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SUNSHINE AND SANITATION FOR HOG HOUSES

These healthy specimens got their start in an Iowa sunlit hog house.

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS

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SUNSHINE AND SANITATION FOR HOG HOUSES

By W. A. Foster and John M. Evvard.

In answering hundreds of inquiries concerning sunshine, sanitation and ventilation in hog houses, considerable data has been collected by the Agricultural Engineering and Animal Husbandry Sections and is now published in this bulletin. Sunshine and sanitation for hog houses are given chief consideration, but in addition, the various health essentials of the hog house are also emphasized. The ventilation problem is being studied and later it is hoped to issue a bulletin covering that specific subject.

Sunlight is recognized as one of the most essential factors in the promotion of health among swine. Sunshine adds warmth, promotes dryness, facilitates lighting, encourages ventilation, makes for better sanitation and, in general, adds to the safety and comfort of pigs as well as to the contentment and comfort of the herdsman.

Correct sanitation is in a sense inseparably linked with the proper provision of sunshine and abundant lighting; hence, sunshine and sanitation go hand in hand, each contributing to the good effects of the other. By sanitation is meant the devising and applying of measures which are effective in the preservation and promotion of swine health, or, in short, the application of the laws of sanitary science, which, when properly observed, discourage disease and promote good health.

In actual practice, ventilation is really inseparable from sunshine and sanitation, and in this bulletin we refer to ventilation only to emphasize its importance and to show wherein it is of great value in securing the proper returns from correctly applied sunshine and sanitation.

Fresh air, therefore, must be doubly emphasized, particularly because modern methods of erecting buildings preclude fresh air unless special provision is made for it. Close fitting doors and windows are the rule. The increased cost of materials and better workmanship naturally have stimulated close-fitting construction, thus making buildings air and wind proof, so much so, in fact, that there is but little leakage of fresh air.

These tight-walled, snugly-roofed houses, whether for hogs or other live stock, have necessitated the development of feasible and practical schemes for ventilation, such as the "King system" and the "Rutherford system". These systems for ventilation and their adaptability to hog houses are now being studied by the Animal Husbandry and Agricultural Engineering Sections.
It is the purpose of this bulletin (1) to emphasize and explain briefly the health essentials of hog houses, and (2) to demonstrate how sunshine and sanitation, two of the most important of these health essentials, can be provided.

ESSENTIALS OF THE HOG HOUSE

The successful, healthful house for hogs should possess provision for the following requirements:

1. **Sunlight.** Direct sunlight is one of Nature's most efficient tonics. It might almost be said that direct sunlight is practically indispensable for successful and prosperous swine husbandry. Direct sunlight destroys pathogenic or disease-causing organisms. Direct sunlight provides some of the warmth so essential. Direct sunlight is composed of many different kinds of rays, which have different properties and, in a general way, contribute to the health and well-being of pigs by their action, not only on the animals themselves, but on their environment. Direct sunlight promotes dryness, especially desirable and sought in the swinehouse. The ideal in hog house construction should be to enable direct sunlight to strike every portion of the interior at some time during the day, and to exercise its beneficent influence in full measure on walls, floors, sides and ceiling. Direct sunlight assists in proper ventilation and, naturally, is of great importance in sanitation. Direct sunlight helps in making the house a safer place for pigs and a more comfortable abode. Direct sunlight adds to the convenience, the utility, the serviceability and the durability of the hog house. Direct sunlight decreases the cost of maintenance and brings out a pleasing appearance of the hogs. Direct sunlight is, in short, indispensable for maximum health, strength and vigor.

The difference between direct sunlight and darkness in the farrowing pen means the difference between success and failure. The sun's influence can hardly be over-emphasized during this period of swine increase. In the late fall and early spring farrowing season, and particularly in January, February and March, direct sunshine has no real substitute. In these earlier months, the rearing of the young pigs is largely an indoor task, and the outdoor benefits should be brought to them in as large a measure as practicable.

Direct sunshine can be supplied by the proper placing of windows, which, together with correct ventilation, brings indoors the outdoor benefits that encourage growth and development of swine. A swineman can advantageously go considerably out of his way, if necessary, in order to secure sunshine in the farrowing pen. He can usually afford to remodel and re-
construct his permanent buildings so that they may be provided with sunshine.

2. **Lighting.** Good lighting naturally comes with an abundance of sunlight, altho other means are possible for its provision, such, for instance, as the increasing of the windows thru which indirect lighting may come. Good lighting in a sense has practically all the advantages of direct sunshine, but in a lesser degree. Swine enjoy greater comfort when the house is well-lighted, and their caretaker is enabled to work to better advantage. In general, a well-lighted house is more likely to be kept clean, dry, warm, well-ventilated and more sanitary than where darkness prevails.

3. **Ventilation.** Proper ventilation calls for the constant admission of fresh, pure air and the outpouring of impure air. In years gone by, the hogs lived in the open woods and the sows farrowed their young in the fence corners or under the protecting ledge of a rocky hillside, where fresh air was abundantly supplied and ventilation was not a problem. With modern, tight structures, artificial conditions have accentuated or multiplied the difficulties of securing this essential fresh air. Much time and thought can well be put into perfecting methods and devices for securing the entrance of a proper amount of fresh air and the removal of foul air from the quarters provided for pigs.

The air which has been breathed by hogs contains considerable moisture. This is evident on cold, frosty mornings when one can "see the breath" of the pigs, the moisture in the air forming very minute particles of frost, which cause the fog-like appearance. This moisture-laden breath from the swine condenses on striking the ceiling or walls and accumulates to such an extent that it may drip down upon the pigs. This harasses the swine and exasperates the herdsman. The hogs get wet, the floors become soaked, the nests are damp and soggy, all of which works to the detriment of good health and encourages unthriftiness, indirectly promoting the causes of disease. The pigs are made susceptible to such diseases as rheumatism, pneumonia and a great many others that are not ordinarily directly associated with wet and damp quarters. Proper ventilation and construction eliminate excessive moisture condensation. To keep the house warm, dry and healthful, proper ventilation that supplies fresh air enough but not too much, and makes provision for the proper exit of foul air, is to be emphasized and reemphasized.

