THE EFFECT OF DIFFERENT HOUSING AND MANAGEMENT SYSTEMS ON BROILER PRODUCTION

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THESIS APPROVAL

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This is to certify that I carried out the work reported in this thesis in the Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University under the Supervision of Dr. K. Piotrowska and Dr. M. B. Olayiwole.

The work of other investigators is acknowledged and referred to. No part of this thesis has been submitted for a degree or diploma.

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S U M M A R Y

The effect of high and low wall housing and battery versus deep litter management on the growth rate, feed efficiency and dressing percentage in Anak broilers was investigated in two experiments. Five poultry houses were used: high wall-battery, high wall-deep litter, low wall-battery, low wall-deep litter and control. A total of one thousand and sixty chicks were used. Micro-climate of poultry houses was recorded on the basis of daily readings: temperature at 8a.m., 1 p.m., 5 p.m., minimal and maximal daily temperature; relative humidity at 8 a.m., 1 p.m., 5 p.m., air velocity at 8 a.m. and 5 p.m., Feed consumption was recorded daily, and live weight weekly.

Results indicated that temperature in all houses was much more than the standards accepted in broiler production. It did not affect feed consumption but probably was responsible for high feed conversion ratio.

The best results in terms of cost of feed per kg. of live weight gain were obtained in broilers kept in the high wall-battery house, followed by high wall-deep litter, low wall battery, low wall-deep litter and the poorest results were obtained from Control House.

Cockerels gained faster than pullets, but no influence of sex on dressing percentage was found.

TO

PETER AND MARTHA KEKEOCHA,

MY DEAR PARENTS

INTRODUCTION

The need for adequate and correct poultry housing has long been recognised and the environmental requirements for poultry shelter design have been obtained. The adoption of intensive and sophisticated forms of poultry husbandry has brought problems in terms of nutrition, disease control and housing as well. Suitably designed yet economical housing is required to provide optimum environmental factors, increase efficiency of feed utilization and help to control disease.

Broiler industry is an extremely specialized section of poultry production requiring good knowledge of management and mass production techniques. Good management implies the provision of optimum conditions for the broilers to grow fast and produce at their best. Specially constructed broiler houses have therefore been advocated and information on inference of environment for growing broilers should be obtained. . .

However, the paucity of literature on tropical animal housing including poultry housing was reported and the review of literature on poultry housing has shown that most of the research on broiler housing was carried out in the

temperate and developed countries, where numerous institutes devoted to farm building and animal housing research have been established. The need for similar research in the tropical zones and developing countries has been advocated to formulate data that are applicable and suitable for local use. For a long time in the developing countries poultry houses have been designed from the principles applied in human dwellings. Investigations into the basic problems of management must be conducted also in Nigeria to provide data for designing more suitable poultry houses. In pursuance of this in 1975, Institute for Agricultural Research, Ahmadu Bello University, Zaria, proposed research programme for poultry housing; "Studies of suitable housing for different levels of production including investigation on effects of heights of walls (high, medium, low and zero walls)". Taking the above into consideration, decision was taken to investigate the effects of low and high wall housing on broiler production using battery and deep litter systems of poultry keeping. The houses were designed for the use of farmers in the villages and to

suit back-yard and smaller units of poultry farms which are as for now the back-bone of poultry industry in Nigeria.

The need to have walls built in a broiler house cannot therefore be over emphasised. The advantages are well recognised which include the reduction of excess radiation from the surroundings, reduction of solar energy reflection, control of draughts and the control of high ambient temperature among other things. However there is the need to determine the height of the walls in connection with battery and deep litter management in a typically fluctuating climate such as in Nigeria. Broiler houses for the small farm units would then be constructed to provide optimum environmental factors for optimum profitable production.

LITERATURE REVIEW

The thermoneutral zone for poultry is that range of temperature that the heat lost by the bird (due to its being alive and growing or producing eggs) will be just enough to enable it to keep in equilibrum with its surroundings and to maintain its own temperature constant. The physiological consequences of deviations in ambient temperature above or below the zone of thermal nuetrality has been studied. Maximum growth and feed efficiency are not attained when broilers are grown in environmental temperatures constantly above or below an optimal range for their ages (Siegel & Drury 1970). At a higher temperature than the thermonuetral zones the bird cannot get rid of all the heat it is producing and it therefore cuts down its heat production by growing less quickly or by producing less eggs. At temperatures below the thermo-nuetral zones, it needs to eat extra food in order to maintain its body temperature.

Birds like mammals are homothermic and their critical temperature may be regarded as the temperature at which least energy is expended in maintaining the body temperature.

Steward & Hinkle (1959) obtained heat out-put of the hen in three parts - heat produced under basal condition, heat increment due to feeding and heat due to activity increment. For the birds to maintain constant temperature at vital organs, heat must be lost or conserved in response to changes in the environment. The internal temperature of birds is higher than that of mammals. The upper and lower lethal deep body temperatures and the thermoneutral range for the chicken were obtained by Sturkie (1965).

There are several inherent factors which influence deep body temperature of the chicken. Newly hatched chicks have body temperatures approximately 2.5°C below those of the adult birds. Adult levels are not reached until 6 days post hatch. This increase is related to feather cover and the increased metabolic rate. Body temperature also varies with size, breed and sex. Sainsbury (1971) observed that the ambient temperatures are more important for broiler chicks than hover temperatures. Too high house temperature will restrict appetite, retard activities and growth.

It is generally recognized that in the temperate climate the growth rate of domestic fowl exhibits marked seasonal variations and that environmental temperature is an influencing factor in this variation. Growth rate of chicken is retarded during the summer months (Joiner & Huston 1957). Chicks grown in a cooled house during the hot summer months weighed more than those grown in an uncooled house because high summer temperatures depress growth. One of the problems associated with the commercialization of poultry industry has been the threat of heavy losses posed by high temperatures. Fox (1951) reported heavy losses during period of high summer temperatures.

Studies have shown that broiler chicks grown in a high temperature environment during the latter part of the production period has poorer growth rates and feed conversion than those grown in a more moderate temperature. Drury (1966) found that increasing the air velocity around chicks in a diurnal cyclic high temperature improved growth rate but not feed conversion of broiler chicks. The common method for improving poultry performances during cyclic high temperature

periods have been to lower the high peaks of daily temperature by some means. Studies showed that by lowering the high peak of the cyclic high temperature mixed effects on chicks performances were noted. However Siegel & Drury (1970) found no difference in broiler performances in a diurnal cyclic temperature of 21.1°C plus or minus 5.5°C and non cycling 21.1°C temperature.

The influence of environmental temperature on feed intake is important because the environmental temperature is explicitly connected with the energy regulation of any warm blooded animal (Payne 1967). Under different climatic conditions especially of temperature a bird will eat different amounts of a given diet and its need for energy will vary. Diet must be formulated to allow adequate intake of nutrients other than energy under the particular conditions at which the bird is kept. It is normal to offer feed *ad libitum*. Payne (1967) observed that energy requirements decrease as environmental temperatures increase and that birds will eat less feed under higher temperatures. The problems of environment and nutrition interactions exist, and the solution will enable birds to

be kept more profitably over a range of climatic conditions.

The adverse effect of high environmental temperatures on egg production and shell thickness has been reported by Mueller et al. (1951). Many suggestions about the optimal environmental temperature for commercial egg production have been advanced. Ota et al. (1953) considered 13°C to be an ideal. Rosenberg And Tanaka (1951) reported the effect of tropical and subtropical climates on egg weight. They observed that there was no adverse effect on egg size and weight under the climatic conditions where daily maximum air temperature ranged around 26°C, throughout the year. It has been recognised that adverse effects exist on growth performances of broilers. Housing designed to reduce high effective temperature can be expected to operate in favour of these performance characters.

HUMIDITY

High humidity is also a very important factor to cope with in poultry housing (Scott, 1973). High ambient temperature above 35°C can be dealt with in areas where the humidity is low by using water sprinklers on the roofs and foggers inside the houses which cool the birds below their

critical temperatures and allow normal growth of borilers or normal egg production.

