Poultry Farm Buildings in Trinidad: Present and Future Prospects

E.I. Ekwue*, M. Gray**, and A. Brown***

Eleven broiler (meat-producing chicken) farms located in five major poultry-producing counties in Trinidad were visited and their housing structures and equipment evaluated. Different aspects of their designs were compared with those found in the relevant literature. Most of the buildings were found to be well-designed and functional. All of them were naturally ventilated, open-sided houses. However, some aspects such as the choice of materials, needed improvement, while other aspects were almost non-existent such as bio-security and environment control. Furthermore, the recent trend is the use of tunnel-ventilated poultry buildings and two such buildings were constructed in Trinidad two years ago. Many such modern buildings exist in the United States, and Jamaica in the Caribbean region. In order to investigate the prospects of promoting the introduction of more tunnel-ventilated buildings in Trinidad to eventually replace the open-sided ones in future, a preliminary investigation was conducted to examine the operation and profitability of six such existing buildings in Jamaica and two in Trinidad. The operation of tunnel-ventilated houses was compared with a typical open house in Trinidad. Results of temperature variations, broiler body weights, feed conversion rates; mortality and financial returns on investment suggest that the introduction of more tunnel-ventilated buildings into Trinidad would be a viable venture. Detailed features of the tunnel-ventilated houses are described.

1. Introduction

The term “poultry” covers a wide variety of birds of several species. The term is relevant whether the birds are alive or dressed. It includes chickens, turkeys, ducks, geese, swans, guineas, pigeons, peafowl, ostriches, pheasants and other game birds. However, the emphasis in this paper is placed on chickens, more specifically broilers, as these are the most produced poultry product in Trinidad [1] and elsewhere in the Caribbean. Due to its value as a protein food, the profitability associated with the investment and the relative ease of entering into the market, poultry-rearing has become quite competitive. An operator can increase his or her competitiveness by improving the breeding (genetics), feeding or housing condition of the birds.

By far, the easiest of the three to implement and the fastest to show results is modification in housing [2]. For instance, placing low speed high volume fans on a hot day shows immediate reduction in house temperature. This modification can result in the housing of more birds per unit area, more meat production per unit area, lower housing cost per bird and hence more profit for the operator [3]. Unfortunately, most poultry farms in the Caribbean, especially those in Trinidad are over 20 years old and the most neglected area of operation is that of housing.

The latest technology available for housing of poultry to ensure that the optimum house temperature is maintained is by the use of tunnel-ventilated houses [4,5]. In tunnel-ventilated houses, the right air velocity

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and air humidity (which are important for hygienic conditions) are carefully monitored and modified to maintain optimum conditions. In effect, the litter stays dry and the birds stay healthy. In spite of the higher infrastructure cost (20-50%) more than natural ventilated [3]), and management required for these houses, the benefits are decreased mortality, increased bird weight and reduced feed conversion rates compared to the conventional naturally-ventilated, open-sided buildings. This manifests itself in a reduction in cost of production. These modern poultry buildings were introduced in the United States within the last decade, and in Jamaica, within the last five years. Mr. Richard Bovell of the Malabar Farms in Trinidad introduced tunnel-ventilated buildings in Trinidad two years ago. They were later bought over by Mr. Shyam Ali of Gerizim farms. Little or no research has been done in the past to compare the performance of tunnel-ventilated, closed buildings with their open-sided naturally ventilated counterparts in the Caribbean region. This comparison is important in order to determine the need to introduce more of these modern closed buildings in Trinidad and the Caribbean region as a whole.

This paper reports the results of the survey of the broiler housing structures and equipment that exist in Trinidad, evaluates their suitability and suggests modifications for improved standards of production. In addition, the paper reports the results of a preliminary investigation done to determine the desirability of suggesting future gradual replacement of existing open-sided buildings in Trinidad with the more modern tunnel-ventilated ones.