4. **Dryness.** The clean, dry house that is well lighted and sunned, properly ventilated, properly located and well drained, is the house that is most likely to be dry and comfortable. The dry house is secured by paying attention to the essentials enum-
erated and exercising good judgment in executing them. The house should be located so as to provide possibilities for proper drainage. Drainage may be secured by the proper placing of tile under the floors and outside of the foundation walls. The floor should, of course, be on a higher level than the grade, so that the ground slopes from the house. This precaution prevents water collecting and discourages the making of wallows and mud holes. Besides dry surroundings, the house should have a smooth, well-drained floor, sheltered by good walls and protected by a dry, tight roof. The roof materials should be such that water will not unduly condense on the ceiling, as may happen with metal construction. It is oftentimes advisable to enclose the rafters under the roof with matched flooring or ceiling, thereby providing a protective air space. This, together with ventilation, will largely eliminate the conditions which make moisture condensation and dripping possible. By dryness is meant dry underfoot, overhead and round about.

5. **Warmth.** The heat which has been released in the house by animals, by stoves, or by the sun, should be controlled so that it may be retained in as large measure as may be desired, or released and replaced with cooler outside air in the warm season. The hog house constructed so as to control the sunshine, the light, the ventilation, the shade, the conduction of heat, and the dryness, is one that bests meets the essentials of warmth.

The well-built hog house needs to have good floors. Tight walls are particularly appreciated in freezing weather. Close-fitting doors and windows which are readily opened and closed, either partially or entirely, are as essential as tight walls. The tight, non-leaking roof, properly built and properly equipped with window sash, has come into successful use in recent years.

The animal and other heat in the house may be retained by the use of a combination floor of hollow tile and cement, or, in case a wooden floor is used, by making the foundation walls tight and impermeable. Clay tile floors, or a combination of clay tile and concrete, are better than solid concrete. Tight walls conserve heat. Close fitting doors and windows prevent air leakage and undesirable drafts. A good, substantial roof helps to insure a dry floor and greater warmth.

By warmth we really mean, therefore, the correct temperature in the winter time being much higher within the house than outdoors. With the opposite true in the hot summer, protection is necessary against both cold and undue heat.

6. **Sanitation.** The hog is an animal which lives close to the ground, eating and breathing continuously in a stratum of air ordinarily not more than a foot and a half deep. This fact is apt to be overlooked. It is on or near the floor usually that unsanitary conditions prevail. Hence, because of its build, the hog
is usually at a disadvantage and for that reason, proper care
should be taken to make the hog house a sanitary place.

Smooth walls and floors, without cracks and crevices, are es­
sential for good hog house sanitation. With smoothness and
tightness of walls and floors and with proper drainage and ven­
tilation, the filth in which disease breeds has less opportunity to
lodge. Practical sanitation is a product of direct sunshining,
abundant lighting, proper ventilation, dryness, necessary warmth,
sufficient space and clean environment. Sprinkling air-slaked
lime over the hog house floors is an excellent practice at times.
Occasionally a good disinfection with a standard coal tar dip,
properly diluted with water, is in order. Spraying with white­
wash is beneficial in killing disease-producing organisms and in
improving the lighting.

7. Shade. As essential as is direct sunshine, shade is just as
important to keep hogs from being over-sunned. A happy con­
trol must be exercised over the direct rays of the sun if the hog­
man would utilize their possibilities to the greatest advantage.
Shade is a great blessing and most essential, not only in the hot
days of summer, but also in the winter. Both high temperatures
and low temperatures have their adverse effects, and shade helps
to reduce the difference between the extremes.

The ideal shade is furnished by a dense growth of leaves, high
enough above the animals so that there will be an abundance of
ventilation thru natural atmospheric currents or breezes below.
The hog house properly built should be so constructed that it
will offer similar comforts to hogs in summer as in winter, pro­
tecting the hogs from sunshine in the hot days of July and Aug­
ust, particularly, and providing sunshine in the winter, altho
not too much of it.

Leafy trees are not always available for shade; hence, artifi­
cial means for providing it must sometimes be adopted. To se­
cure shade is the reason for including in hog houses side doors
that lift and hang horizontally, and sliding curtains over win­
dows to shut off the sun. Roof doors that may be opened for sun­
shine or closed for shade may also be provided.

Shade, to be most effective, must be dependable; that is, it
must not move unduly or in a casual fashion as the sun shifts,
as happens when shades are built high from the ground in con­
trast to those built low. The shade provided by roof doors
hinged at the ridge or peak of the roof of "A"-shaped hog
houses, is not constant enough nor dependable enough for good
results. To enjoy the shade under such undesirable shelters,
the hog must keep moving, which is a serious disadvantage.

Shades must be advantageously placed over a portion of the
hog wallow. Otherwise fattening shoats or other hogs that wal­
low to cool themselves are forced to absorb an immense amount

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of heat from the direct sunshine, which defeats the very object of the wallow.

The hog requires much more protection than horses, cattle or sheep, and protection from undue sun heat is to be most emphasized. This protection is secured thru the judicious and effective use of those devices which provide shade at the right time and in the right place.

8. **Comfort.** The uncomfortable hog is not the best money-maker. The marketman knows that the fattening hog should be made comfortable so that he will lie down in peace and quiet, particularly when he is being "finished off". The breeder knows that the brood sow at farrowing time should have things comfortably arranged so that she can produce her brood most advantageously.