But in humid tropical areas where humidity is always high even during the dry season, more tightly enclosed houses with more mechanical ventilation may increase the interest in the use of evaporative cooling methods even though it is known that the potential cooling effect is less. The use of evaporative cooling for broiler production in areas of hgh relative humidity was investigated by Reece & Deaton (1971). The increase in humidity of the air inside an evaporatively cooled house has been reported as a main concern to poultrymen. Hutchinson (1954) suggested that an increase in humidity from evaporative cooling is not likely to increase heat stress in fowls greatly.

Water may be used as cooling agent for birds in an enclosed house primarily in two ways: on the roof to help cool its surface and inside the house as a spray directly on the birds. Roof sprinklers cool the top of the building and help reduce the radiant heat transferred to the birds. Hart et al. (1957) found some slight reduction in the inside air temperature due to roof cooling. Since roof cooling by

water requires large quantities of water, disposal of waste water may be a problem.

Foggers inside a house should actually wet the birds but care should be taken that the dropping are not wetted so much that fly breeding is increased. However, neither Drury et al. (1964) in hot humid environment nor Wilson et al. (1957) in hot dry environment obtained any direct production benefits from either method of using water. However, both systems may prevent losses through death during periods of extremely high temperature. The methods of applying the water have been discussed by Hart et al. (1957) and Wilson et al. (1957).

In hot humid areas poultry facilities should be located where at least the night time temperature are below 35°C and preferably in areas where the relative humidity is low enough to allow some cooling, (Scott 1973).

Broiler chickens are sensitive to constant high relative humidity if this is accompanied by temperatures above 38°C, (Siegel 1968). Weight gains, efficiency of feed conversion, pigmentation and feathering are all adversely affected. At lower temperatures, high humidity has no apparent effect.

Evaporative cooling has generally been considered effective only in hot dry areas where there is a large differential between dry bulb temperature. However even in humid areas where there may be relatively small wet bulb depression of around 8°C it is possible to cool the inside air several degrees and this can be a big help. Drury et al. (1964) obtained cooling of 3 to 8°C in humid South East section of the United States.

It has also been reported that extremely dry environments are also detrimental during the first 2 or 3 weeks after hatch. Smith et al. (1962) established that relative humidity within the range of 35 to 75% did not influence growth rate of broilers.

Evaporative heat loss is virtually constant for a given bird over a wide range of temperature. At a high temperature however evaporative heat loss becomes the main way which bird loses heat and the humidity of the surrounding air is of importance. The lower the relative humidity the higher the air temperature that can be tolerated.

There has been no evidence to show that the generally accepted pattern of relative humidity for broilers should be followed too slavishly as a range between 40 and 70% has been shown to give satisfactory results by Sainsbury (1972). Nevertheless attention should be drawn to the fact that birds do require a higher humidity than many modern systems provided and if humidity becomes too low, circumstantial evidence points to a rather poorer growth and an increased susceptibility to respiratory disease.

AIR VELOCITY

Increasing air speed has the same effect as reducing temperature since air velocity influences heat loss at both ends of the temperature spectrum. At low temperature, rapid air passing the body, increases heat loss by convection. Furthermore velocity sufficient to ruffle the feathers disrupts the insulative blanket of the still air provided by the plumage and further heat loss occurs (Seigel 1967). At high environmental temperature but below panting, temperature increases air movement, aids the birds in heat removal by moving the heated air away from the body and replacing it with cooler air. But as the ambient

temperature becomes higher than that of the body nothing is gained by such movement.

Wilson et al. (1957) indicated that wind up to 150cm/s was slightly beneficial in naturally varying hot weather but that wind of 250cm/s or faster was detrimental during any season of the year at Davis, California, In areas where wind movement over chicken may be higher than about 250cm/s partial walls may be useful as wind breaks. However Bond (1967), observed that partial walls can help control wind but in some cases may reduce air movement more than is desirable.

Ferguson (1970) suggested that where there is high air movement for most of the year like in Khartoum where climatological data ranged from 6.4 to 9.5 knots, operation of animal evaporative heat loss mechanism is efficient. In this situation the line of approach to housing design is the use of that, that modifies the radiation components of the environmental heat load. The principles incorporated in the traditional open light frame human dwelling in the humid tropics are applicable to poultry housing in all environment in which it is desirable to attain

maximum heat loss by evaporation and conduction. It is obvious that evaporative heat loss will be more dependent on rate of air movement in humid tropics than in drier areas.

Strategic siting of houses to take advantage of topographical features will favour air movement. Records of local wind speed and direction should be studied to take advantage of the prevailing breezes (Ferguson, 1970). Orientation of a poultry house with respect to summer and winter wind is an important consideration in natural and fan ventilation. The prevailing summer breeze can then be used to an advantage.

Another factor not too often considered is the air drainage around a poultry house. Although houses located in dished areas will be protected from the winter wind, they may be colder during still clear nights than houses located on high ground. Thus they may be more difficult to ventilate for temperature control and moisture removal. Often times houses located in a low area are more likely to have freezing conditions than those located in areas with good air drainage. Air at low temperature, like water, flows to the lowest level. Thus both water and air should

drain away from a poultry house (Ota, 1967). According to Ministry of Agriculture, Fisheries and Food (1970) convective heat loss is also affected by air speed. Increasing air speed has the same effect as reducing temperature.

VENTILATION

Ventilation requires air movement: movement of fresh air into the building and movement of stale and contaminated air out of the building. The minimum rates of ventilation in broiler house must be related to the need to keep humidity at an acceptable level and to eliminate from the building the vaporous by-products of the birds. Ogundipe (1976) reported that most of the poultry houses in the world are conventional which means that they rely on the free flow of air through the house for ventilation. Ota (1967) observed that two types of ventilation are commonly used which he called the gravity or natural system and the fan operated. The gravity system depends on cold out door air to force the warmer, lighter air out of the house. This works well with fresh air entering through windows or narrow slots or special inlets. The gravity system is used in insulated houses by providing ducts or ventilator

heads for the escape of the exhaust air. If the air inlets or windows are well distributed and easily adjustable as the weather changes, thissystem works well.

The natural ventilation relies on two phenomena: the pressure difference created by wind and that created by differences in temperature. The former takes place when ventilators are placed at any level in the vertical walls of a building. The latter which is frequently referred to as 'stack effect' occurs when ventilator are placed in pairs with a considerable difference in height between the two. Tilley (1967) reported that both types of natural ventilation take place together in poultry buildings a s it was impossible to have one without the other.

In well insulated houses more positive control of ventilation can be obtained with a fan system. The obvious and by far the most consistent method of ventilation is by fan. The pressure type of ventilation has been successfully used in insulated houses with tight ceiling. The baffle under the fan is important to prevent drafts inside the house.

It has been common practice in most design to keep the incoming air velocity to a level of approximately 60

metres per minute. Sainsbury (1972) mentioned a notable exception in certain specialist cross-ventilated buildings where a higher intake velocity is required as an integral part of the ventilation system. Apart from this exception, it seems that a low velocity is important in order to achieve a good distribution of the air and prevent drafts. A low incoming air velocity is needed to ensure uniform and draft free circulation through the house. This in turn ensures uniform use of the whole floor area by the broilers.

MaCarthey (1971) has reported that there has been considerable interest in the use of windowless type of houses for the production of broilers. It is generally agreed that houses of this type which are fan ventilated tend to be superior to conventional houses with respect to growth, feed conversion, mortality and condemnation of broilers to market age.

LIGHT

Light and temperature interaction exists for broiler weight gain. Broilers reared in a high cyclic temperature weighed significantly more than when given 12 hours of light in cool portions of the temperature cycle. The latter

grew better than those given 12 hours of light in high portions of the temperatures cycle (Deaton et al. 1970). It was also observed that broilers reared under continuous light regime gained significantly more body weight when compared to those reared under a regime of 12 hours of continuous light and 12 hours of continuous darkness. Again interaction between light and egg production has been reported by Byerly (1957). Seasonal variation in rate of egg production is associated with seasonal variation in length of day. Rate of egg production is proportional to daily light period and to daily dark period so that a maximum rate is reached with a daily period of illumination of about 13 to 14 hours. There are wide individual differences with respect to minimal daily light periods required for egg production and individual response to increase in length of daily light periods.

