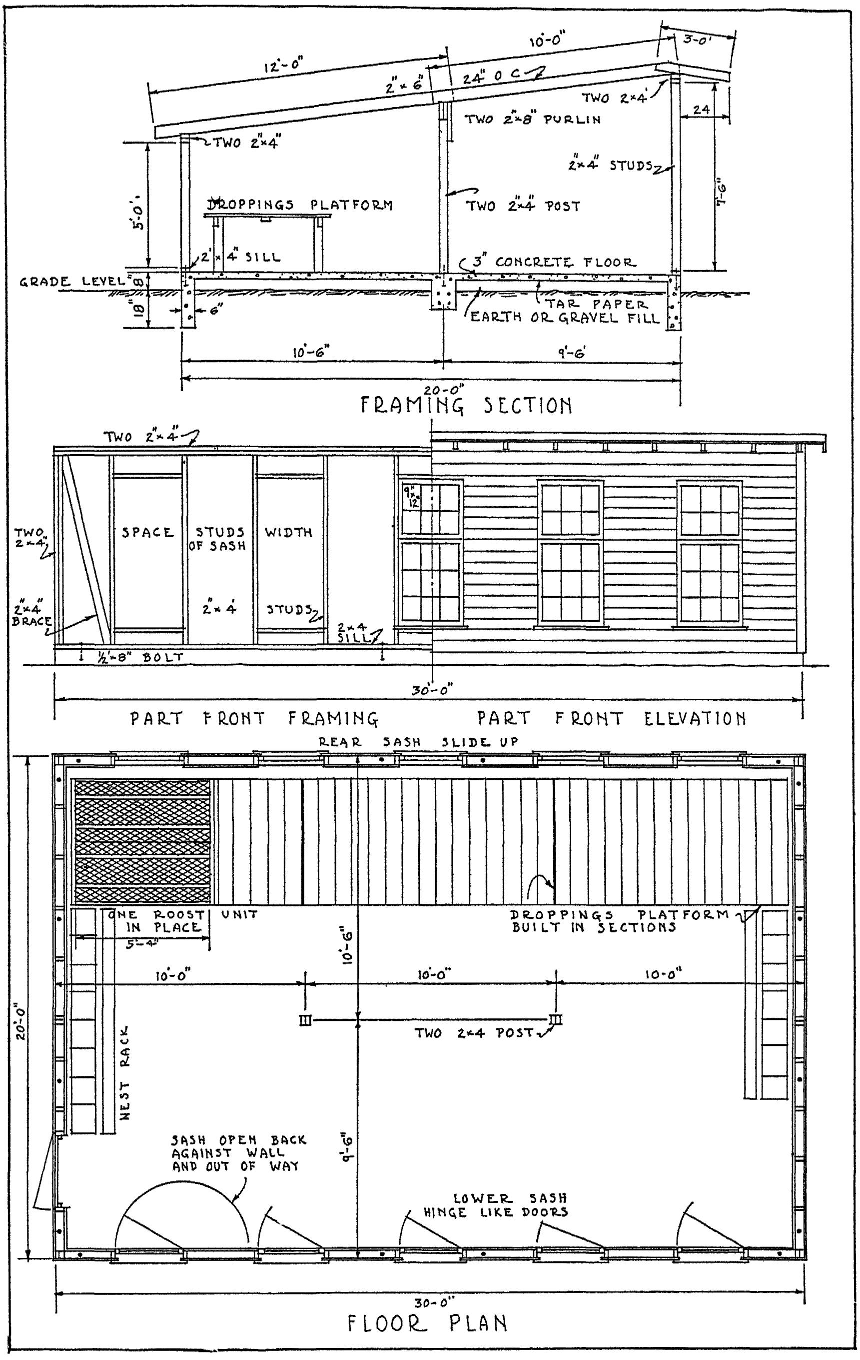

Fig. 28.—End view, front, and floor plan of 20- by 30-foot shed roof house.

Use	No. Pieces	Size Inches	Length Feet
Purlin	2	2 × 8	16
Purlin	2	2 × 8	14
Posts	4	2 × 4	6½
Post ties	2	2 × 4	2
Rafters	16	2 × 6	12
Rafters	16	2 × 6	10
Lookouts	16	2 × 4	3
Droppings boards, frame	3	2 × 4	16
Droppings boards, frame	3	2 × 4	14
Droppings boards, posts	18	2 × 4	2½
Roosts	10	2 × 2	5
Roosts for stationary platform (rounded)	20	2 × 2	5⅓
Or: Roosts for movable platform	12	2 × 2	10