Warm floors in winter and cool ground underneath in summer promote comfort. Rough, uneven floors cause restlessness and discomfort. Cold pigs will pile up and squeal, and here the lack of comfort may become a costly matter, resulting in the death of swine. To secure the greatest gains with the largest margin of profit is one of the hogman's aims, but such results may be secured only thru proper care and management under suitable conditions that provide a reasonable degree of comfort to the swine.

9. **Safety.** Freedom from danger or risk is essential in the swine house. Avoidable injury or harm should be guarded against. This means the avoidance of slippery floors, cracks or corners that catch and hold feed and other body parts, heavy, banging doors, the falling of timbers or storage material from overhead, and so on. High door sills should not be permitted and narrow doorways should be shunned. On the other hand, provision may well be made for fenders that save the lives of suckling pigs and pig-proof fences that do not permit lodging.

10. **Convenience.** To make the hog house most convenient, it must not only be well located, but it must be built to make it as convenient as possible.

The location should be easily accessible to the cribs and barns and yet at a reasonable distance from the dwelling. It should not be too close to the poultry yard, because swine and poultry may not get along well together, and poultry is likely to be found too much in the hog yards. Sometimes swine eat chickens and the poultry will steal the feed intended for the swine.

The plans should be adapted to the needs of the individual feeder, being as handy, flexible and practical as possible, so that the house may be easily cared for and with the largest saving of labor.

11. **Permanency.** The hog house that will last for a number of years is always preferable to the temporary kind of building.
In permanent building, workmanship is as important as the material used. Permanency also calls for a suitable and good design or plan.

Paint is to be emphasized for wooden structures. Masonry and clay tile construction with hollow walls deserve particular consideration in selecting materials that stand for permanency. Concrete is another durable material. Steel reinforcements and wire panels and gates are important because of their stability. Masonry walls should be built to keep dry and the mortar joints should be well pointed.

12. Appearance. Good design, attractive colors and an intelligent arrangement of buildings improve the general appearance of the farmstead. All this, with proper planting of trees and shrubbery, helps to enhance the value of the farm. The attractive building group with suitable plantings of trees and shrubbery is an asset that is sometimes overlooked. It develops a home pride that is not inconsiderable.

13. Flexibility, Serviceability and Utility. By flexibility in a hog house is meant a plan and construction that will permit it to be adapted quickly to different purposes. For instance, it should be easy to throw two pens into one, or practically the whole house into one large pen, if necessary. It should be easy to make adaptations to new situations as regards ventilation. The same is true of the needs of sunshine and warming.

By serviceability is meant that every portion of the house should perform its proper function as nearly 100 percent as possible.

By utility is meant the usefulness of the house for many purposes, particularly as to its being in service every day in the year, whether as a hog house, a sheep shelter, or a calf barn, poultry house, granary, vegetable storehouse or what not. To fulfill all of these functions requires much forethought and foresight in the planning and building.

To provide the greatest serviceability and utility, it is essential that the capacity of the house be consistent with the number, weight and kind of hogs to be housed. Too much floor and overhead space is usually better than too little, although a middle ground is to be sought.

14. Simplicity of Construction. Construction should be as simple as possible.

15. Reasonable Initial Cost and Maintenance. The first cost is important. It should be consistent with the kind of structure built. To build so cheaply as to necessitate a high maintenance cost later is a pitfall that should be guarded against. It is better to increase the original cost 50 to 100 percent and so build that the upkeep will be at a minimum throughout the years to come.
than to build hastily in a ramshackle sort of way and thus necessitate a higher maintenance cost, as well as early rebuilding.

**PROPER PLACING OF WINDOWS FOR SUNLIGHT**

The efficiency of many hog houses has been reduced by the improper location of windows, some being placed too high and others too low. Windows should admit sunshine when needed, and two factors must be considered in securing such a result. One is latitude, which determines the direction of the sun’s rays; the second is the time of the farrowing season.

Latitude is the distance north or south of the equator, measured in degrees (°) and minutes (′), and indicated on the sides of a map. The latitude map of Iowa is shown in fig. 1. For example, John Jones lives near Marshalltown. Follow the nearest line to the sides of the map and you find this is 42°. Mr. Jones lives at 42° north latitude — north because north of the equator.

The farrowing season varies according to the practice of the individual breeder. The spring farrowing season usually ranges from January thru May. The month of March is most commonly chosen, because the cold weather is ordinarily somewhat moderated by then and also because March pigs are ready for market following the corn harvest and before the cold weather of winter comes on.

The sun is lowest and casts its longest shadow at noon when it is farthest south. This is about December 21. It then moves northward and climbs higher each day until June 22, when at

![Fig. 1. Latitude map of Iowa.](image)
high noon it is nearly directly overhead. Consequently, the shadow of a post at noon shortens from December 21 to June 22, then lengthens again until December 21, when it is longest.

Windows should be located so that the sunshine, when passing thru the top of a window on the south side of an "east and west" house at noon, will fall at the north edge of the pen. This means that the band of sunshine in the house will extend from the north edge of the pen as far to the south edge as the height of the window will permit. It is important also to locate the windows so that the sunshine will strike the floors of the pen in the desired season of farrowing. To do this it is necessary to have information as to the sun's height and the angle of its rays at noon time at any given latitude at the different seasons of the year. This information will be found in table I, simplified and applied to the state of Iowa. Table I gives in feet and inches the height of window tops for Iowa, so figured that the sunshine will strike the north edge of pens 8'-0" deep, or will fall 8 feet inward from the wall in which the window is placed. It covers the spring farrowing months of January, February, March, April and May, and also the fall farrowing season from August to November, inclusive.