In considering the effect of photoperiods on egg yield and egg size in the chicken, it is essential to take into account the whole pattern of lighting from day old to the end of the pullet year. The importance of early light pattern to subsequent reproductive performances is reported

by Bowman et al. (1964 and 1966). However Cherry & Barwick (1962b), illustrated the fact that rearing with 6 hours and 9 hours of light from 4 weeks of age, when compared, was found satisfactory for both treatments.

Research and practical experience have shown that there are combinations of lighting programme to use. The use of combination of artificial and natural, or artificial light alone or natural light alone have been advocated by U.S. Department of Agriculture (1967). If the combination of the two are used the light should be turned on before sunrise or after sun set to get extra hours of light. When only artificial light is used, windowless poultry houses that are well ventilated which can be closed against day light can be used.

Skoglund & Palmer (1962), observed that the role that light intensity plays in broiler production had never been fully evaluated or understood. The possibility of a relationship between the amount of light in broiler houses and the problem of feather picking and cannibalism has been suggested by Skoglund & Palmer (1962). Light intensity studies with

broilers at the University of New Hamphsire were initiated to determine if intensity played a role in the incidence of cannibalism. Skoglund & Palmer (1962) found that light intensities of 15, 60 and 120 feet candles at the feeder height exert no influence upon the incidence of feather picking in broilers; but there was a slight trend for the broilers exposed to the lower light intensities to have a heavier body weight.

Morris (1967) suggested that the lower limited to which light intensity can be reduced is governed by practical considerations of the light needed for supervision of the flock. Cherry & Barwick (1962a) have shown that in a large house, growth rate was depressed slightly at an intensity of 0.2 lux. Haartsen and Weerden (1965) using replicated pens of 200 chicks obtained 1% better growth at 0.341 lux. He recommended that in closed broiler houses artificial lighting should be provided almost continuously. The use of a 23 hours photoperiod has the advantage that it allows maximum growth while giving the birds some experience of darkness so that they are less apt to panic if there is sudden power failure. Brigth lights (20-50 lux) should be used until

the chicks have found the food and water but thereafter intensity should be reduced to a minimum level that allows efficient supervision of the flock. For broilers reared in natural day light, artificial lighting should be provided throughout the night if the local cost of electricity is low enough to be covered by 5% increase in growth rate. There is a lack of data about the intensity of artificial lighting needed in those situations but it must be enough to stimulate feeding throughout the night.

HOUSING

The type of poultry houses to build is determined by the climate of the locality and the economic status of the farmer. In the temperate countries, complete environmental control in poultry houses have been achieved. Smith et al. (1962), Ota (1967) and Bond (1967) have shown that the use of air conditioned or fan ventilated and/or insulated poultry houses is possible. The approach to poultry housing in the tropics is quite different.

In the hot humid zones where the temperature and the humidity are very high, Williamson & Payne (1965), Emslie (1968), Ferguson (1970), Nuru (1974) and Ogundipe (1976)

reported the use of the open house to allow for maximum natural ventilation. They agreed in the use of the traditional malaya house which is a light frame structure and very efficient in protecting the chickens from radiant heat. It affords optimal air movement which promotes improved heat loss by evaporation and conduction by removing the saturated and heated air in contact with the chickens. Ehuslie (1968) described one of the commonest poultry houses which is a simple structure with solid walls to 0.46m made of 0.10m. concreate blocks and wire netted to the eaves at 1.67m. There is an overhanging at the eaves to keep the rains out. This house should not be more than 9.14m. wide. The ridge overhangs to prevent the entry of driven rains and is netted to keep wild birds out. The whole structure is supported by a 7.62cm by 10.16cm post at 3.05m intervals.

In the hot arid areas where dry conditions prevail throughout the year and wide diurnal and seasonal fluctuations in temperature occur, the use of massive thick walls, high heat retaining constructions with small windows have been advocated by Ferguson (1970) and Nuru (1974). The heavy walls are of low temperature conductance so that there is a

considerable time lag after sunrise before the interior surfaces heat up. This highthermal capacity walls are responsible for a similar delay in loss of interior heat when the outside ambient temperature drops at night thus resulting in narrowing of the diurnal temperature fluctuation within the house.

Nuru (1974) has described the high thermal capacity and low thermal conductivity type of walls when ventilation requirements are minimum. Mud or brick walls about 0.30m thick are often used. The houses are either round huts with 3.05m internal diameter, 2.13m high and fitted with a small door and 0.30m shuttered windows (or wire netting) or rectangular with several windows on all sides. This principle has been adopted successfully at a back-yard scale poultry housing level in Northern Nigeria and elsewhere (Ferguson, 1970). Where generous natural ventilation is provided, the heat bypass effect to the interior has to be accepted and consideration for minimal ventilation requirements becomes irrelevant. This design incorporates the cooling effect of air movement which promotes maximum dissipation of heat by convection, conduction and evaporation. The feature of this design is with side walls which are open or adjustable to some degree so that optimum rate of air flow through the

building can be obtained for cooling purposes. Traditional houses shared by humans and animals in hot arid areas and which incoporate such design are the Shuwa Arab dwellings to be seen in Bornu State of Nigeria and certain Turkhana dwellings in North Kenya.

The addition of partial walls to poultry shades have been considered by Ogundipe (1976), Nuru (1974), Ferguson (1970) Emslie (1968), Bond (1967) and Williamson & Payne (1965). A partial wall helps reduce solar energy reflection to the chicken from surrounding surfaces, cuts the radiation heat load on the chickens and helps control wind but in some cases may reduce air movement more than desirable. The walls of the usual poultry houses serve a dual purpose; they confine the birds and aid in controlling climate within the house (Hart et al. 1957). When laying chickens are housed in cages, confining walls are not necessary. Protection from winds is desirable especially in open houses where birds may be severely exposed to winds. Commercial poultry-men often report of a noticeable drop in production following windy periods. A wind break type of side walling has there-fore become quite common in cage houses.

Different heights of walls were recommended by different

authors. Ota (1967) suggested the use of poultry houses with no walls or with wire walls in very warm countries. Bond (1967) suggested the use of walls 1 or 2m. high. Williamson et al. (1965) observed that in dry countries the wall should be 2.44 meters high at the eaves. The side of the house least exposed to the sun should be walled to about 0.61m. and wire netted above. The opposite wall should be built to 1.22m. and the remainder netted. They concluded that in wet countries driving rain may necessitate the closure of the house on all sides in which case ventilation should be provided from drop shutters placed 46cm. above the floor on one side and under the eaves on the other side and light from windows running the full length of the lee side of the house.

The important effects of good housing on broiler production and feed consumption have been reviewed. Air temperature, relative humidity, air velocity, ventilation and lighting programme are among the factors affecting the poultry housing considered in the literature review. Differences in climate account for most of the variations in type of poultry houses. Temperature, sunshine, wind and relative humidity are probably the most important climatic

factors to consider in determining the structural designs of poultry houses. Houses with no walls or wire wall are used in very warm climates. The uninsulated building with large front wall opening is used in places where the average temperature ranges from 2°C - 25°C while warmly built house with insulated walls and controlled ventilation is recommended for places where the average temperature is below-6.5°C most of the time. In hot humid areas with high temperature and humidity open houses should be used whereas in the hot arid areas high thermal capacity and low thermal conductivity type of walls are recommended.

Poultry are raised in almost every part of the world. Climates vary; management and the economics of the poulty industry vary; building and their materials vary and the degrees of environmental control also vary. It is not surprising therefore that poultry housing and design should vary from place to place.

