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D F Hessels

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"CONTROLLED ENVIRONMENT" BROILER HOUSES IN WESTERN AUSTRALIA

by D. F. Hessels, M.D.A., Broiler Officer, Poultry Branch

The three main features which contribute to the better returns from controlled environment broiler housing are higher density, better conversion and a reduction in labour. The higher initial cost of housing and higher running costs are more than covered by these three advantages.

Construction of the houses is based on the use of steel trusses made from angle iron, the size of angle iron depending on the width of the sheds. Roof and side walls are of corrugated iron or aluminium.

Size of Shed
Shed sizes in Western Australia vary in width from 40 to 150 ft. and in length from 200 to 400 ft.

The areas range upwards from 12,000 sq. ft. (300 ft. x 40 ft.). The most recently built shed has ten sections of 9,600 sq. ft. each. Each shed has a common wall with the next one. One hot air unit heats two of the units, the ducting for hot air being incorporated in the common wall between two sections. One other type of shed provides 45,000 sq. ft. of floor space (150 ft. x 300 ft.). It remains to be seen whether ventilation in these wide sheds will be as effective as in narrower sheds, because fresh air must be drawn over long distances.

It is rather unfortunate that growers tend to make the same mistake here as overseas by continually increasing shed sizes instead of limiting them to a reasonable size. Growers tend to forget the importance of social stress and technical difficulties associated with large sheds.

Sheds on some farms have now become so large that the all-important "all-in-all-out" system cannot strictly be maintained without having sheds lying idle for long periods.

It is difficult to recommend a shed which would be ideal in all respects. However, the shed described below is patterned on the original 40 ft. x 300 ft. shed which has given excellent results on the Brajkovitch brothers' farm at Middle Swan. The width of the shed has been increased to 48 ft. and length shortened to 250 ft. to allow for more efficient feed and water distribution, cheaper construction costs per square foot of floor space and a shorter distance for the hot air to travel.

A "controlled environment" broiler house is a shed in which heating, cooling, ventilation and lighting are controlled to the extent that the birds are raised under highly favourable conditions. Density of housing can thus be greatly increased without loss of efficiency in the birds' performance.

The desirability of this type of housing in Western Australia was in doubt until the Brajkovitch brothers at Middle Swan tested it at the end of 1964. Much useful information and first hand experience was also gained during the author's study of broiler industries in England and Europe during 1963.

Since then there has been a major swing to controlled environment broiler housing in W.A. Results have been excellent.
CONTROLLED ENVIRONMENT BROILER SHED OF 12,000 sq. ft. (48ft. x 250ft.)

STRUCTURE:
The steel trusses are 48ft. wide, either "clear span" or with pillars. The position of the pillars will depend on the feed and watering system to be used. (See sections on feed and water).
The trusses are placed 12ft. 6in. apart. The apex of the truss is 13ft. and the sides are 7ft. high if they are bolted on concrete blocks. If they are to be set in concrete the legs should be increased by 18in. to 2ft., depending on the type of soil.

ROOF:
The roof is galvanised corrugated iron or aluminium with insulation of polyurethane foam, fibre glass or rock wool with a vapour barrier, or other suitable insulating material. It is preferable to use an insulating material which will stop thermal and radiant heat from escaping or entering the shed.
The purlins are at 3ft. centres if tube feeders are used or 6ft. centres if an automatic feeding system is installed.

END WALLS:
The end walls are corrugated iron or brick with a 10ft. sliding door in the centre of the shed for cleaning out.

SHED WALLS:
The side sections of the shed are made of two walls. This is necessary to allow for the inlet area to be covered by the second wall to exclude natural light from entering the shed.
The maximum number of birds is 24,000 and if the birds are kept until they weigh 3.25 lb. each, the shed will hold a total of 78,000 lb. of meat. This means that the maximum air extraction should be at least 78,000 cubic feet per minute (C.F.M.) and allowing an inlet area of 5 sq. ft. per 1,000 C.F.M., the total inlet area will be 78 x 5 = 390 sq. ft. There is 500ft. of side wall which means that the inlet area should be 1/500 x 390 = 0.78ft. = 9.36 inches wide.