The distance of 8 feet inside the wall that contains the window is taken because the standard pen is about 8 feet long. Table I shows a difference of about 8 inches between northern Iowa (43° 30') and southern Iowa (40° 30') in height of window for March 1. A greater difference is seen for April 1 and May 1, or 13 inches and 22 inches respectively.

HOW TO PROCEED TO LOCATE WINDOWS

First, locate your latitude on the map of Iowa (fig. 1), using the nearest half degree line. Second, decide upon the date of the farrowing season. Third, take the height of the window direct from table 1.

<table>
<thead>
<tr>
<th>HEIGHT of WINDOW for SUNLIGHT 8:0 inside WALL</th>
<th>Spring January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lat.</td>
<td>I</td>
<td>15</td>
<td>I</td>
<td>15</td>
<td>I</td>
</tr>
<tr>
<td>40°30'</td>
<td>4:0&quot;</td>
<td>4:2&quot;</td>
<td>5:0&quot;</td>
<td>5:10&quot;</td>
<td>7:2&quot;</td>
</tr>
<tr>
<td>41°</td>
<td>3:10&quot;</td>
<td>4:4&quot;</td>
<td>4:11&quot;</td>
<td>5:10&quot;</td>
<td>7:0&quot;</td>
</tr>
<tr>
<td>41°30'</td>
<td>3:10&quot;</td>
<td>4:13&quot;</td>
<td>4:10&quot;</td>
<td>5:9&quot;</td>
<td>6:16&quot;</td>
</tr>
<tr>
<td>42°</td>
<td>3:9&quot;</td>
<td>4:2&quot;</td>
<td>4:19&quot;</td>
<td>5:8&quot;</td>
<td>6:8&quot;</td>
</tr>
<tr>
<td>42°30'</td>
<td>3:8&quot;</td>
<td>4:11&quot;</td>
<td>4:18&quot;</td>
<td>5:6&quot;</td>
<td>6:8&quot;</td>
</tr>
<tr>
<td>43°</td>
<td>3:7&quot;</td>
<td>4:2&quot;</td>
<td>4:17&quot;</td>
<td>5:5&quot;</td>
<td>6:6&quot;</td>
</tr>
<tr>
<td>43°30'</td>
<td>3:6&quot;</td>
<td>4:11&quot;</td>
<td>4:16&quot;</td>
<td>5:4&quot;</td>
<td>6:6&quot;</td>
</tr>
<tr>
<td>44°</td>
<td>3:5&quot;</td>
<td>3:10&quot;</td>
<td>4:15&quot;</td>
<td>5:3&quot;</td>
<td>6:5&quot;</td>
</tr>
</tbody>
</table>

Table I For State of Iowa and Similar Latitudes At Noon.
Figs. 2, 3, and 4. These figures show the differences in height of window applicable to different parts of the state. There is a difference of three inches in window heights between central and southern Iowa for January 1. This difference is 7 inches April 1, and 11 inches May 1. The difference for the north and south borders for January 1 is 6 inches, and as much as 22 inches on May 1. The angle of the sun’s rays is greater (i.e., the sun is higher) at noon than at 10 a.m. or 2 p.m. from September 21. The angle is the same throughout the day on March 21. After March 21 until September 21, the angle of the sun’s rays is greater (the sun is higher) at 10 a.m. or 2 p.m. than at noon time. This is shown on fig. 5, next page.
An example may be helpful. Iowa State College at Ames is located at about the center of Story county, or near 42° north latitude. If March 1 is the desired farrowing season, then on line 42° under March 1 will be found 6'-9", the necessary height of the top of window.

A farmer living at Red Oak, Montgomery county, wishes to secure the greatest amount of sunlight February 15. How high must he place the windows? Red Oak is near 41° north latitude (see map, fig. 1). On line 41° under February 15, table I, is found 5' 10" for height of the top of window.

In fig. 2, the height of the window top and the angles of the sun’s rays at noon are shown for 41° north latitude. This figure would include practically the three lower tiers of Iowa counties.

Fig. 3 gives practically the same information for 42° north latitude. It includes the three middle tiers of counties. Fig. 4 includes the three northern tiers of counties, 43° north latitude.

In fig. 5, the full lines give the angle of the sun’s rays at noon and the broken lines the angle of the sun’s rays at 10 a.m. or 2 p.m. It will be seen that these rays coincide March 21.

![Diagram of sun's rays at noon and 10 a.m. or 2 p.m.]

Fig. 5. The full lines indicate the angle of the sun’s rays at noon, the broken lines their angle at 10 a.m. or 2 p.m.
The manner in which the sunlight falls thru a window may be illustrated by holding a glazed sash upright in the sun. The sunshine will pass thru the glass and cast a shadow of the sash as shown in fig. 6. As this sash is raised or lowered, the position of the shadow changes. The shadow begins at the sash when the sash rests upon the ground, as shown in a, fig 6. When the sash is raised or placed on a post, (b, fig 6) the shadow is back some distance from the foot of the post. This distance depends upon the height to which the sash is raised.

The window of a hog house is a sash built in a wall. The sunshine passes thru the glass in the same way as it passes thru the sash supported on a post. If we had a long window with a sliding sash and a means of closing up both top and bottom, we should have a window which would be ideal. (See fig. 7). It would be a simple thing to adjust the sash each day so that it would allow the sunshine to reach the proper place in the pen. Since this movable sash is impractical, the glass must be placed in the best position for a selected farrowing time. A wall section showing a window and the position of the sunlight is shown in fig. 8.

**HOW TO LOCATE WINDOWS IN A SOUTH WALL**

By the aid of the map, fig. 1, and table I, the height of the top of the window for the south wall may be readily found. By the top of the window is meant the top of effective glass. This will depend upon the kind of sash used.
A number of wall sections of different type hog houses which demonstrate the position of the sunlight, are presented. These have been grouped according to the different types of houses.