MATERIAL AND METHODS

1. Place:

The experiment was conducted in the College of Agriculture and Animal Science, Kaduna. The town is situated on latitude 10.36°N and longitude 7.27°E, the latitude rises to a height of about 645 meters. The average temperature is 24.3°C. Rainy season covers the period of approx. 6 months (May-October) with about 1313mm annual rainfall (The Nigerian Handbook, 1953).

2. Period of Study:

The whole studies consist of two separate experiments. The second one being a replication of the first experiment. Because of the difference in time during which the two experiments were conducted (Table 1) they are considered separetely.

Each experiment covered the period of 10 weeks with the two sub-periods: brooding - 5 weeks and rearing - 5 weeks.

TABLE 1: DURATION OF EXPERIMENTS

Sub-period	Experiment I	Experiment II
Brooding	27.03.76-1.05.76	18.07.76-21.08.76
Rearing	2.05.76-5.06.76	22.08.76-26.09.76

3. Poultry Houses:

Five types of house were used. Four of them were built based almost on the same design except for the height of side walls. These four houses have the same sizes and the same type of building materials were used for the construction. They measure 3.05 metres long and 3.05 metres wide with height of 2.15 metres at the front slopping to 1.5 metres at the eaves of the back of the houses. They were often facing West-wards and slopping East-wards. The walls were made of corrugated iron sheets on wooden frames hinged on the wooden posts that carried the entire structures. The unwalled portions of the houses were netted and the roof was asbestos .

These four houses were divided into two groups according to the heights of the side walls - the high wall and the low wall houses. The high wall houses have a height of the side walls of 1.37 metres while the low wall houses have their side walls 0.7 metres high. Each group had two houses. House numbers 1 and 2 were the high wall houses and house numbers 3 and 4 were the low wall houses.

The fifth house was the school brooding house which is made of solid cement blocks. This type of house is very common on Goverument farms all over Nigeria. It measures 36.6 metres long and 9.15 metres wide and partitioned into 3 rooms with cement block walls. The room used for this experiment is 9.15 metres wide by 12.2 metres long. The portion needed for each experiment was marked out and partitioned as required with movable boards. The flooring is concrete and the roof is absstos. The windows are made of glass and the ceiling made of ceiling boards. Pictures of high wall, low wall and inside of the Control House are given on pages 71 & 72.

4. Management Systems:

Two management systems were used: Battery and deep litter. The cage used in this study is the T.A. improved type of battery used for rearing broilers which is being marketed by Dizengoff West Africa (Nigeria) Limited. The cage measures 1.37 metres long and 0.7 metres wide. It has four compartments of 38 cm high. The feeders and the drinkers were fitted into the cages by the makers. Flat pans were fitted underneath each chamber for collection of faeces which were removed every other day.

The deep litter system was furnished with dry wood-shavings of 5.0 cm deep. The litter was not removed except when wet, as it was occassionally observed in house 4. The hanging conical feeders were used at the rate of 3 for each hundred broilers. The feeders were lowered or raised according to the height of the birds. The galvanized watering fountains (8 litters each) were used at the same ratio as feeders. The drinkers were placed on wooden frames on top of the litter to avoid contamination of water with the litter.

Houses 1 and 3 were used for battery rearing; Houses 2 and 4 were used as deep litter houses. House 5, being a standard brooding house with a floor covered by deep litter, was used as a control one.

Brief description of the houses used for the experiment is given in Table 2.

5. Stock:

Anak broilers imported from Israel were used in both experiments. Chicks reached Kaduna at the age of 3 days. Total number of chicks bought was 1160 = 660 and 500 for the first and second experiments respectively.

Table 2: DESCRIPTION OF EXPERIMENTAL POULTRY HOUSES

Number of the House	Height of Walls	Management System
1	high wall	battery
2	high wall	deep litter
3	low wall	battery
4	low wall	deep litter
5	School brooding house	deep litter

6. Brooding period:

The chicks were brooded in the House 5. The wooden hovers measuring 1.22x0.61 metres were used. The source of heat was electricity (three 100 watt bulbs in each hover). The floor was littered with wood shavings. During the first 4 days feed was sprinkled on the paper, later on the galvanized flat feeders were used. Water was given in plastic drinkers.

The commercial broiler Starter Mash bought from Pfizer Company Ltd. was used. Nutritive value of starter mash according to proximate analysis results obtained at the Biochemistry Laboratory, NAPRI Shika is given below:

Dry Matter	90.7%
Crude protein	23.3%
Ether extract	5.2%
Crude fiber	3.3%
Ash	8.1%

The broilers were vaccinated against New Castle disease twice.

7. Experimental (rearing) period:

After five weeks of brooding the broilers were divided into 5 groups and transferred to the four experimental houses the fifth group remaining in the brooding house. Number of chicks allocated to each house was calculated on the basis of rearing space per bird. The floor space/bird was 0.093 m^2 and 0.048 m^2 for deep litter and battery cage respectively.

Equal sex proportion in each group was also taken into consideration. The sex proportion in the population was 35% of cockerels to 65% of pullets for both experiments.

The number of chicks in each group is given in Table 3.

TABLE 3: DISTRIBUTION OF CHICKS

Experiment	House	Total	Cockerels	Pullets
1	1	80	28	52
	2	100	35	65
	3	80	28	52
	4	100	35	65
	5	240	84	156
2	1	80	28	52
	2	100	35	65
	3	80	28	52
	4	100	35	65
	5	100	35	65

The Pfizer commercial broiler Finisher Mash was used with a nutritive value according to proximate analysis (Shika Lab.) given below:

Dry Matter	75.9%
Crude protein	19.8%
Ether extract	4.3%
Crude fiber	3.2%
Ash	8.1%

At the third rearing week in the first experiment, Gumboro disease attacked the broilers.

At the termination of experiment all broilers were sent to the Animal Products Laboratory, Ahmadu Bello University, Zaria for slaughtering and processing. The weight of each broiler was recorded immediately before slaughter then the dressed carcass weight was obtained.

8. Data collected:

- Feed consumption (per group) - daily
- Liveweight (individually) - weekly
- Micro-climate in poultry houses:
- Temperature at 8 a.m., 1 p.m. 5 p.m. - daily
- Maximal daily temperature - daily
- Minimal daily temperature - daily
- Relative humidity at 8 a.m., 1 p.m., 5 p.m., - daily
- Air velocity at 8 a.m. and 5 p.m. - daily (only in Experiment I before the kata thermometer got broken).

Each poultry house was furnished with the maximal minimal wet bulb thermometer and thermo-hygrometer fixed inside the house about 0.5m above the floor level.

9. Date processing:

All tabulated data were processed and analysed at the Ahmadu Bello University Computer Centre. One and two way analysis of variance, correlation and regression coefficients were computed for according to suggestions and methods appropriately developed by the Biometric Section.

RESULTS

1. BROODING PERIOD

During the five weeks of brooding period, all chicks were kept together in the brooding house described in Material and Methods as House 5. Mortality and culls during brooding period in the experiments are given in Table 4. Average number of chicks in a given week was calculated according to the formula:

$$\text{Average} = \frac{\text{TOTAL NO. IN DAY 1} + \ldots\ldots\ldots + \text{IN DAY 7}}{7}.$$

Table 4: MORTALITY AND CULLS DURING BROODING PERIOD

	Experiment I				Experiment II			
Week	No. of Chicks	Losses No.	%	Ave. No.	No. of Chicks	Losses No.	%	Ave. No.
0	660				500			
1	641	19	2.8	650	493	7	1.4	494
2	633	8	1.2	637	489	4	0.8	490
3	629	4	0.6	631	487	2	0.4	489
4	626	3	0.5	627	481	6	1.2	483
5.	624	2	0.3	625	475	6	1.2	478
Total	-	36	5.4	-	-	25	5.0	-

Mortality and culls were within acceptable ratio in both experiments and reached similar level of approximately 5%, for the whole brooding period. The chicks for both experiments started with almost the same body weight (Table 5) but in Experiment I they gained better and finally reached higher body weight than those in Experiment II.