The unobstructed passage between the two walls should be 9.12 inches wide. If corrugated iron is used the distance between the two walls must be 10 inches. The corrugations must run vertically to achieve the minimum air flow resistance.
The outside wall extends from under the roof to 12in. from the ground while the inside wall is 5ft. high from ground level. In areas where the outside temperature is usually very cold, the height of the inside wall could be increased to 6ft. This will give incoming cold air more time to mix with warm air before it reaches the birds.
The inlet area should be adjustable and this can be done by installing an adjustable hinged flap between the two walls. The flap should be hinged on the outside wall opposite the top of the inside wall. A winching mechanism to operate this flap can be installed above the flap. It is essential that the shed is as airtight as possible (wall structure in photograph is opposite to plan).
The distribution of the hot air (1 on photograph) in the shed can be done by an overhead duct which in turn has smaller ducts (2) leading from it. Diffusers at the bottom of the down duct (5) have an adjustable gap. This adjustable gap can be used as an aid to regulating the distribution of heat if the sheds are very long.
The chicks are brooded in a restricted area to minimise the space which must be heated.
Brooding is carried out in the centre of the shed by suspending two polythene (0.004in. thickness) curtains 18ft. apart. These must be properly fixed to the purlins to prevent cold air from entering the brooding area. Sheets of corrugated iron 3ft. wide are used as surrounds at the bottom of the curtains. The surrounds can be gradually moved outwards as the chicks grow older. The birds are not given access to the whole shed until they are at least four weeks old.
Recirculation of warm air from the brooding area can be carried out by installing a return main duct (7) to the hot air.
Explanation of items numbered on photograph:

1. HOT AIR INLET DUCT: The size of this duct depends on the size of the area to be heated, the length of the shed and the capacity of the fan in the hot air unit. This duct should be properly insulated to prevent heat loss, especially that section of the duct before it enters the shed.

2. PLASTIC HOSE: This hose can be either plastic or canvas, polythene (0.004 inch thickness) is commonly used as it is inexpensive and can be discarded after each batch of broilers.

3. METAL ELBOW: The elbow is necessary to regulate the height of the diffuser.

4. PULLEY: To raise or lower the diffuser.

5. DIFFUSER: Diffuser with adjustable opening to off-set drop in hot air pressure in hot air duct.

6. TAPE: To connect hose to diffuser and is also used to attach hose to the elbow.

7. RETURN HOT AIR DUCT: A considerable saving in fuel costs can be achieved by recirculating the warm air from inside the shed through the hot air unit. Oxygen, carbon dioxide, ammonia and moisture levels are so low in the initial brooding periods (first 10 to 14 days) that it is unnecessary to heat a complete new supply of fresh air. The amount of return hot air and of fresh air can be regulated through the air inlet of the hot air unit.

8. WATER TROUGHS WITH PLASTIC SPINNERS: Continuous 2½ in. angle iron water troughs with ¼ in. plastic spinners.

9. POLYURETHANE SEAL: This photograph was taken before the roof had been insulated. Controlled environment sheds need to be properly sealed and this was done under the eaves by spraying polyurethane foam to prevent air leaks.

10. SHAFT FOR WINCHING MECHANISM OF WATER TROUGHS: This shaft (¼ in. water pipe) runs the full length of the shed, which enables lowering or raising of the complete trough in one operation.

11. PLASTIC TUBE FEEDERS: Plastic tube feeders are positioned in their permanent position with the object of "patterning" the chicks.

12. TEMPORARY GUARD TO STOP DRAUGHT ON YOUNG CHICKENS (later removed): The double walls in this shed are the reverse from the recommended position in the plan. This enables cool air to enter the shed at a low level and the birds derive immediate benefit, but this type of wall structure does not allow the air to be pre-cooled by a fogging system.
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METSAPOL has a comparatively quick solvent action on this wax covering and tests have proved that it produces a high final mortality on the scales.

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The hot air unit is equipped with an adjustable inlet which regulates the amount of fresh air passing through the heater.

Fuel can be saved by re-using the warm air from inside the shed during the early brooding period. Thermostatic controls inside the shed are connected to the unit to give the required temperature inside the shed.

Humidity in the shed can also be increased by installing a humidifier in the hot air ducting system. This humidifier is connected up to a humidistat to give the required relative humidity inside the shed.

This unit can also be used for cooling during summer. (See section on cooling).