2. Experimental Investigation

2.1 Farms visited in Trinidad and Objectives of Survey

Eleven farms (Table 1) chosen from the five major poultry-producing counties in Trinidad (Caroni, St. George, St. Andrew, St. David, Victoria and St. Patrick) were selected and visited as a part of the survey of poultry farm buildings and equipment in Trinidad. The data on poultry production in Trinidad, which guided the choice of farms to visit, were obtained from the Central Statistical Office of Trinidad [1]. The objectives of the field visits were to assess the layout (arrangement) of the poultry structures and facilities with respect to each other. The type and number of birds that are and can be accommodated in each building were also investigated. The building materials for construction were appraised. The size and materials for the construction of the structural elements (columns, beams, roofs, walls and floors) were also noted. The type and sizes of the facilities such as waterers and feeders as well as methods of waste disposal and environmental control are described.

2.2 Investigations into Tunnel-Ventilated Poultry Buildings in Trinidad and Jamaica

Eight tunnel-ventilated poultry buildings (two from Trinidad and six from Jamaica) were investigated in the second phase of this study. Two such buildings are located in Malabar, Trinidad. Mr. Ali, the Manager of Gerizim Farms owns them both. In Jamaica, the six buildings investigated are owned by Jamaica Broilers’ contract farmers and are located in May Pen, Clarendon. Some operating parameters of these modern buildings were also investigated and compared with Mr. Jai Ramkissoon’s open house (Table 1), investigated in the first phase of the study. These operating parameters include the building interior temperatures, body weights of the broiler birds, feed conversion rates, mortality of the birds as well as the production rates, house design and financial returns on investment. These were investigated for one grow-out of the birds from one day old to point of sale.

3. Results and Discussion

3.1 Summary of Findings from Field Visits in Trinidad

All the poultry farms visited utilize naturally ventilated, open-sided buildings (Figures 1 to 3) with similar and in some cases, different design specifications, some of which are detailed in Table 2. The following are summarised from the findings during the field visits, which were conducted between September 1999 and June 2000.

3.1.1 Farmer Affiliations

All the farmers were contract farmers. The farmers surveyed were contracted either to Supermix Group of Companies or to Nutriva Farms Limited, both based in Trinidad. Most farmers started out as private farmers, producing broilers for live-weight sales. Due to heavy vertical integration (a
management system in which one company undertakes more than one operation in the production chain) of the poultry industry, they were unable to compete and hence aligned themselves with the large producers. Both large producers had hatcheries, feed mills, broiler farms (contracted and self-operated), processing and rendering plants as well as organised transport and marketing facilities. The Supermix Group of Companies had its processing and rendering plants in Pinto Road South, Arima while those for Nutrina Farms were located in Marabella in south Trinidad. Contract broiler-farming is also common in the United States [6].

### TABLE 1: Some Details of the Poultry Farms visited in the Survey

<table>
<thead>
<tr>
<th>Name of Farmer</th>
<th>County</th>
<th>Location</th>
<th>Number of Broilers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jai Ramkissoon</td>
<td>St. George</td>
<td>Mausica Road, D'Ababie</td>
<td>407,000</td>
</tr>
<tr>
<td>Samaroo Lakham</td>
<td>St. Andrew</td>
<td>Acam Village, Cunarepo, Sangre Grande</td>
<td>8,000</td>
</tr>
<tr>
<td>Andrew Gooding</td>
<td>St. Andrew</td>
<td>Mapaire Trace, Cunarepo, Sangre Grande</td>
<td>8,000</td>
</tr>
<tr>
<td>Shaffic Mohammed</td>
<td>St. Andrew &amp; St. David</td>
<td>Eastern Main Road, Valencia</td>
<td>54,000</td>
</tr>
<tr>
<td>Tobida Mannan</td>
<td>St. Andrew &amp; St. David</td>
<td>Ramautai Trace, Valencia</td>
<td>8,500</td>
</tr>
<tr>
<td>Harry Baboolal</td>
<td>Caroni</td>
<td>Chin-Chin Road, Cunupia</td>
<td>120,000</td>
</tr>
<tr>
<td>Ahamad Ali</td>
<td>Caroni</td>
<td>Sarsak Trace, San Raphael</td>
<td>18,000</td>
</tr>
<tr>
<td>Farouk Shah</td>
<td>Caroni</td>
<td>Arena Road, Freeport</td>
<td>18,000</td>
</tr>
<tr>
<td>Beatrice Gople</td>
<td>St. Patrick</td>
<td>Teeluck Trace, Penal</td>
<td>36,000</td>
</tr>
<tr>
<td>Harry Jeenath</td>
<td>St. Patrick</td>
<td>Arin Road, Penal</td>
<td>14,500</td>
</tr>
<tr>
<td>Shaffee Mohammed</td>
<td>Victoria</td>
<td>Subratee Road, Barrackpore</td>
<td>70,000</td>
</tr>
</tbody>
</table>