**GABLE ROOF TYPE, SET EAST AND WEST**

The gable roof house is one of the most popular types. It is used in all parts of the United States, especially in the corn belt. All sections are shown for central Iowa, or 42° north latitude.

![Diagram showing sunshine at noon for different periods of the year.](image-url)

**Fig. 7.** Placing of sash to get full benefit of noon sunshine at different periods of the year.
The 20-foot width having two rows of 8-foot pens with a 4-foot feed alley between, is a very popular house. (See fig. 9) It is used in most cases where the house is small and the number of pens not large. The roof window is placed below the purlin, so the purlin does not break into the sunshine band and cast a shadow therein.

Another popular house is the 24-foot width, 8-foot drive. (See fig. 10.) The drive is necessary for the service and cleaning of a large house. In this case, the purlin would cut thru the window. Since the posts are 6 feet apart, they come under every other rafter; hence, the purlin on the south side may be left out. Short collar beams which stiffen unsupported rafters and hold the roof rigid, are used. This leaves only the posts to cast shadows.

The low-wall hog house with 10-foot pens is gaining favor (fig. 11). Two rows of continuous windows are used. The purlin is omitted. It may be well to nail a 2x4 on the under side of the rafters, as shown at a.

Frequently the triple-row hog house is built set east and west (fig. 12). In this there is no interference by purlins.
Figs. 9, 10, and 11. These figures show the position of the sun's rays at various periods in central Iowa in a hog house 20 feet wide, one 24 feet wide, and in a low gable roof house 24 feet wide, respectively.
PIPE AND WIRE PEN FRONT

Considerable sunlight is lost in these houses, due to the fence or gates at the front of the pens. This is easily remedied by using wire fencing or gates as shown in figs. 13, 14 and 15.

Metal fencing and gates for the hog house have much to commend them. In brief, their advantages are:

1. They allow a practical maximum of sunshine to strike on the floors and walls.
2. They make the pens better lighted, by favoring reflection.
3. They permit of more thorough circulation and hence of more thorough ventilation. This favors warmth.
4. They promote dryness and sanitation.
5. They make it possible for the swine to see each other and what is going on around them, and this makes them more "easy" in their pens.
6. They are in some respects safer. The hogs are not tempted to look over and climb up if they can see thru. Solid board partitions encourage the hogs to be inquisitive.
7. They are more convenient in that they are easily handled and less "dingy" than the board construction.
8. They are more permanent. Swine cannot gnaw them as they do wood, and they will not rust as fast as wood will rot.
9. They have a better appearance generally, they have greater flexibility and serviceability, and their maintenance cost is lower, if we disregard initial outlay.

The disadvantages may be enumerated as follows:

1. Present day difficulty of securing standardized products. This may be eliminated with a development of demand and a scheme for standardizing the units.
2. Relatively high initial cost as compared to wood, tho cheaper than the concrete partitions, which are not advised. As the gates and fence units are standardized, the cost should lessen.

3. They require special attention and methods to put sow off by herself. A few solid board partitions could be kept on hand for such emergencies. Where a larger degree of isolation is desired, the open wire partition and gates are not satisfactory.

4. There is a greater tendency for drafts in the poorly built hog house, inasmuch as the wire mesh will not protect as do solid boards.

5. In case of broken wires, the repairs are made with difficulty. To avoid this, a No. 9 or larger wire should be used in construction.

The combination solid panel with inserted gate, as shown in fig. 13, furnishes an idea as to how the metal construction may be designed for the front partition. Equipped with standard pipe couplings, it could be built at the farmstead. Usually it would not be profitable to “make at home”, however.

The inserted gate offers disadvantages to the caretaker; he would have to crawl thru or climb over the partition proper. However, this undesirable feature is partially eliminated in the design of fig. 14. In this design the gate swings from top attachments which make it possible to open it quickly in case the hogs are to be turned in together. It is also in one piece, which is advantageous. However, the caretaker has difficulty in entering and leaving the pen with this type also.

A better type of gate is outlined in the upper design of fig. 15,
Fig. 14. A front view of pipe and wire pen front with gate swinging from top attachments.

Fig. 14a. A side view of a gate swinging from top attachments.

Fig. 15a. Detailed view of hinge for gate in fig. 15.
this pen front being very practical, swinging from the side, as it does. This gate can be easily removed to throw all pens into one. It may also serve as a gate across the alley way. The herdsman can enter and leave the pens conveniently. Such a
gate is very useful and practical and has the endorsement of experienced men. This gate can be cheapened in construction costs by standardizing sizes and specifications covering material units.

The lower gate with the fence end necessitates a floor hole support, an open sleeve set in the concrete so that the vertical center pipe may slip therein. Other things being equal, this sleeve in the floor is objectionable. This scheme allows a small gate to be used in preference to the entire unit, but the herdsman must be satisfied with a small entrance opening. This style of gate can be made on the farm.

We recommend the side-swinging pen front (see upper design, fig. 15) for standardized use, and believe it has a good future in swine house construction. Its merits deserve consideration.

**COMBINATION TYPE HOG HOUSE**

The two-slope roof or combination type hog house is popular and successful. It is used extensively throughout the corn belt. A 20-foot width with a 4-foot feed alley is shown in fig. 16. It has a collar or tie beam which breaks the band of sunshine in the early and later part of the day. Since this beam is in tension, heavy wire may be used instead. The wire should be doubled and twisted until taut. Old silo hoops may be used for this purpose.

A low two-slope house is shown in fig. 17. The wire tie is used in this section. A 25-foot width house is shown in fig. 18. This
Figs. 16, 17, and 18. Position of the sun's rays in central Iowa at different periods in a 20-foot wide two-slope-roof house, a 20-foot wide low two-slope-roof house, and a 25-foot wide low two-slope-roof house.
allows for a driveway. Two rows of windows are shown. The silo hoop tie would serve well for the tie or collar beam illustrated.