The advantages of hot air brooding over the conventional types of hover brooding are:

- Complete control of heating.
- Labour saving, as the plant is completely automatic.
- Better feed conversion as birds can be raised under optimum growing temperature.
- Use of bottles during early brooding minimised. Chicks use the automatic waterers sooner as the temperature of the whole brooding area is uniform.
- Less stress for chicks; the whole brooding area can be used by the birds as there is no need to crowd around the source of heat.
- Humidity control.
- No obstructions in brooding area when feeding and cleaning out.

The disadvantages of hot air brooding are the dependance on electricity and the higher initial cost. Hot air, gas, charcoal and hot water costs $140, $120, $24 and $100 respectively for equipment to brood 1,000 birds.

FANS:

The maximum weight of the 24,000 birds is 78,000 lb. at marketing. This means that sufficient fans must be placed in the roof to give maximum extraction of 78,000 cubic feet per minute. The rate of extraction per pound of body weight in the shed varies from 1/2 C.F.M. in winter to 1 C.F.M. in summer.

Overseas standards of ventilation are higher than 1 C.F.M. per lb. of body weight during high outside temperatures but experience in Western Australia has shown 1 C.F.M. to be sufficient. Relative humidity of air in summer is very low and it could well be that in climates with a very high relative humidity in summer the extraction rate will have to be increased above the 1 C.F.M. per lb. of body weight.

The most desirable conditions can be achieved by having 13 fans each of 6,000 C.F.M. capacity. These are connected in five circuits, giving 13 different rates of extraction by using the circuits in various combinations.

Desirable rates of extraction depend on the age and weight of the birds and on the climate outside. Condition of the litter is a very good indicator of the adequacy of the rate of extraction.

FEEDERS:

The general recommendation for the number of tube feeders is from 25 to 30 per 1,000 birds; with the high density the lower
rate of 25 will be sufficient. The 600 feeders should be suspended according to the diagram below.

If automatic feeding lines are to be used, two circuits are necessary, the outside circuit being 6ft. from the walls and the inner circuit 6ft. on either side of the middle of the shed.

It is important that the feeders be evenly distributed.

LIGHTING:

Low intensity lighting is essential if full use is to be made of high density housing.

Five lines of lights are required, two on the outside walls, one line 12ft. from side walls and one in the centre of the shed, (see diagram).

To give a gradual reduction in intensity the centre line has 100 watt globes for the first seven days, 60 watt globes from seven to 14 days, 30 watt globes from 14 to 21 days and 15 watt globes from 21 days onwards. The other four lines have 15 watt globes. The chicks should be restricted to the centre of the shed and should not have access to the full shed until they are four weeks old.

Chicks should be taught "panic lighting" from day-old by switching lights off at indeterminate times for varying lengths of time.

Light intensity might also be regulated by rheostat control, but this is an inefficient method of reducing intensity.

WATERING:

The use of running water in 2½ inch angle iron troughing is very popular in Western Australia. This can be achieved by grading the site to have a fall of 1 inch in every 10ft. This fall is necessary to allow the water to flow fast enough to carry away any dirt which might lodge in the trough. It the gradient is lower, blockages will develop and cause overflows. Four and five lines of water troughing are necessary for tube and automatic feeders respectively (see diagrams).

Chicks are weaned off bottles in three to four days in controlled environment sheds, as the uniform temperature in the brooding area will induce chicks to use running waterers immediately. Eight one-gallon water bottles, filled once, provide ample water for 1,000 day-old chicks until they can rely on trough waterers. This is an important saving in labour.

Spinners are needed above the water troughs to prevent spillage and litter breakdown. Plastic spinners are popular because they make relatively little noise when the birds happen to come into contact with them.
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COOLING:

The importance of heating in controlled environment housing is obvious but attention should also be given to ways and means of cooling the sheds. Temperatures above the optimum of 75° F. after six weeks of age will lead to a marked depression in growth due to a reduced feed intake.

Evaporative cooling is the only way in which a shed can be cooled economically. The effectiveness of this method depends on the relative humidity of the air to be cooled, decreasing as the relative humidity of the air increases.

Radiant heat can be prevented from entering the shed by insulating the roof and side walls, and heat produced by the birds can be extracted by the fans.

But replacement of air from within the shed with hot air from outside in summer will not reduce shed temperature, and the incoming air needs therefore to be pre-cooled before entering the shed.