### 3.1.2 Access and Services

Most farms were easy to access, as they were either near the main road or had good roads leading to them, with the exception of Mr. Shah’s farm in Freeport where the Arena road leading to it was in bad condition. Most farms were far from the poultry-processing plants, e.g., Mr. Baboolal’s farm in Chin-Chin Road, Cunupia was 16.1 km from the Arawak Processing plant in Arima. All farms had water, electricity and telephone services.
### TABLE 2: Some Information collected from Field Visits

<table>
<thead>
<tr>
<th>Name of Farmer</th>
<th>No. of Buildings</th>
<th>Typical Building Dimensions (Length, Width, Height, m)</th>
<th>Stocking Density (m²/bird)</th>
<th>Building Orientation</th>
<th>Typical Spacing between Buildings (m)</th>
<th>Roof Shapes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jai Ramkissoon</td>
<td>64</td>
<td>91, 12, 4.9</td>
<td>0.09</td>
<td>North-south</td>
<td>12</td>
<td>Gable</td>
</tr>
<tr>
<td>Samaroo Lakham</td>
<td>1</td>
<td>61, 12, 4.0</td>
<td>0.11</td>
<td>East-west</td>
<td>-</td>
<td>Semi-monitor</td>
</tr>
<tr>
<td>Andrew Gooding</td>
<td>3</td>
<td>21, 12, 4.0</td>
<td>0.10</td>
<td>North-south</td>
<td>23</td>
<td>Semi-monitor</td>
</tr>
<tr>
<td>Shaffic Mohammed</td>
<td>8</td>
<td>61, 9/12, 3/4.6</td>
<td>0.09</td>
<td>North-south East-west</td>
<td>10</td>
<td>Semi-monitor</td>
</tr>
<tr>
<td>Tobida Mannan</td>
<td>3</td>
<td>31, 9/12, 3.7</td>
<td>0.11</td>
<td>East-west</td>
<td>12</td>
<td>Semi-monitor</td>
</tr>
<tr>
<td>Harry Baboolal</td>
<td>14</td>
<td>61/152, 9/12, 3.9</td>
<td>0.11/0.10</td>
<td>North-south</td>
<td>13</td>
<td>Semi-monitor</td>
</tr>
<tr>
<td>Ahamad Ali</td>
<td>4</td>
<td>30/61, 12, 3/4.5</td>
<td>0.09/0.11</td>
<td>East-west (3) North-south (1)</td>
<td>13</td>
<td>Semi-monitor</td>
</tr>
<tr>
<td>Farouk Shah</td>
<td>2</td>
<td>61/67, 12, 5.5</td>
<td>0.08/0.09</td>
<td>North-east</td>
<td>33</td>
<td>Monitor</td>
</tr>
<tr>
<td>Beatrice Gopie</td>
<td>3</td>
<td>91, 12, 4.9</td>
<td>0.12</td>
<td>North-south</td>
<td>23</td>
<td>Semi-monitor</td>
</tr>
<tr>
<td>Harry Jeenath</td>
<td>5</td>
<td>15-40, 7.6/11, 3/4.9</td>
<td>0.1/0.13</td>
<td>East-west</td>
<td>12</td>
<td>Semi-monitor</td>
</tr>
<tr>
<td>Shaffee Mohammed</td>
<td>8</td>
<td>55-67, 9/18, 2.4/4.5</td>
<td>0.1/0.12</td>
<td>East-west</td>
<td>13</td>
<td>Semi-monitor</td>
</tr>
</tbody>
</table>
FIGURE 2: Elevations of One of the Three Buildings in Mr. Groening's Farm
3.1.3 Stocking Density
The average stocking density was 0.1 m²/bird and most farms were not producing at their maximum capacity. Hence, productive potentials were not realised. This could be attributed to two factors; the first due to the stocking density dictated by the contractors and the second due to climatic considerations and experience. The recommended maximum stocking density is 0.09 m²/bird [7].