Miscellaneous Lumber

850 feet B.M. fir drop siding pattern No. 106
850 feet B.M. 1″ × 8″ shiplap roof sheathing
175 feet B.M. 1″ × 6″ tongue and grooved dropping boards, 5 ft. lengths
1,150 sq. ft. insulation board for lining house (none added for wastage)
200 linear feet 2″ × 2″ nailing strips for insulation board
5 pieces 1¼″ × 8″, 3 feet long, white pine window sills
5 pieces 1¼″ × 5″, 3 feet long, white pine window sills
125 linear feet 1″ × 1″ window and door strips
30 linear feet ¾″ × ¾″ quarter round, under window sills
48 linear feet 1″ × 4″ verge board
30 linear feet 1″ × 4″ corner boards
30 linear feet 1″ × 3″ corner boards
1 piece 1″ × 6″, 14 feet long, door braces

Hardware, Roofing, Sash

8 rolls prepared roofing with nails and cement (not slated covered roofing)
600 square feet tarred felt paper for floor
5 6-light 9″ × 12″ sash } Sash may be glazed with ordinary glass or covered with glass substitute.
5 9-light 9″ × 12″ sash }
5 3-light 9″ × 12″ cellar sash
29 linear feet 1½″ mesh poultry netting, 5 ft. wide for roosts
38 linear feet 1″ mesh poultry netting, 3 ft. wide for windows
5 pairs 3½″ butts with screws for windows
5 pairs 3″ butts with screws for windows
5 pairs 2″ butts with screws for window adjuster
1 pair 6″ T-hinges with screws for door
1 door latch
200 ft. No. 10 wire
20 ½″ × 6″ lag screws for roosts
18 ½″ × 8″ bolts, with nuts and washers
20 lbs. 1½ gal. roofing nails with ⅜″ heads for insulation board
2 lbs. poultry netting staples
20 lbs. 6d common nails
20 lbs. 8d common nails
20 lbs. 10d common nails
20 lbs. 20d common nails

Shed Roof Laying House, 20 by 30 Feet

This laying house is similar to the frame house in every detail except the material used. With this house, concrete blocks or hollow tile are used in place of the frame construction. Bill of material and blueprints on request.

A pre-cast cap reinforced with ½-inch round bars is made for all windows and door openings. If the concrete blocks are allowed to rest upon a wooden window frame, they will usually sag and crack.

The windows are the same size as used in the other houses, and are hinged for ventilation in the same manner. The inside of the concrete walls and ceiling is lined with insulation board similar to that used in the wooden houses.

The masonry walls can be constructed of either concrete block, brick, or hollow tile. A new material on the market made of burned shale or slag used

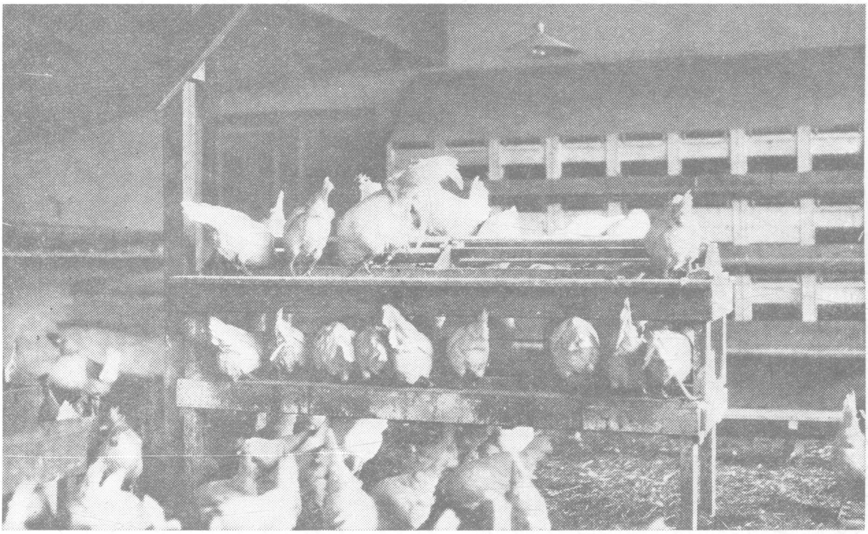

Fig. 29.—Sufficient mash hopper space is an important factor in high egg production.

in the manufacture of concrete blocks and bricks is claimed to have more insulating value than ordinary concrete block.

The mortar used in laying the bricks or tile of a masonry house should be made of one part Portland cement, one part commercially slaked or hydrated lime, and six parts of clean sand (measured by volume). Both the horizontal and vertical joints should be approximately ¼ inch thick.

The corners are usually built up first and a chalk line is stretched tightly between them to serve as a guide for building a straight wall.