**LOCATION OF ROOF WINDOWS**

In locating roof windows so that they will admit the sunshine as desired, the problem is to determine the proper height and slope of the roof and the length of the rafters, as well as the proper position of the window openings. As in the case of the south wall windows, the latitude and the desired time of farrowing must be taken into consideration, and again the data in table I are valuable.

To fix the roof window locations, it is necessary first to learn the angle or slant of the sun's rays at the farrowing time chosen for the latitude in which the house is to be built. Then this angle must be applied to the house building plan.

To illustrate, assume that a house 20 feet wide is to be built in latitude 41° north, and that the desired farrowing time is March 1.

First, make a triangle of card board or thin board with angles which represent the slant of the sun's rays March 1. (See fig. 19). For the bottom or base of the triangle, draw a line representing the 8 foot standard width of pens, on the scale of one inch to the foot. This base line will therefore be 8 inches long. For the height of the triangle, refer to table I, and to the latitude 41°-March 1 column. The height there given, 7 feet, is to be taken as the height of the triangle. Draw this height line at right angles to the right end of the 8 inch base line, then connect the ends of the two lines with the slant line, and cut out the triangle. The slant line shows the slant of the sun's rays at the date chosen.

Next, apply this triangle or slant to the hog house building plans, in this manner:

*Procedure*: 1. Fasten a plain piece of paper to a table or smooth board with small tacks. (See fig. 20.)

2. Draw the floor line (a-b-c) 20 inches long, representing the 20-foot width of the house on the basis of the one inch scale. The point b is midway between a-b-c. It is best to use a
steel square, or straight edge and rule, for drawing the various lines.

3. Draw lines a-e and c-d for the side walls.
4. Place the base line of the triangle on the floor line a-b.
5. Draw the line a-g, following the slant edge of the triangle, being sure that the lower left angle or corner of the triangle is placed directly at a and extended to h. This slant line represents the direction of sunshine rays.
6. From b draw an upright line b-f. For a gable roof house, the ridge or gable falls on the line b-f. The ridge should be far enough above the point where the line b-f crosses the line a-g-h so that the window can be made watertight thru proper flashing, the window being placed in the south slope of the roof.
7. Draw the lines e-f and f-d for rafters.
8. Measure down from h on the rafter the length of the window and mark k.
9. Draw a line thru k parallel to the line a-g-h by moving the triangle to the right on the upper edge of the steel square. The sunshine band will extend from the wall at point a to the point l on the floor, March 1, at 41° north latitude.
10. Measure the distance from the ridge down to the top of the window. Remember, this is according to scale. Suppose it is $\frac{3}{4}$ of an inch, this represents $\frac{3}{4}$ of a foot, or 9 inches. Also,
measure the height from the floor to the ridge on the line b-f, converting the reading in inches to feet.

The foregoing method is used to locate the position of windows in the roof of a gable house or the combination house. In the case of the combination house, the line b-f is drawn to the right of the mid-point on the floor, making the ridge nearer to the south wall than to the north wall.

Where the rafter lengths are known, cut one for a "master" rafter or pattern, and make the others accordingly.

A very similar procedure is used to locate high windows in a half-monitor hog house. The half-monitor windows stand upright. The only way to balance this type of house so that the sunshine distribution would be equalized on both pens would be to make the shed roof portion lower than the monitor portion, which is impractical because of the resulting improper drainage, inconvenience and odd appearance.

This method is also used where the wall is low; that is, not as high as the required height of window. In such cases, the sunlight does not fall to the front of the pens under the shed roof portion. (See fig. 21.) Here is it shown that the March 1 rays do not strike quite far enough inward. If this were arranged to throw the sunlight to the end of the pen, then the pens under the monitor roof would suffer accordingly.

MISCELLANEOUS TYPES OF HOG HOUSES

HALF-MONITOR TYPE

The half-monitor type house is a very popular building for hogs or poultry. It is simple and easy to construct. The 20-foot width house — 4-foot feed alley is shown in fig. 21. The long span of the north slope makes it advisable to use these rafters 2'-0" on center.

The wide 8-foot drive house is shown in fig. 22. Since a purlin supports the north roof slope, the rafters may be 2"x 4" and spliced over the purlin. It is advisable to utilize old silo hoops in place of the tie or collar beams shown. These ties should be spaced 6'-0" on center.

A modified house which is recommended is shown in fig. 23. While this house is not extensively used, it is meeting the approval of some feeders. It gives maximum efficiency of the window panes. This is really a roof window modification.

ONE ROW PEN TYPE HOG HOUSE

There is a demand for the one-pen-row hog house where the farm is small and few hogs are kept. It also meets the need of the retired farmer who raises his own meat, the suburban family which has a small farm, and the married hired man who has little stock.
Figs. 21, 22, and 23. Sun's rays in a 20-foot half-monitor hog house, 2 25-foot half-monitor house, and a special type house 24 feet wide.
Figs. 24, 25, and 26. A one-pen-row hog house with feed alley on the south side is shown in fig. 24, with the alley on the north side in fig. 25, and with a two-slope roof and roof windows in fig. 26.
This house, with a feed alley on the south side, is shown in fig. 24. The walls are low and the sunlight is lost, as shown in figs. 13 to 15, unless a wire front is used for the pens. The same house with an alley at the north side is shown in fig. 25. The walls are made higher to provide head room.

Fig. 26 shows the one-pen-row house equipped with roof windows, which has its obvious advantages. The two-slope roof is used. These houses may be equipped for a combination house, — hogs in one end and poultry in the other. A tight partition should, however, divide it into two parts.