3.1.4 Farm Houses
The number of houses on the farm varied significantly, ranging from one in Mr. Samaroo Lakham’s farm to 64 in Mr. Ramkisson’s farm (Table 2). The houses were basically north-south or east-west-oriented. East-west orientation is preferred in the tropics due to the resulting cooler environment that is created. This is because the shorter sides of the building are exposed to the sun.

Typical house dimensions ranged from lengths (15m - 152m), widths (9.1m - 18m) and heights (2.4m - 5.5m). In Trinidad, a poultry house that was 2.6m - 3.3m high in the centre was acceptable about 30 years ago. Today, a height of 3.9m - 5.3m is preferred for greater ventilation in order to reduce heat stress on birds [3].

In most cases, the spacing between the poultry buildings (12m - 13m) did not satisfy fire hazard requirements. This could be due to land constraint. A 20 m distance is normally recommended but only three of the farms achieved this (Table 2).

Material of similar sizes and types were used for similar elements of building construction as shown in examples given below.

3.1.4.1 Foundation
Poured concrete was used on all farms for the foundation, while concrete blocks were used for the foundation wall.

3.1.4.2 Floors
The floors were of dirt, with sawdust, wood shavings or baggase litter, i.e., all farms surveyed had the deep litter arrangement in place. This floor arrangement was recommended by Feltwell [8]. The floors were disinfected between grow-outs using commercial disinfectants.

3.1.4.3 Walls
The walls of the house were made mainly of one to three rows of concrete blocks with chicken wire on top the blocks and some means of securing the wire to the block, usually a length of timber.

3.1.4.4 Doors
The doors were usually made of similar materials as the walls, the sizes ranging from 3.0m - 9.1m in width.

3.1.4.5 Roof Shapes and Covering
Most of the buildings in the farms had the semi-monitor roof shape (Table 2 and Figure 2). This was a good choice, since this roof shape allows for the efficient escape of hot air rising from the house. However, gable roof was used in Mr. Ramkisson’s farm which at more than 30 years is the oldest farm visited (Figure 1). The more preferred double-monitor roof shape in farm buildings [9] was used in Mr. Shah’s farm (Figure 3). Galvanised zinc sheets were normally used as roof cover, but on one farm, Mr. Shaffic Mohammed’s, alu-zinc was used. This latter option was preferred, since it considerably reduced the heat stress on the birds. This is because alu-zinc has very low emissivity and therefore radiates a large percentage of heat absorbed and makes for a cooler house. Zinc is also a good roof covering material since it is impervious to rain and keeps out radiation. It is however, a good absorber and emitter of radiant heat. For better environmental control using zinc, roofs should be insulated and/or have heights of 4m to 5m [9].

3.1.5 Feeders
Common feeders were of the galvanised steel tube types (20cm to 40 cm in diameter and about 0.6m long), with instances of chain conveyor being used. The bell dome drinker was used in almost all farms with the exception of Mr. Jeenath’s farm, which uses homemade automatic trough waterers. Farmers usually provided adequate waterers (83 to 100 birds per equipment) but insufficient feeders, with respect to the 5 cm length per bird recommendation [7].

3.1.6 Ventilation
All houses used natural ventilation and some provided fans for supplemental cooling of the birds.
3.1.7 Brooding
Chicks were normally brooded in the entire house, by placing waste feed bags around the entire structure and providing heat using electric bulbs.

3.1.8 Water Supply
All farms got their water from the public supply, however some farms like Mr. Ramkissoon's also had private wells in addition. Mr. Mohammed’s farm had a pond for providing water for the birds. Generally, portables water from the public supply was of better quality.

3.1.9 Bio-Security
In general, the only means of bio-security seemed to be chlorination of the water. No farms had any footbaths at the doors to the buildings, though the floor was regularly disinfected.