Table 5: AVERAGE BODY WEIGHT AND GAIN/CHICK/WEEK(IN GRAMS)

	Experiment I		Experiment II	
Week	Body Wt.	Wt. Gain	Body Wt.	Wt. Gain
0	40	-	42	-
1	80	40	83	41
2	145	65	154	71
3	250	105	249	95
4	412	162	386	137
5	592	180	513	127
Total	-	552	-	471

Since the feed consumption in Experiment II was higher and live weight gains lower, feed conversion in chicks in Experiment I was much better. As indicated in Table 6 for 1 g. of live weight gain 2.5g. of starter mash were used in Experiment I while 3.4g. in Experiment II.

Table 6: AVERAGE FEED CONSUMPTION AND FEED CONVERSION PER CHICK/WEEK (IN GRAMS)

	Experiment I		Experiment II	
Week	Feed Consumption	Feed Conversion	Feed Consumption	Feed Conversion
1	92	2.3	136	3.4
2	155	2.4	223	3.1
3	306	2.9	319	3.3
4	397	2.4	416	3.0
5	456	2.5	494	3.9
Total	1,406	2.5	1,590	3.4

Some, but not regular changes in feed conversion were observed within 5 weeks of brooding in Experiment I and II as well. It indicated that feed efficiency ratio slightly increased during this period.

The economical effect of brooding period expressed in total cost of feed per one chick amounts 37 and 41 kobo in Experiment I and II respectively.

It can be concluded that in the same brooding house and with similar levels of mortality chicks in Experiment I gave better results than the birds in Experiment II.

2. EXPERIMENT I.

(a) MICRO-CLIMATE IN POULTRY HOUSES

After the 5 weeks of brooding, chickens were transferred to experimental houses according to scheme given in Table 3. Micro-climate of each house is described on the basis of temperature, relative humidity and air velocity. Analysis of the differences between houses in based on the average value obtained for each house from 35 daily readings while each analysis of variance in respect of micro-climate traits contains 175 readings (5 houses x 35 days).

Table 7: AVERAGE TEMPERATURES AT 8A.M., 1P.M. AND 5P.M. INSIDE THE POULTRY HOUSES (IN °C)

	8a.m.			1p.m.			5p.m.		
House	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range
1	26.91	2.88	21-30	33.46	1.54	31-37	31.34	2.58	25-38
2	26.86	2.51	22-31	32.91	1.65	28-35	31.86	2.37	28-38
3	26.17	1.81	22-29	31.83	1.77	29-36	30.94	1.85	28-35
4.	25.71	2.66	21-30	31.63	1.90	29-37	30.46	2.36	24-35
5	28.00	2.12	22-31	33.09	0.89	31-34	32.77	1.35	30-34

When temperature at 8a.m., 1p.m. and 5p.m. is considered it was observed that irrespective of the house, temperature is rising sharply from morning to the afternoon and dropping gently in the evening. The highest differences were observed in the high wall battery (House I) in which the morning rise amounted 6.55°C and afternoon drop 2.12°C. The Control House 5, showed the least daily differences, but the temperature inside this house was consistently higher than in the remaining 4 houses. Low wall deep litter House 4 had the least temperature in the morning, afternoon and evening.

Comparing the high wall (1, 2) and the low wall (3, 4) houses it can be seen that the temperature inside the low wall houses was slightly lower.

When two systems of management in each type of house are considered, the results indicated that deep litter provides lower temperature than battery cages.

From the statistical analysis, differences between houses were highly significant at ($P < 0.01$) at 8a.m. and ($P < 0.001$) at 1p.m. and 5p.m.

Temperature at 8a.m., 1p.m. or 5p.m. does not necessarily indicate the highest and the least diurnal temperature inside the house. Daily readings on maximal - minimal thermometers installed in each house provided above mentioned data.

High wall houses had significantly higher maximal diurnal temperature than low wall ones and what is interesting, the least minimal temperature was also found in the high wall houses (Table 8).

Table 8: AVERAGE MAXIMAL AND MINIMAL DIURNAL TEMPERATURES INSIDE THE POULTRY HOUSES (IN ^{o}C)

	Maximal			Minimal		
	Mean	S.D.	Range	Mean	S.D.	Range
1	36.94	0.94	34-38	20.26	1.56	18-23
2	37.23	0.88	36-39	19.34	1.37	16-22
3	35.40	1.36	33-38	20.66	1.53	18-23
4	35.43	2.24	30-39	22.03	1.60	19-25
5	35.89	1.26	33-38	20.43	0.88	18-22

System of management did not affect the maximal and minimal diurnal temperature.

Relative humidity (RH) follows the opposite daily pattern of the temperature. In the morning RH inside the houses reached the peak, dropped in the afternoon to rise slightly in the evening (Table 9).

Table 9: AVERAGE RELATIVE HUMIDITY AT 8A.M., 1P.M. AND 5P.M. INSIDE THE POULTY HOUSES (IN%)

	8 a.m.			1 p.m.			5 p.m.		
House	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range
1	80.37	11.54	66-96	61.22	8.04	49-88	66.49	7.11	50-85
2	78.46	9.76	61-95	56.22	7.83	31-70	64.43	10.84	40-90
3	71.69	4.70	60-80	60.23	5.31	52-74	63.80	9.74	40-90
4	77.66	11.62	58-96	59.14	5.88	49-70	61.97	9.85	45-90
5	74.80	7.05	44-83	64.09	5.08	52-73	64.51	7.41	50-80

The difference between high and low wall houses is RH can be observed in the morning and evening when the former ones showed slightly higher readings. Influence of management system was markedly better expressed in high wall houses, since deep litter House 2 had consistently lower RH. In low wall houses higher difference appeared only in the morning when deep litter was related with higher humidity.

As in the case of temperature, control House 5 showed the least daily variation in humidity.

From the analysis of variance, RH in the houses was considered significant only for 8 a.m. and 1 p.m. at ($P<0.001$).

Air velocity (Table 10) measured at 1m. above the floor level was consistently lower in control House 5 followed by high wall and finally by low wall houses in which the air velocity reached very higher level. Morning readings were lower than evening ones.

Table 10: AIR VELOCITY AT 8 A.M. AND 5 P.M. INSIDE THE POULTRY HOUSES (F T /MIN.)

	8 a.m.			5 p.m.		
Hourse	Mean	S.D.	Range	Mean	S.D.	Range
1	424	506	20-2000	668	524	10-2000
2	439	443	10-2000	677	662	140-2000
3	598	637	50-2000	694	691	60-2000
4	823	714	40-2000	672	632	60-2000
5	242	150	60-760	418	389	55-2000

Range of the air speed is considerably high because of some readings done during the storms.

b. PERFORMANCE OF BROILER CHICKS

General information of broilers performance is provided in Table 11 in which mortality and culls are given.

Table 11: MORTALITY AND CULLS

	W E E K					T O T A L	
House	1	2	3	4	5	No	%
1			1	5	2	8	10
2	1		1	4		6	6
3			6	1	1	8	10
4			5			5	5
5			5	3		8	3.4
TOTAL	1		18	13	3	35	5.8

In the first two and the last week of experiment chickens did very well. Almost the whole number of losses came within the 3rd and 4th week when broilers were attacked by Gumboro disease. The percentage of loss is low since very often Gumboro disease claims over 20% mortality while the range 3 to 6 is considered as normal.

Control House 5 had the least mortality of broilers (3.4%) while in the houses equipped with battery cages mortality reached the level of 10%.

Feed consumption was recorded daily and average feed intake per chicken was calculated for each day and each house. (Table 12).

Table 12: AVERAGE DAILY AND TOTAL FEED CONSUMPTION PER CHICK (GRAMS)

	H O U S E				
Week	1	2	3	4	5
1	70.1	72.0	75.4	82.1	74.2
2	91.8	93.5	102.7	101.1	85.0
3	97.1	86.8	90.5	73.5	90.0
4	97.1	95.0	111.5	109.0	105.8
5	115.2	121.5	134.0	123.4	115.7
TOTAL	3299	3285	3599	3423	3295

Gumboro disease affected feed intake in the third week of experimental period. In some houses there were decreases in intake while in some, only slight increases.