IOWA SUNLIT HOG HOUSE

The Iowa sunlit hog house, fig. 27, is one of the best of its type. Its efficiency has been demonstrated throughout the corn belt. Built in a north and south direction, its roof slopes, in which the windows are placed, are exposed to the direct rays of the sun throughout the day. The rising sun furnishes light and sunshine to the ceiling of the west slope. As the sun goes higher, the west and north inside walls and floor are reached by the sun's rays. This band of sunlight gradually passes over the floor as the day advances, and finally, as the sun sets, the sunlight strikes the ceiling of the east roof slope.

The sunlight positions for the various hours of the day are shown in fig. 28. This figure was drawn from actual observation made March 29, 1915, in the Iowa sunlit hog house at Ames. This house is 25 feet wide by 60 feet long, and is shown in fig. 27.

A photograph of the interior of this house shows one band of
Fig. 28. Direction, extent and duration of sunlight at various times of the day on March 8, in the Iowa sunlit hog house at Ames.

Fig. 29. Interior view of Iowa sunlit hog house, showing concrete posts, framing and partitions.

sunlight on the driveway floor and the other band in the pen (fig. 29.) The shadow of the purlin is seen on the floor. Careful
location of the windows will save this sunlight and avoid the shadow. The shadows of the tie beams are also shown. In December and early January, when the days are shortest and the sun is low, these shadows are wide and cut off much of the sunshine. The value of the wire or rod ties cannot really be appreciated until installed. Concrete posts are shown.

The construction of skylight windows has been difficult for some. The proper construction is shown in fig. 30. The upper sash rail extends under the roofing, thus preventing leakage. Battens are used over the sash joints. Hinging every other window allows the fastening of the intervening windows. The battens are fastened to the hinged window stiles so that this sash may be raised for additional ventilation. It is advisable, however, to plow a groove in each stile at the edge of the batten to prevent leakage under the batten (fig. 31).

Fig. 30. Skylight windows. Cross section details.

Fig. 31. Detail of sash stile for skylight windows.
MOVABLE HOG HOUSES
Movable hog houses, properly constructed and intelligently used, are successful. Dry, sanitary, comfortable conditions are

Fig. 32. The Iowa gable roof movable hog house affords plenty of sunlight.

Fig. 33. The Iowa gable roof house also provides shade when needed.
Fig. 34. The “A” type is a successful movable hog house.

secured thru the movable hog house if care and common sense is practiced.

Sunlight is secured by selecting a well designed house and following the construction details. The Iowa gable roof movable hog house gives excellent service. (Fig. 32.) This house is designed for both sunshine and shade when needed. (Fig. 33.) Sashes are used for admitting sunlight during cold weather.

Another popular type of movable house is the “A” shaped. It is much in demand and easily built. (Fig. 34.) The “A” shaped house is provided with a gable ventilator, (fig. 37).

Movable hog houses made from metal are not recommended for several reasons:

1. Metal is high priced.
2. Sunlight facilities are not provided.
3. The temperature range is greater than in the wooden house. The conductivity of the metal cools the house rapidly, resulting in low temperatures at night and high temperatures during the day.

SOURCE OF SUNLIGHT DATA

Much time was taken to work out the data taken from the U. S. Naval Observatory sun observations, published in Farmers’ Bulletin 438, U. S. Dept. of Agriculture, and to apply them to
the practical problems of hog house construction. This data was used in plotting window height curves shown in fig. 35 for the United States from 30° to 48° north latitude, for both noon and 10 a.m. or 2 p.m.

A latitude map of the U.S. is shown in fig. 36. This map aids in the use of the curves. The curves give accurate figures for the days between the first and the middle of the month. By means of these the required height of the window can be found for any day from January 1 to May 1. They may also be applied to the late summer and fall months, August 13 to December 11. Since the weather is not severe during the late summer and fall months, the need of sunlight is not great because the pigs may go out doors.

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Fig. 35. Window height curves, 30 to 48 N. Lat., for noon and 10 a.m. or 2 p.m.
"My hogs contract colds and pneumonia. What is the matter with my hog house?" This question is asked often by prominent Iowa farmers and stockmen.

"I built the house exactly like your plan. It is the Iowa sunlit house, 25 by 60 feet. I have two ventilators. Moisture collects on the ceiling, freezes in the form of frost, thaws and drops on the sleeping hogs. The pens are wet as a result. The hogs get pneumonia and die. I have lost a number. What shall I do to save the rest?"

"How many hogs do you shelter in this house?" is asked.

"About 120 fat hogs almost ready for market," is the reply.

"Have you used this house for farrowing? Did you lose sows and pigs from cold and pneumonia?"

"No," he replied. "I had good results and no loss."

This man's loss was apparent. It was due to lack of ventilation. About 12 square feet of floor space was allowed each hog. This was about right. Only 100 cubic feet of air space, however, to each animal was provided, whereas 250 cubic feet is desirable. The ventilators were working, but they could not carry off the foul air fast enough. The air was breathed and rebreathed and became damp like a thick fog, and the moisture settled on the ceiling.
With the ventilators working at their full capacity, only 800 cubic feet of air was removed each minute. This would take 15 minutes for a complete change of air and allow each hog 400 cubic feet of air per hour. A grown hog should have about 1500 to 2000 cubic feet of air per hour. This means that each hog in this farmer's hog house was forced to rebreathe the air four or five times. This stockman was advised to open the skylight windows a few inches and partially open the end doors, but to avoid draughts. This was done, and the trouble overcome.
The usual method of ventilation is shown in fig. 38. No fresh air intakes are provided. All fresh air enters thru ill-fitting doors and windows and leakage thru walls, causing draughts.