3.1.10 Waste Disposal
Waste litter from the deep litter houses was given to other farmers to be used as fertilisers, while the dead birds were either burned or fed to the dogs.

3.1.11 Summary of Survey
In general, all the buildings were structurally well-designed and functional for the production of broilers. However, there are a few modifications that could improve the designs. These modifications, in some instances, may be put in place during structural improvements and repairs and definitely when new farm structures are built. These recommendations include making the buildings bigger, preferably 122m long, 11m wide and 4.3m high. Using the recommended maximum stocking density of 0.09m²/bird [7], this house is able to house approximately 15,000 birds. The larger buildings will facilitate greater air movement and comfort to the birds [3]. Such buildings in the tropics provide more shade per floor area. The roof should be double-monitor type like in Figure 3 and be made with alu-zine. Compared to the gable roof, this design, although more expensive to construct, allows considerable light in the centre of the building which improves ventilation considerably [9].

3.2 Detailed Descriptions of the Tunnel-Ventilated Poultry Buildings in Trinidad and Jamaica
The closed tunnel-ventilated buildings from Trinidad and Jamaica were more or less the same in structure. This is because these buildings were not constructed locally but were bought pre-fabricated from Britain (BETCO Company).

3.2.1 Dimensions
The dimensions of the building are 122m long, 12.2m width and 2.95m high (Figure 4) to house 25,000 birds at a stocking density of 0.06 m²/bird. Tunnel-ventilated houses can be of any convenient length. Common lengths are 122m and 150m. The tunnel effect is optimum for a width between 11m and 15m, thereafter, ventilating the house becomes difficult unless if proper equipment is used, especially end wall fans. Excessive building length could also be a problem if the building has a lot of leakage. The height is usually chosen to facilitate human and managerial activities and the raising and lowering of automated equipment.

3.2.2 Foundation
The foundation was made of poured reinforced concrete of ratio 1:3:5 (cement: dry sand: gravel) and was made 80cm wide and 40cm deep. This is similar to that of the open-sided building. The foundation wall is made of 20.3cm concrete blocks filled with concrete and reinforced with steel rods in every block.

3.2.3 Floor
The floor of the building consisted of dirt with wood shavings litter.

3.2.4 Walls
The wall was made of one row of concrete blocks (rendered finished) and PVC-covered chicken wire (Figure 4). The wire was held in place on the blocks by a 5.08cm x 15.2cm nailing board. The wire was held in the vertical direction by hog rings onto the 5.08cm x 10.2cm lumber located at the mid bay of the trusses. The truss was made of compound struts (two channel sections welded back to back) of nominal size
FIGURE 4: Different Elevations of a Tunnel-Ventilated Building in Trinidad
305mm x 102mm. In the area of the fans and the back and front entrances to the building, the wall was totally made of alu-zinc panels. There was a corner trim, also of alu-zinc, to facilitate total sealing of the building. Along the wire was an adjustable, tautly-positioned, highly woven curtain.

### 3.2.5 Doors
The main entrance doors and end sections (Figure 4) were made of wood and alu-zinc sheet metal with 25 mm of rigid board insulation and resistance of 1.2 m²·K/W [10].

### 3.2.6 Roof
The roof was of gable design and was made of alu-zinc sheet panels. A monitor or semi-monitor arrangement was not necessary for ventilation, since the evaporative cooling pads and extractor fans provided all ventilation. The roof was clear spanned and was supported by steel trusses. The elements on the trusses were as follows: 305mm x 102mm compound struts truss legs; 500mm x 500mm equal angle main tie; 5.08cm x 15.24cm timber purlin and 250mm x 250mm equal angle internal bracing, spaced at 4m apart. The space between the drop ceiling and the roofing panels was insulated using 0.9m of blown-in cellulose insulation of resistance value 19m²·K/W. A vapour barrier of novathene ceiling liner was installed beneath the insulation to protect the insulation for condensed moisture. Moisture can greatly reduce the effectiveness of the insulation. A polyethylene film could also be used [3].