Differences between weeks and houses were found significant (Appendix 3). Total amount of Finisher Mash consumed by one chick was almost equal in the two high wall and Control House and was lower in the two low wall houses.

One of the factors affecting feed intake in poultry is temperature inside the poultry house. This problem has been investigated for experimental period. Average temperature for each day and house was calculated from the readings at 8 a.m., 1 p.m. and 5 p.m., and correlated with average daily feed intake/broiler. Correlation coefficients were obtained for each week separately. (Table 13).

Table 13: CORRELATION COEFFICIENTS BETWEEN TEMPERATURE AND FEED INTAKE

Week	n	r	p	Range of mean Temperature
1	35	-0.07	0.96	27°-33°
2	35	-0.31	0.06	28°-33°
3	35	+0.24	0.15	28°-33°
4	35	-0.19	0.26	28°-32°
5	35	-0.10	0.55	28°-33°

In all cases except the 3rd week (Gumboro disease) correlation coefficients were negative and non-significant. It can be concluded that average daily temperature ranging from 27° to 33°C did not affect, significantly, daily feed intake in broiler chickens.

Individual weights were recorded in the first day of experimental period (week 0), then in the first day of each

successive week, before morning feeding. At the end of 3rd week, weight was not recorded to avoid further stressing of broilers attacked by Gumboro disease.

Analysis of variance was done for each week since the results of significance are alike in all cases, data for week 0 and 5 are only given in Appendix 4.

According to multiple range test, initial weight of chikens in House 1 to 4 did not differ significantly while in House 5 it was significantly lower than the rest. In random choosing of broilers for each experimental group, the emphasis was put on equal sex proportion, and it was almost impossible to equalize the weight in all groups. However the difference between the extreme groups (House 5 - House 3) was only 43 grams. Finally the difference in above mentioned groups reached 188g. and was caused by higher feed intake in House 3.

Average total gains were higher in both houses equipped with battery cages (House 1 and 3). Difference between Houses 1 and 2 amounts 11% (112g) while between Houses 3 and 4 16% (115g.). Broilers kept on deep litter and in Control House gained equally (Table 14).

Well known fact is that for intensive commercial broiler production only cockerels are used because of their faster growth and better feed conversion. In Annak broilers obtained from Israel, both sexes were represented in the proportion

of cockerels to pullets amounting 35:65. Comparison of the growth rate of two sexes seemed to be interesting. Results are given in Table 15 and Appendix 4.

At the beginning of experimental period (week 0) cockerels were heavier by 60 grams/bird. After 5 weeks difference rose to 198 grams proving the faster growth rate in males.

In spite of the differences in live weight there was no difference in the dressing percentage of 69.1 for cockerels and 69.2 for pullets. Standard Deviation amounts to 5.65 and 3.50, dressing percentage ranged from 45.4 to 78.6 and from 46.3 to 81.0 for cockerels and pullets respectively.

Economical effects of Experiment I are given in Table 16.

Considering feed conversion and total cost of feed per kg. of gain the best results were obtained in high wall - battery House 1 followed by low wall - battery House 3, high wall - deep litter House 2, control House 5 and finally low wall - deep litter House 4.

Table 14: AVERAGE BODY WEIGHT AND TOTAL GAIN OF CHICKEN (GRAMS)

Week		H O U S E				
		1	2	3	4	5
0	Mean	604	591	615	611	572
	S.D.	99.4	112.8	113.1	116.2	95.7
	Range	400-800	400-850	400-900	400-850	400-850
1	Mean	776	736	793	746	713
	S.D.	115.0	143.0	143.7	145.1	145.7
	Range	500-1000	450-1050	450-1100	500-1050	400-1000
2	Mean	993	931	1021	968	905
	S.D.	124.9	162.9	203.2	167.0	485.2
	Range	700-1300	600-1300	500-1500	700-1300	500-1200
4	Mean	1435	1291	1440	1294	1246
	S.D.	206.6	252.0	227.7	233.4	205.2
	Range	900-2000	700-1950	1000-2100	800-1800	800-1900
5	Mean	1702	1577	1741	1582	1553
	S.D.	222.0	275.7	245.5	270.3	240.6
	Range	1050-2100	1000-2200	1200-2300	1000-2200	1000-2000
Total gain		1098	986	1126	971	981

Table 15: AVERAGE BODY WEIGHT OF COCKERELS (C) AND PULLETS (P) IN WHOLE POPULATION (IN GRAMS)

Week	Sex	Mean	S.D.	Range
0	C	631	114.7	400-900
	P	571	95.2	400-850
1	C	793	150.1	500-1100
	P	714	132.9	400-1000
2	C	1011	208.2	700-1400
	P	913	154.4	500-1400
4	C	1417	242.6	900-2100
	P	1251	206.5	700-2000
5	C	1730	267.2	1000-2300
	P	1532	224.7	1000-2100

Table 16: ECONOMICAL EFFICIENCY OF REARING PERIOD AND WHOLE EXPERIMENT I

Period	Trait	H O U S E 1	2	3	4	5
Rearing	Feed Conversion	3.00	3.32	3.20	3.52	3.35
	Total cost of feed/chick/(Kobo	85	86	94	90	86
	Cost of feed/1kg of gain	77	87	83	93	88
Whole of Expt. I	Total cost of feed per chick (Naira)	1.22	1.23	1.31	1.27	1.23
	Cost of feed/1kg. of gain (kobo)	74	79	78	83	80

3. Experiment II

A. Micro-climate in Poultry Houses:

Experimental period covered the second half of rainy season (22nd August - 26th September) while in Experiment I, it included the beginning of rains (2nd May - 5th June). It is worth special attention to look at the problem whether the elements of internal environment of the poultry houses followed the same pattern in both experiments or some differences can be observed.

In respect to temperature at 8 a.m., 1 p.m. and 5 p.m. general pattern is the same (rise from morning to afternoon and small drop in the evening) however the magnitude of daily range is lower in the second experiment.

Table 17: AVERAGE TEMPERATURE AT 8 A.M., 1 P.M., AND 5 P.M. INSIDE THE POULTRY HOUSES ($IN^{O}C$)

House	8 a.m.			1 p.m.			5 p.m.		
	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range
1	26.29	1.64	24-30	29.89	1.18	27-32	29.66	1.51	27-34
2	25.69	1.62	23-29	29.01	1.31	26-31	29.03	1.12	27-31
3	24.77	2.10	21-29	29.45	1.93	26-35	29.11	1.21	26-32
4	26.51	1.96	23-30	30.03	1.67	27-35	39.66	1.92	25-34
5	25.60	1.33	24-29	29.57	1.96	25-32	27.89	1.23	26-31

Temperature in the morning was similar in the two experiments while at 1 p.m. and 5 p.m. was lower in Experiment II. Only in one case it exceeded $30^{O}C$, while in Experiment I after-noon and evening temperatures were always above that level.

Difference between high and low wall houses are not significant and management systems gave very low but reverse of the previous effect in the two high walls.

High wall deep litter House 2 had slightly lower temperature than high wall battery House 1 while in low wall house, deep litter was connected with higher temperature.

Diurnal maximal temperature reached higher level in this experiment. Differences between houses and management systems are significant only in respect to high wall houses in which House 2 with deep litter provided lower maximal temperatures than House 1 with battery cages.

Table 18: AVERAGE MAXIMAL AND MINIMAL DIURNAL TEMPERATURE INSIDE THE POULTRY HOUSES (IN °C)

	MAXIMAL			MINIMAL		
House	Mean	S.D.	Range	Mean	S.D.	Range
1	37.80	1.32	35-40	19.49	0.56	19-21
2	35.94	1.38	29-40	20.43	1.44	18-23
3	37.00	2.04	32-40	19.57	1.38	16-22
4	36.34	2.06	32-40	19.77	1.26	18-24
5	35.69	1.35	33-38	20.31	1.39	17-24

Minimal diurnal temperature was slightly lower in this experiment. No regularities in respect to housing and management system have been found.