The frames for doors and windows are set in position and built into the wall. The triangular openings at the top of the wall next to the roof are usually filled with monolithic concrete. The cap for the windows and doors may be cast in place or cast previous to building the house.

The plates are attached to the top course of blocks by bolts at least 10 inches long, with nuts and large washers inserted in the air spaces of the block and filled around with concrete to insure a firm anchorage. The bolts should be from 4 to 6 feet apart in the wall.

Equipment for the Laying Houses

NEST RACK

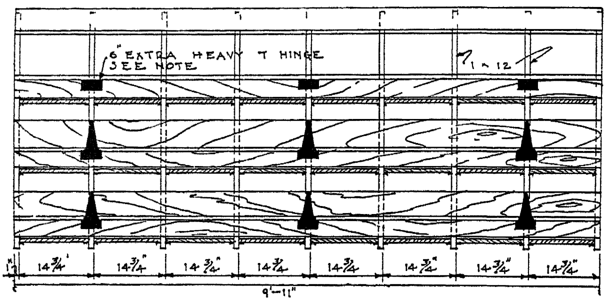

Fig. 30.—Front view of nest rack.

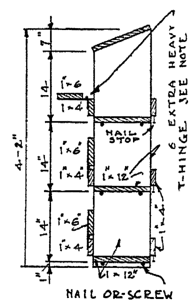

Fig 31.—Cross section of nest rack.

The nest racks are fastened against the end walls, as shown in Fig. 23. This arrangement is superior to having the nests underneath the dropping board where they are likely to harbor disease and lice.

These nests are easy to reach for cleaning and disinfecting. The nest bottoms rest on nails driven part way into the 1" × 12" partitions, and can easily be removed for cleaning.

The hinged door-like shelves or platforms serve two purposes: (1) The birds can walk along them to enter the nests; (2) In case the birds tend to roost in the nests at night the platforms can be closed up. Put the hinges on backward so they will act as brackets. (See Fig. 30.)

A sloping top prevents the hens roosting on top of the nest rack. Allowing one nest for five hens, this nest rack will take care of 120 birds.

Bill of Material for Nest Racks

Dimensions given are nominal size. The amount of material given below will build only one nest rack

3 pieces 1" × 12", 12 ft. long (each piece cuts into 3 pieces 4' 2" long—this is possible because of the diagonal cut.)
6 pieces 1 × 4, 10 ft. long.
3 pieces 1 × 6, 10 ft. long.
1 piece 1 × 12, 10 ft. long.
1 piece 1 × 3, 10 ft. long.
24 pieces ½" × 12" × 14" stiff insulation board, for nest bottoms.
8 6" extra heavy T hinges, with ¾" No. 10 screws.
2 lb. 6d box nails.

DRY MASH FEEDER FOR LAYERS

In order to insure maximum egg production, it is necessary to provide ample feeding space for the birds. In the old type mash hoppers—so-called "self-feeding hoppers"—a large quantity of mash usually was placed in the box, much of which would become stale before being consumed.

This new type of hopper requires very little space in the house, and allows the birds to feed on both sides; its great advantage is that fresh mash must be supplied every day, a practice which stimulates mash consumption and egg production. It is waste-proof and keeps the feed clean. The feed is easily accessible, and with ample light the birds naturally eat more mash.

The hopper itself is often built "V" shape, instead of rectangular as shown.