### 3.2.7 Ventilation and Equipment
There are two ways that fans can be used to ventilate a poultry house: pushing air in or pulling air out. When a fan blows air into the house, it is referred to as a positive pressure system. When air is drawn out of a house through the use of exhaust fans, it is referred to as a negative pressure system. This creates a slightly lower pressure area within the house. Air outside the house rushes in through cracks in the sidewalls and curtain openings to the partial vacuum created. Negative pressure ventilation system has proven to be the most effective means of ventilating poultry houses, and thus was chosen for use in the enclosed building [11]. The ventilation system used in the enclosed building consisted of 1.2 m diameter extractor fans. In Trinidad, 10 such fans were involved and were placed towards the back of the house. Three of them were along the length of the house on either sides and two on either sides of the back entrance (Figure 4). The fans each had a rated capacity of extracting 9.43m³/s of air, though the rated capacity was not verified. In Jamaica, there were seven such fans placed at the back of the house. The fans each had a rated capacity of extracting 10.85m³/s of air, though the actual rate during operation was again not verified. There were two evaporative cooling pads each 15.24m in length in an enclosed building (Figure 4) i.e., the ends were completely sealed and the side curtains were pulled in to seal the sides due to the vacuum created by the exhaust fan. The effect was a tunnel through which the air entered only through the pads or any other designated openings, and exited only through the fans. The pad and fan system was chosen because of its superior efficiency in evaporating water compared to conventional misting or fogging systems and also, because the pads required mechanical ventilation in order to force airflow through the pads and with tunnel ventilation, cooling benefits attributable to the combined effects of high air speed and reduced temperature could have been achieved [12]. This system keeps the birds cool in two ways. Firstly, by passing air at a high speed of 2.5m/s, a wind chill effect is set up. A wind chill is the cool effect felt by birds when air moves over their bodies at high velocity. Secondly, by evaporating moisture from moisture laden air. Evaporative cooling is the release of water into the air as vapour to lower air temperature [12]. In Trinidad as well as in Jamaica, all the equipment used in the house were automated, hence the birds were fed using automatic feeders in the form of conveyor and pan system. Water was pumped from a nearby well and was treated by chlorination before entering the house and into the nipple-drinking system through which the birds fed. There were four rows of waterers which ran the length of the house. There were three rows of feeders (about 5cm in diameter) with each row having 180 feeders. The open house used to compare its effectiveness with that of the modern tunnel-ventilated buildings was one building from Mr. Ramkisson’s farm (Table 1). This open building had the same dimensions as the tunnel-ventilated ones described. The building was similar to the ones described in section 3.1 above and had no cooling system. The building was north-south-oriented.
3.3 Summary of Data collected from the Six Tunnel-Ventilated Buildings and One Open-Sided Building

The differences in the values of the data for the individual tunnel-ventilated buildings in Trinidad and Jamaica were small. Mean data from the two tunnel-ventilated closed houses in Trinidad as well as mean data for the six equivalent ones from Jamaica were therefore reported. These mean values were compared with the single value reported for the open house from Trinidad. All the data were collected between October and December 2001 as part of a student project, with the co-operation of the owners of the farms.

3.3.1 Temperature

Air temperatures were measured daily for each house using two thermometers placed at each end of the buildings. Figure 5 shows the temperatures recorded for each house plotted alongside the actual target temperatures expected for broiler growth in a tunnel ventilated broiler house [13]. In Trinidad and Jamaica, the temperatures obtained for the tunnel-ventilated closed houses were almost the same as the required target ones. This was because the temperatures in these buildings were adjusted lower as the birds grew up and could take more of the cold weather. The temperatures recorded for the open house were way above the requirement for bird comfort.

3.3.2 Bird Weight

Body weights of representative 20 birds in each building were measured weekly using weighing scales to determine the average weights. Figure 6 shows that the bird body weights obtained for the tunnel-ventilated houses were close to the weights recommended for broilers five to six weeks old [10]. The general trend was that broilers in Trinidad were kept for 37 days before they were sent to the processing plants while in Jamaica, the birds were kept for 6 weeks. This means that the broilers from Jamaica weighed a little more than the ones from Trinidad. Broilers reared in the open house took seven weeks to reach maturity and even weighed less than the broilers reared in the tunnel-ventilated buildings (Figure 6).