Daily changes in relative humidity followed the same pattern in both experiments but with considerably higher RH at 8 a.m. in Experiment II

Table 19: AVERAGE RELATIVE HUMIDITY AT 8 A.M., 1 P.M., AND 5 P. M. INSIDE THE POULTRY HOUSE (IN %)

	8 a.m.			1 p.m.			5 p.m.		
House	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range
1	86.32	3.56	56-96	62.11	5.26	53-74	69.71	8.55	56-87
2	84.74	7.09	69-95	63.43	4.95	52-80	67.57	10.52	54-95
3	86.29	6.79	69-96	65.46	8.28	55-96	65.71	20.20	53-97
4	80.17	9.80	59-96	62.60	5.85	50-75	67.11	10.40	52-87
5	78.71	2.20	75-82	63.69	13.60	43-87	67.14	6.06	54-78

Significant differences between houses were found only for 8 a.m. (Appendix 6). It can be concluded that deep litter was connected with lower RH in high and low wall houses as well.

b. Performance of Broiler chickens

Chicken survival in Experiment II was better than in Experiment I. Total losses amounted 3.9%

Table 20: MORTALITY AND CULLS

	W E E K					T O T A L	
House	1	2	3	4	5	No.	%
1	1					1	1.3
2				4		4	4.0
3			2			2	2.5
4	8	1	2			10	10.0
5		1				1	1.0
T O T A L	9	2	4	4	-	18	3.9

Higher mortality in House 4 was caused by heavy storm in the first day of experiment. Chicks pilled together in one corner of the house killing 8 of them. The least losses were found again in Control House 5. Feed consumption is given in Table 21.

Table 21: AVERAGE DAILY AND TOTAL FEED CONSUMPTION PER CHICK (IN GRAMS)

	H O U S E				
Week	1	2	3	4	5
1	73.1	71.8	74.0	69.5	76.4
2	88.4	91.0	107.1	85.4	97.2
3	108.1	108.2	118.8	114.0	107.2
4	115.0	114.0	123.0	112.7	103.7
5	118.5	114.2	123.2	122.5	110.2
TOTAL	3522	3495	3823	3529	3465

Total feed consumption per chicken was higher in Experiment II than in the former one. It was mostly due to continuous increment of feed intake not disturbed by health troubles as happened in Experiment I. As the latter, chickens in low wall-battery House 3 consumed more, while the remaining 4 groups kept almost the same level of feed intake.

As in Experiment I, feed consumption was negatively correlated with temperature but significant only in the first week of experiment (Table 22).

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Table 22: CORRELATION COEFFICIENTS BETWEEN TEMPERATURE AND FEED INTAKE

Week	n	r	P	Range of Mean Temperature
1	35	-0,42	0,01	26-30
2	35	-0,13	0,43	25-31
3	35	-0,07	0,65	25-30
4	35	-0,14	0,93	27-30
5	35	+0,27	0,11	26-30

This time average daily temperatures were lower, what could have resulted in the significant correlation coefficient for the first week. It should be considered in further investigations which ambient temperature makes a "critical point" above which the increment of temperature does not affect feed intake considerably.

At the beginning of experimental period average body weight were equal in all experimental houses (Table23) while the control group had lower mean live weight of approx. 40 grams. Finally live weight gain was similar in Houses 1 - 4 and approx. 100g, lower in House,5.

W hen the results of live weight gains in Experiment I and II are compared it can be stated that while some differences were observed between deep litter and battery cages in Experiment I, that kind of differences did not appear in Experiment II.

Broiler chicks gained better in Experiment II. The differences between Experiment I and II ranges from 43g. for House 3 to 195g. for House 2.

Table 23: AVERAGE BODY WEIGHT AND TOTAL GAIN OF CHICK (IN GRAMS)

Week		HOUSE 1	2	3	4	5
	Mean	521	529	523	521	481
0	S.D.	70.6	107.5	78.7	79.2	89.5
	Range	400-700	300-1100	350-750	400-800	300-700
	Mean	705	727	743	708	690
1	S.D.	100.9	99.0	135.7	107.5	126.0
	Range	500-900	500-950	350-1000	500-1100	450-1000
	Mean	1041	1003	1082	988	996
2	S.D.	105.2	95.9	141.8	131.3	184.0
	Range	850-1300	800-1200	650-1400	700-1500	650-1250
	Mean	1314	1255	1330	1256	1150
3	S.D.	170.7	124.4	188.7	167.9	171.0
	Range	900-1700	950-1500	850-1800	900-1900	850-1600
	Mean	1503	1470	1532	1419	1345
4	S.D.	189.7	148.8	207.7	200.1	215.5
	Range	1100-2000	1100-1800	1100-2000	1100-2300	900-1900
	Mean	1693	1710	1692	1636	1535
5	S.D.	201.6	193.1	204.1	235.1	275.5
	Range	1250-2100	1300-2200	1400-2200	1100-2500	1000-2000
Total gain		1172	1181	1169	1165	1054

Advantage can be attributed to the health status of broilers which were not attacked by Gumboro disease as were the ones in Experiment I.

During the second brooding period growth rate of chicks were lower what probably caused a small difference in mean live weight of cockerels and pullets amounted only 15g. (60g. in Experiment I). At the end of fifth rearing week it increased to 270 g. proving again the faster growth rate in cockerels (Table 24).

Table 24: AVERAGE BODY WEIGHT OF COCKERELS (C) AND PULLETS (P) IN WHOLE POPULATION (IN GRAMS)

Week	Sex	Mean	S.D.	Range
0	C	523	78.0	400-800
	P	508	39.5	300-700
1	C	776	110.0	500-1100
	P	679	102.3	350-950
2	C	1080	153.8	750-1850
	P	679	116.9	650-1350
3	C	1350	177.7	860-1900
	P	1197	149.7	850-1650
4	C	1615	178.6	1000-2300
	P	1382	166.0	900-2000
5	C	1870	220.7	1400-2500
	P	1566	182.0	1000-2100

Difference in total gain between cockerels and pullets amounts 138g. and 255g. in Experiment I and II respectively. Solution of this significant difference lies probably in Gumboro disease. Cockerels seem to be more sensitive to this type of disease and respond in higher growth rate retardation than pullets.

Influence of sex on dressing percentage has not been stated since the values obtained are: 64.0% (S.D. 3.58, range 42.2-76.9%) and 64.6% (S.D. 3.15, range 57.3-821) for cockerels and pullets respectively.

Economical effects of Experiment II are given in Table 25.

Table 25: ECONOMIC IMPLICATIONS OF REARING PERIOD AND WHOLE EXPERIMENT II

Period	Trait	H O U S E 1	2	3	4	5
Rearing	Feed Conversion	3.04	2.95	3.27	3.02	3.28
	Total cost of feed per chick (k)	92	91	100	92	91
	Cost of feed/kg. of gain (kobo)	73	77	85	79	86
Whole Exp. II.	Total cost of feed per chick (Naira)	1.33	1.32	1.41	1.33	1.32
	Cost of feed/kg.	80	79	86	81	86

In terms of feed conversion and cost of feed per kg. of gain the best results were obtained in high wall - deep litter House 2 followed by high wall - battery House 1, low wall - deep litter House 4 and House 3 and 5 with similar results.

DISCUSSION

As a result of acute meat shortage in Nigeria a considerable expansion of poultry industry is planned in the commercial and rural sector as well. According to Federal Livestock Department, rural backyard poultry production still predominates in terms of the number of birds kept and meat produced.

Total number of poultry kept by small farmers in 1974 amounted 45 million providing 40000 tons of meat while the number of birds kept in the commercial farms amounted 5 million providing 20000 tons of meat per year.

Considering that the present ratio of poultry number in rural and commercial sector is 9:1, all possible steps to improve poultry productivity in small farms should be undertaken.