Installing a fogging system between the double walls is the most effective method of pre-cooling all the air entering the shed. This system can be thermostatically controlled to come into operation when required.

Building a cooling tower next to the air inlet of the hot air unit and blowing cool air instead of hot air into the shed is of limited value as the quantity of air introduced into the shed is only small (about 6,000 C.F.M.).

Lawns outside the sheds, heat-reflecting paints and sprinklers on uninsulated roofs are other useful aids in reducing the temperatures inside the sheds, but for really effective cooling a fogging system between the double walls is required.

Economics

It is difficult to compare the merits of different types of housing under all climatic conditions. The table below gives only comparisons obtained under Western Australian conditions. The differences between the four methods of housing should be considered, not the actual performance of the four systems.

The figures clearly indicate that the results from controlled environment housing are far better than those from the other system. The returns per year per shed of 12,000 sq. ft., after deduction of feed, chick and brooding costs are:

- System 1.—4 x 12,000 x 11.50 cents = $5,520.00
- System 2.—4 x 12,000 x 17.30 cents = $8,304.00
- System 3.—4 x 12,000 x 22.86 cents = $10,972.80
- System 4.—4 x 12,000 x 33.27 cents = $15,969.60

System 1 is obsolete, while system 3 is wasteful without hot air brooding. The difference in return between system 2 and 4 is $7,665-60 per year.

However, the initial cost of the controlled environment shed is $6,000.00 higher than the controlled naturally ventilated shed and the electricity cost for the fans and hot air unit amounts to about $700 per year. The $700 is based on 2.7 cents per unit of electricity. This increase in running costs is offset by a reduction in labour costs. Because of climatic and other differences it is difficult to assess the electricity costs to run the extractor fans and the hot air unit.

Comparison in performance of broilers at ten weeks of age between four methods of housing in Western Australia

<table>
<thead>
<tr>
<th>System of Housing</th>
<th>Density sq. ft. per bird</th>
<th>Av. live-weight lb.</th>
<th>Conversion ratio</th>
<th>Profit per bird*</th>
<th>Profit per sq. ft.*</th>
<th>Approximate cost of fully equipped shed per sq. ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Non-controlled natural ventilation</td>
<td>1.0</td>
<td>3.0</td>
<td>3.0</td>
<td>11.50 cents</td>
<td>11.50 cents</td>
<td>$0.70</td>
</tr>
<tr>
<td>2. Controlled natural ventilation</td>
<td>0.80</td>
<td>3.1</td>
<td>2.9</td>
<td>13.85 cents</td>
<td>17.50 cents</td>
<td>0.90</td>
</tr>
<tr>
<td>3. Forced ventilation (fans)</td>
<td>0.66</td>
<td>3.1</td>
<td>2.8</td>
<td>15.24 cents</td>
<td>22.86 cents</td>
<td>1.20</td>
</tr>
<tr>
<td>4. Controlled environment (fans and hot air)</td>
<td>0.50</td>
<td>3.1</td>
<td>2.7</td>
<td>16.63 cents</td>
<td>33.27 cents</td>
<td>1.40</td>
</tr>
</tbody>
</table>

* Profit is the return above costs of chicks, feed and brooding at a selling price of 23c per lb. liveweight.
The above comparative figures do not include costs for mortality, labour, management, rates, taxes and so on. These should be used for comparison between systems rather than as an accurate guide to the potential performance of the systems. The differences between the figures are fairly accurate for Western Australian conditions and, although the actual performances might differ in other States, it is more than likely that the differences obtained in Western Australia will also apply elsewhere. Experience in England and Europe has shown that even under their unfavourable climatic conditions the 0.5 sq. ft. per bird density and the better feed conversion is commonly achieved with control of environment.

There is no doubt that much work needs to be done to improve existing houses. Methods of insulation, cooling, heating and feeding and watering systems all need investigation, but growers in Western Australia have gone a long way towards supplying ideal conditions for their broilers by adopting controlled environment housing.

The figures indicate that under West Australian conditions a broiler grower can recoup the additional outlay for a controlled environment shed in the first year of operation and in each succeeding year is about $7,000 better off for every controlled environment shed of 12,000 square feet, compared with the returns from a controlled naturally ventilated shed.