3.3.3 Feed Conversion Ratio

Feed conversion is the ratio of the average feed consumption of the bird (obtained from the feeding records of the farm) to the average weight of the birds [10]. The general trend noticed in the study was that as the weights of the birds increased, the conversion ratio decreased. This was because in the tunnel-ventilated buildings, as the birds were comfortable, they tended to eat more and converted most of the feed into meat, leading to lower feed conversion ratio. However, in the open-sided building, the birds were stressed from heat, and they tended to drink more and eat less and die eventually. They could also eat more to try to convert the feed into energy and to try and cool down. These latter birds had a higher feed conversion ratio than the birds reared in the closed buildings (Table 3).

3.3.4 Mortality

Mortality is the percentage of dead birds at the end of the grow-out period. This was obtained by keeping record of dead birds in each building during a grow-out. Due to the ability of the tunnel-ventilated closed buildings to modify the temperature to increase bird comfort, the mortalities were much less than the open-sided buildings (Table 3). The mortalities for the houses in Jamaica were generally higher than those in Trinidad. This may be mainly because the houses in Jamaica had a lower stocking density (Table 3), meaning that more birds were housed per square meter of space.

3.3.5 Production

Production is the number of birds that are housed for the grow-out period. This information was collected from farm records. The tunnel-ventilated houses in Trinidad, each housed 22,500 birds although they could have housed up to 25,000. The Jamaica ones each housed 24,000 out of the possible 25,000. By comparison, the open building housed only 14,000. This was because since the open house provided no cooling, the birds had to be spaced farther apart in order to enhance production.

3.3.6 Returns on Investment

The method used for computations of returns on investment for tunnel-ventilated buildings in Trinidad is summarised below and calculated values are stated in Table 3 for all the buildings. The actual values used for the computations are based on information either received from the farmers themselves or data collected during the test period.
FIGURE 5: Air Temperature for the Different Buildings
FIGURE 6: Bird Weights for the Different Buildings
TABLE 3: Some Information of the Closed Houses compared with the Open House

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Trinidad Closed House (2 in Number)</th>
<th>Jamaica Closed House (6 in Number)</th>
<th>Trinidad Open House (1 in Number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of bird at the end of grow out (kg)</td>
<td>1.81 (After 37 days)</td>
<td>2.00 (After 42 days)</td>
<td>1.68 (After 49 days)</td>
</tr>
<tr>
<td>Feed conversion rate (Kg feed/kg meat)</td>
<td>1.90</td>
<td>1.94</td>
<td>3.61</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>1.40</td>
<td>1.50</td>
<td>16.79</td>
</tr>
<tr>
<td>Stocking density (m²/bird)</td>
<td>0.066</td>
<td>0.62</td>
<td>0.106</td>
</tr>
</tbody>
</table>

**Owning Costs**

- Cost of building ($TT)*        800,000        1,041,666         200,000
- Capital recovery factor    0.1917          0.1917             0.1917
- Owning cost ($TT) per grow out  21,911.44    28,526.71         6,390

**Expenses**

- Labour cost ($TT)                            4,000          1,666.7             6,000
- Cost of repair and maintenance ($TT)         500            833.33              300
- Water ($TT)                                  500            833.33              500
- Electricity ($TT)                             1,000          4,166.67           500
- Miscellaneous expenses ($TT)                  700            972.22              400
- Total expenses ($TT) per grow out           6,700          8,472.25           7,700

**Returns on Production**

- Production size                            22,500          24,000             14,000
- Price per kg of meat                      1.10            1.08               1.10
- Average bird weight (kg)                  1.81            2.00               1.68
- Returns on Production ($TT) per grow out   44,170          51,062.4           21,551.39

**Other Costs**

- Depreciation ($TT) per grow out            3,428.57       4,761.90           1,333.33
- Cost of tax & insurance shelter ($TT) per grow out 571.43       744.05             416.67
- Profit ($TT) per grow out                  11,558.56      8,557.49           5,711.39
- Profit ($TT) per annum                     80,909.92      59,902.43         34,268.34

*1US$ = 6.3TT$

Capital recovery factor, \( CRF = \frac{i(1+i)^n}{(1+i)^n-1} \)

\[\text{.....(1)}\]

where:

- \(i\) is interest rate (14%) and \(n\) is the amortisation period of 10 years. This equation was used to calculate the owning costs shown in Table 3. The other expenses like labour and electricity are detailed in Table 3.