Within the wide range of breeding, nutrition, health and management problems, investigation on poultry housing was chosen as a subject of the present paper. Assumption was made to investigate the type of houses which are not expensive and can be easily constructed by a farmer himself.

Following this realistic guideline, artificial lighting has not been applied and studies on the influence of light intensity and length of photoperiod were not undertaken.

The only one more expensive installation was a battery. It seemed to be interesting to look at the problem of the broiler's response for more intensive system of management connected with a simple poulty house.

Micro-climatic conditions in all five poultry houses were far from the standards especially in respect to temperature. In the tropical backyard type of production, temperature of approximately 20°C is impossible to be achieved and in such case the role of investigator is to observe the performance of birds in much higher ambient temperatures, exceeding the standard one even by 100%. Maximal diurnal temperature of 40°C have been recorded in this experiment.

In respect to feed consumption, the results obtained in the experiment do not fully agree with the wide spread opinion that high ambient temperature negatively influences the feed intake. Total feed intake (brooding + rearing period) per a broiler varied from 4.6kg. in House 2 Experiment I to 5.4kg. in House 3 Experiment II and can be considered as high.

Correlation coefficients between average daily temperature and feed consumption were not significant. May be the ranges of temperature were not high enough to influence the appetite, as found by Siegel & Drury (1970). In his experiment deviation of 5.5°C did not affect broilers peformance.

Visible effect of too high temperature was the excessive panting of broilers observed at noon hours.

Feed conversion ranging from 2.95 to 3.52kg. of concentrates per kg. of gain is not too satisfactory confirming the results obtained by Siegel & Drury (1970), Sainsbury (1971), Joiner & Huston (1957) and Fox (1951) who found that too high ambient temperature cuts down the growth rate and feed efficiency.

During the rainy season in which the experiment was performed relative humidity inside the houses ranged within the limits accepted for broiler production. Slightly lower humidity inside the low wall houses than inside the high wall ones was caused by higher air velocity in the former.

Air velocity exceeding the limits, very positively affected the air exchange in the houses. Probably the worst results obtained in the control House 5 were caused by poor or inadequate ventilation. Although the diurnal changes in temperature and relative humidity were the least in the House 5 making micro-climate more uniform, the low velocity caused inadequate air exchange, finally affecting the growth rate of broilers.

Many factors are responsible for broiler production, but the final financial aspect is the most important for the producer. Taking the above into consideration the effect of different housing and management systems has been expressed in cost of feed per kg. of live-weight gain.

For two experimental periods following results were obtained:

House 1 77.5 kobo

House 2 82.0 kobo

House 3 84.0 kobo

House 4 86.0 kobo

House 5 87.0 kobo.

The best results were obtained from broilers allocated to high wall-battery House 1. The difference between House 1

and remaining four houses, ranges from 4.5 to 9.5 kobo per kg. of gain. This differences should be considered significant since if several hundred of birds are kept in few rotations per year then a difference of few kobo per chick rises to several hundreds of Naira within the year.

If for some reasons purchasing of the batteries is impossible then high wall-deep litter house could be recommended.

It is difficult to conclude which factor or factors were responsible for better conversion and finally higher profitability of broilers kept in the high wall houses. Although micro-climatic differences between houses in most cases showed statistical significance, the differences appeared to be rather low and not consistent in their patterns. Anyway the general conditions in high wall houses seem to be more suitable for broiler production during the rainy season.

C O N C L U S I O N S

(1) Successful broiler production can be arranged in small farm units in cheap and easily constructed poultry house. When separate house for brooding is used and broilers are consequently transferred for rearing into another house nine rotations can be arranged per year.

(2) During the rainy season better results were obtained in the poultry houses with side walls having height of 1.37m. than in those with side wall height of 0.7m.

(3) Within high and low wall houses broilers kept in batteries performed slightly better than those kept on deep litter.

(4) The best results were obtained when chicks were allocated in high wall house and kept in the battery, followed by ones kept in high walls house on deep litter.

(5) During the rainy season the local type of house does not create any problems with relative humidity since the air velocity inside the house is high enough. Temperature is always much higher than accepted for broilers.

(6) High temperature did not affect feed intake but probably was responsible for rather too high feed conversion ratio obtained in the study.

Appendix 1. ANALYSIS OF VARIANCE FOR TEMPERATURE INSIDE THE POULTRY HOUSES IN EXPERIMENT I (MEAN SQUARES)

Source	d.f	Temp. 8 a.m.	Temp. 1 p.m.	Temp. 5 p.m.	Max. Temp.	Min. Temp.
House	4	25.6800[b]	22.8086[c]	27.6800[c]	25.7343[c]	32.8571[c]
Residual	170	5.9066	2.5254	4.6054	2.0151	2.0000

Appendix 2.

ANALYSIS OF VARIANCE FOR RELATIVE HUMIDITY AND AIR VELOCITY IN EXPERIMENT I (MEAN SQUARES)

Source	d.f	RH 8 a.m.	RH 1 p.m.	RH 5 p.m.	AV 8 a.m.	AV 5 p.m.
House	4	404.0771[c]	287.1800[c]	91.8229[NS]	1658489.70[c]	1117491.00[a]
Residual	170	87.0346	42.8945	82.9331	278352.08	416258.86

NS = not significant

a = P/ 0.05

b = P/ 0.01

c = P/ 0.001

Appendix 3:

ANALYSIS OF VARIANCE FOR AVERAGE DAILY FEED CONSUMPTION BY WEEK AND HOUSE (MEAN SQUARES)

Source	d.f.	Experiment I	Experiment II
Week	4	11490.691^{c}	12077.051^{c}
House	4	584.577^{b}	605.694^{a}
Week x house	16	348.609^{a}	169.512^{NS}
Residual	150	174.533	229.827

Appendix 4:

ANALYSIS OF VARIANCE FOR BODY WEIGHT BY SEX AND HOUSE IN EXPERIMENT I (MEAN SQUARES)

	Week 0		Week 5	
Source	d.f	Mean squares	d.f	Mean squares
Sex	1	490091.09^{c}	1	4803895.12^{c}
House	4	44305.56^{b}	4	602024.31^{c}
Sex x house	4	16801.18^{NS}	4	130491.18^{a}
Residual	588	10221.65	553	536666.91

NS = not significant

a = P$\angle$ 0.05

b = P$\angle$ 0.01

c = P$\angle$ 0.001

Appendix 5: ANALYSIS OF VARIANCE FOR TEMPERATURE INSIDE THE POULTRY HOUSES IN EXPERIMENT II (MEAN SQUARES)

Source	d.f	Temp. 8 a.m.	Temp. 1 p.m.	Temp. 5 p.m.	Max. Temp.	Min. Temp.
House	4	16.2143[c]	13.5857[c]	18.3371[c]	25.5800[c]	6.5286[b]
Residual	170	3.0705	2.6971	2.0461	3.0995	1.5624

Appendix 6:

ANALYSIS OF VARIANCE FOR RELATIVE HUMIDITY INSIDE THE POULTRY HOUSES IN EXPERIMENT II (MEAN SQUARES)

Source	d.f	8 a.m.	1 p.m.	5 p.m.
House	4	445.2371[c]	57.6714[NS]	199.5229[NS]
Residual	170	54.1146	67.9691	147.3005

NS = not significant

a = P/ 0.05

b = P/ 0.01

c = P/ 0.001

Appendix 7:

ANALYSIS OF VARIANCE FOR BODY WEIGHT BY SEX AND HOUSE IN EXPERIMENT II (MEAN SQUARES)

	Week 0		Week 5	
Source	d.f.	Mean squares	d.f	Mean squares
Sex	1	24606.19[c]	1	7329891.62[c]
House	4	34147.33[NS]	4	509224.63[c]
Sex-house	4	10826.06[NS]	4	13373.70[NS]
Residual	456	7006.92	431	34404.78

NS = not significant

c = P/ 0.001

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Fig. 3.



Inside of Control House

Fig. 4.



Broilers in the Battery.

Fig. 1.



High Wall House

Fig. 2.



Low Wall Battery House