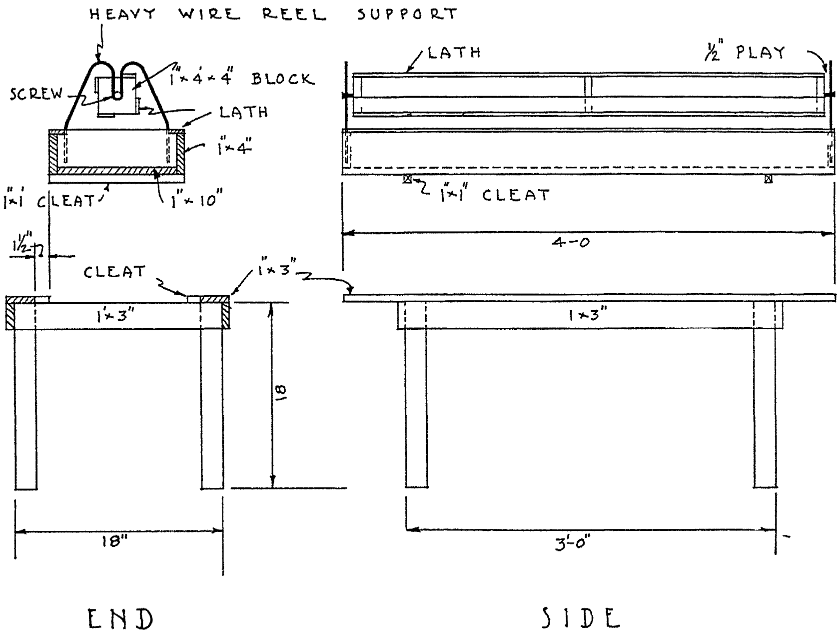

Fig. 32.—Dry mash feeder for layers. This feeder will serve about 40 birds. Six feeders this size are necessary for a 25- by 30-foot house. The clearance between the reel and edge of the box should be 3½ inches for Leghorns and 4½ inches for the heavier breeds.

Bill of Material for Dry Mash Feeder for Layers

Dimensions given are nominal size

4 pieces 2" × 2", 1½ feet long.
2 pieces 1" × 3", 1½ feet long.
2 pieces 1" × 3", 3 feet long.
2 pieces 1" × 3", 4 feet long.
2 pieces 1" × 4", 4 feet long.
2 pieces 1" × 10", 4 inches long.
1 piece 1" × 10", 4 feet long.

3 linear feet 1" × 1" cleat.
6 lath, 4 feet long.
3 sq. blocks 1" × 4" × 4"
6 ft. No. 7 wire.
2 2½" No. 10 screws.
½ lb. 6d box nails.

WATER FOUNTAIN

Of all the fountains and watering devices on the market the common 14-quart galvanized water pail has many points of advantage when provided with a stand as illustrated. The water is kept clean and is easily accessible. The birds will take all but the last 1 or 2 inches of the water, which leaves a convenient amount to rinse the pail before putting in a fresh supply.

During very cold weather the pail filled with warm water will supply the birds for some time before freezing. In case the water does freeze, the ice is readily removed by heat or by the use of warm water. The pail is easy to clean and disinfect. The platforms may be made for one, two, or three pails as desired. This one-bucket stand will accommodate 75 to 100 birds.

Bill of Material for Water Stand

Dimensions given are nominal sizes

20 linear feet, 1″ × 2″. ½ lb. 6d nails.

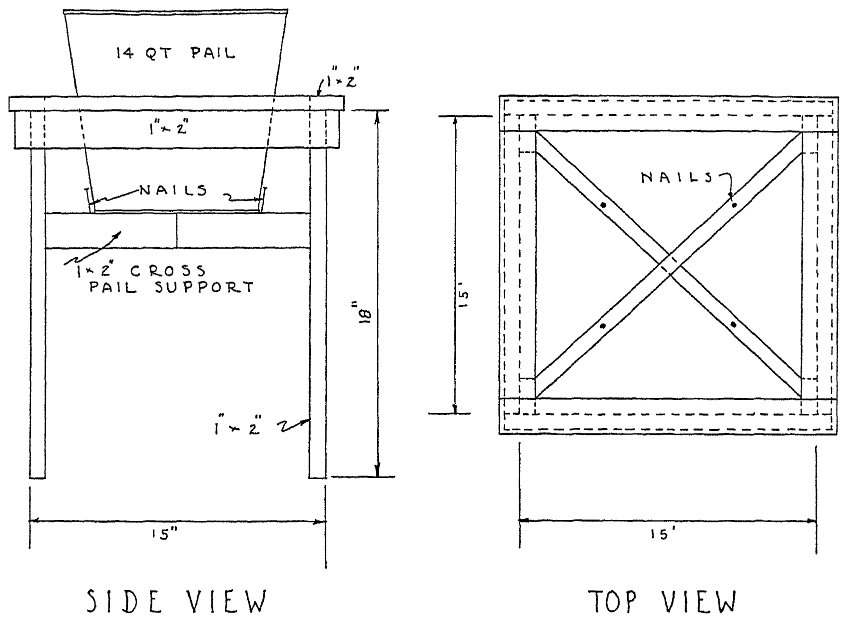

Fig. 33.—Practical watering stand made of an ordinary galvanized water pail. The table can be made longer, to hold two, three, or more pails.

INCINERATOR

One of the most dangerous practices on the average poultry farm is the method used to dispose of the carcasses of dead birds. If a bird dies of an infectious disease and is thrown out of the poultry house, dogs may drag it around and as a result, the entire premises may become infected. Also, birds feeding on these carcasses may spread the infection to the entire flock.

A simple incinerator can be made of concrete. The fuel is placed in the opening at the bottom; iron bars are embedded in the concrete about a foot high and on these the carcasses are placed. A chimney may be added. This equipment is all that is necessary for efficient incineration of carcasses.