The returns on production were computed using the production rate of birds described in the last section and the average mortality shown on Table 3. Returns on production is equal to:

\[(1 - \text{Average mortality rate}) \times \text{No. of birds housed} \times \text{Average birth weight} \times \text{Price per kg of meat}\]

\[\text{.....(2)}\]
Depreciation was calculated using straight-line method assuming a life span of 25 years and a salvage value of 25% of original cost of building for the tunnel-ventilated buildings and 0% for the open buildings. Tax and insurance (TIS) was calculated at 0.5% of the cost of the house per annum. Profit was calculated as:

\[
\text{Returns on production} = \frac{(\text{Owing cost} + \text{Expenses} + \text{Depreciation} + \text{TIS})}{\text{Cost of the house per annum}} \tag{3}
\]

The calculation was based on only seven broiler grow-outs per annum because one grow-out lasted for 37 days and the period between grow-outs is at most one week. For the open house, only six grow-outs per annum were possible since one-grow out lasted for 49 days and the period between grow-outs was taken to be one to two weeks. The cost of day-old chicks' feeds as well as for medicine was not considered in the calculations since the contract farmers supplied these to the farmer. In return, the contract farmers bought the birds at agreed rates (Table 3), which were about 10 times below market prices.

The returns for implementing tunnel-ventilated broiler houses were much greater than that with naturally ventilated broiler houses (Table 3). It was much higher in Trinidad than in Jamaica because energy was much cheaper in Trinidad, as the latter is an oil-producing country. It was seen, however, that using tunnel-ventilation in Trinidad could lead to profits of close to two and half times that for a naturally ventilated one.

4. Conclusion
Designing buildings for broilers is a complex task involving a combination of ideas relating to environmental conditions, physiological requirements of the bird, bird-comfort, ease of carrying out managerial operations, comfort of the workers, complying with building codes of the relevant country, material management, engineering requirements and overall personal preferences, in order to produce a structure that can range in relative simplicity from an open-sided house to a more modern, totally enclosed tunnel-ventilated house. Choosing any of the proposed alternatives is dependent on the climate of the area, power availability, availability of funds, power cost and management preferences. It takes a vast amount of measures to modify the environment of the open-sided houses while for the most part, the tunnel-ventilated enclosed house is fully automated to adjust the climatic conditions in the house as the external environment changes. It is difficult for the open house to be modified in a similar fashion for the reason that its very operation is dependent on external conditions. Typical tunnel-ventilated enclosed house costs approximately TT$ 800,000 while a well-built open house structure of similar dimension costs TT$ 200,000 (Table 3). In spite of the differences in original cost, both are projected to pay back for the initial investment in five years. Persons in the poultry business in the Caribbean who were interviewed confirmed this. The enclosed house is able to stock 25,000 birds per flock while the open house has a maximum capacity of a little over 16,000 birds per flock. This is because as the environment is cooler, the farmer can afford to allow a smaller stocking density which enhances production. Tunnel-ventilated houses have been shown to hold up to 1.5 times more birds than open houses.

In Jamaica, the mortality in the enclosed house has been shown in this study to be approximately 1.5% for the overall grow-out period and for Trinidad, it was 1.4%. For the open house in Trinidad, it has been recorded to be as much as 16.79%. Typical feed conversion for the birds grown in the enclosed house has been shown to be 1.90 - 1.94 kg feed/kg meat produced. For the open house, the conversion is as high as 3.61 kg feed/kg meat produced. Above all, the profit of the investment of the tunnel-ventilated buildings has been shown to be in the range of 250% of the open buildings.

Choosing an enclosed house in Trinidad seems like a step in the right direction. The Malabar Farms Limited in Trinidad has taken a right step in setting up two tunnel-ventilated buildings in Trinidad, following the example of producers from the United States and Jamaica.

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References