A fresh-air intake is shown in fig. 39. This is a small opening in the plate or top of the wall. The only objection is that the fresh air falls upon the sleeping hogs and continually disturbs them. This may be overcome by placing the ceiling over the two rafters where the opening is placed so that the air will be carried over the hogs.

The King system of ventilation is shown in fig. 40. This is successfully used in barns and other farm buildings. The fresh air is taken thru the walls a few feet above the ground and carried to a point over the front of the pens. The out-take flues take air from the point in the pen where the pigs are fed. This removes the odors from the feed and assists in keeping the pens sanitary and healthful.

Both the intake and the out-take flues should be controlled by dampers. The ventilator is divided and the damper placed so that air pocketing near the ridge may be removed.

Fig. 39. Detail of arrangement in wall of fresh-air intakes.

Fig. 40. King system of ventilation.
Another method of using the King system is to place a canvas tube down from the ventilator. This is made from canvas and wire hoops. Weights are attached and it is telescoped or lowered as needed. It is made circular and may be extended or compressed like a camera bellows.

**DRAINAGE AND FLOORS**

A clean, dry floor is the result of proper drainage and floor construction. Many materials are used for flooring, but the more permanent kinds that have low absorbent values are preferred. The hog naturally chooses a clean, warm, dry, well-bedded floor in cold weather.

The dirt floor is much used, but is unsatisfactory in many ways. If dry, it is dusty; if wet, it is likely to be muggy, if not muddy. In winter it is very likely to be rough and frozen, or else dusty, or damp. The hog is inclined to root out holes, and cause mud wallows. Rats will burrow under and undermine dirt floors.

The cement floor is much used. It has the advantage of being permanent, but it is likely to be somewhat cold and damp in winter. Concrete conducts the animal heat rapidly, which makes it feel cold. Moisture from the ground below is conducted to the surface by the concrete and there condenses, due to the coldness of the concrete.

A combination tile and concrete floor gives excellent service and
is well adapted for the pens of a hog house. It is warmer and drier than solid concrete and just as permanent. It is easily constructed and has all of the advantages of the concrete floor, but is without some of the disadvantages.

A section of this floor is shown in fig. 41. Building blocks 3” x8”x12” or 4”x8”x12” are laid on a gravel fill. The gravel is tamped well and a thin cushion of sand spread over the fill. Blocks are laid on this and tamped to place. About one inch of concrete is spread over the tile and floated smooth.

Drain tile have been used instead of the building blocks. They make a satisfactory floor which is slightly damper than the tile block floor, because it gives a greater chance of condensing moisture due to the triangular projections of concrete between the tile. The “seconds” of building blocks serve well for floor purposes. They may be secured at a much reduced price, about one-third to one-half of regular values. These blocks are those which are warped, cracked or underburned.

The wood cot is quite commonly used. It is easily built from matched boards. It may be used in the pen during winter, but has its greatest field of usefulness during farrowing and suckling periods. It is movable for cleaning. It may be taken out during the summer, when not needed, and thoroly dried out during the storage period. It affords a warm, dry bed for the sleeping pigs and their mother. (Fig. 42.)

WALLOWS

The unsanitary mud wallow found in many feed lots should be prohibited. A sanitary concrete wallowing pool, with shade cover, is an asset worth many times its cost to a feeder. Fig. 43 shows a wallow provided by a well known Iowa breeder and
feeder. This type of wallow can be built by farm labor at a reasonable cost. It will pay for itself each season in the saving of feed, in comfort to the hogs and in healthful, sanitary quarters.

A well designed concrete wallowing pool is shown in fig. 44. This is built with a curb or wall on the outside, a sloping floor and an approach. Provision is made and shown for a pipe-frame shelter. This, however, could be made from timber.

With the shelter, the pool could be used for an all-year structure—a feed floor during the spring and fall, a wallowing pool for the hot days of summer and a hog house during the winter season.

The floor slopes approximately one-half inch per foot. By using several lengths of overflow pipe, the water depth may be regulated to suit the needs. The overflow is placed in a corner, where it is protected by a concrete protection built across the corner. This prevents the hogs from interfering with the overflow pipe and at the same time keeps scum and filth from clogging the pipe. This pipe empties directly upon the ground, which makes it accessible for cleaning. It is advisable to place a quantity of gravel under the spill to conduct the water to a drain tile. Drain tile should extend to the spillway.

By building movable shutters, the house may be thrown open in summer to allow free air circulation.

Timber posts set in the ground may be used in place of pipe to support frame and roof. These can be built by farm labor to meet the individual needs of feeder. If pipe is used, pipe sleeves are set in the concrete curb and the pipe frame set in this.

Fig. 43. This sanitary wallow can be built by farm labor.
These sleeves should extend about two inches above the curb top and should be threaded on the exposed ends. When the frame is removed the sleeve can be capped with the galvanized pipe cap to prevent dirt filling the sleeve.

Satisfactory gains mean profit in hog feeding. It is only thru careful feeding, proper rations and ample shelter that these gains are made. The hog must be contented and comfortable to be profitable. An underfed hog is uncomfortable. His nature demands an abundance of substantial food. He needs shelter in winter and a wallow in summer. He will provide a wallow, furnish a nest and help himself to food if given a fair chance. When all these are provided, he is comfortable and contented.

A satisfactory shelter and an abundance of food furnish all the comfort he desires. Man must furnish the shelter and food or allow the hog to return to his native haunts, the forests. Nature provided nuts, roots, fruits and herbs for food. She furnished bushes, brush and groves for shelter and streams for wallows.

Warm, sanitary houses must be provided. Ample food must be given. Self feeders have done much to solve the food problem. The hog has not abused this privilege. He neither wastes nor overeats. He never abuses a comfortable, common-sense house. The swine producer’s problem is to furnish the food and shelter and keep the hog comfortable, and he will do the rest.