LAYERS PERFORMANCE AS AFFECTED BY SOME ENVIROMENTAL FACTORS

By

Khalid Osman Elmussaad Elnor

B.Sc. (Honours) Agricultural Engineering

Sudan University of Science and Technology

2000

A thesis submitted to the University of Khartoum in partial fulfillment for the requirement of the Degree of Master of Science

in Agricultural Engineering.

Supervisor

Dr. Mohammed Ayoub Ismail

Department of Agricultural Engineering

Faculty of Agriculture

University of Khartoum

May - 2006

DEDICATION

To soul of my father

To soul of my sons Osman & Iman

To my dear mother

To my wife and daughter Isrra

To my brothers and sisters

To all my family and friends

With love and respect

Khalid

Acknowledgements

I wish to express my special appreciation to my supervisor Dr. Mohamed Ayoub Ismail for his helpful guidance, suggestions, odorizes, cooperation and persistent encouragement to carry out this study.

My deepest thanks to my teacher Dr. Mohammed Eltigani Salih, Sudan University for Science and Technology and special thanks to my teacher Awad Al-Karim Eltigani, University of Sinar and Dr. Elsadig Elmahadi, Head Department of Agricultural Engineering, Sudan University for Science and Technology for their assistance.

Iam also indebted to my family member, my wife, friends on Colleagues for their assistance and encouragement.

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

ABSTRACT

The objective of the present study was to investigate the effect of some environmental factors on layers performance with such as; egg production percentage, egg weight, feed intake, feed conversion ratio (CFR) and mortality rate.

The data being used in the present research work was obtained from an experiment carried out at the Demonstration Farm of Kuku Animal Production Research Station during the period of 25/8/2005 to 14/12/2005.

The housing system employed in the experiment was stepped batteries in an open housing. The layers used were Hisex breed at an age of four mouths. Two types of poultry rations (maize and dura) which were carefully balance in energy and protein were used in feeding layers.

The temperature range inside the housing system during summer was (33°c-38°c), while for winter it was 29°c- 35°c.

Generally results showed that, for all layers performance parameters being studied, winter is superior to summer and maize is superior to dura. Duncan's Multiple Range Test (DMRT) showed that, for egg production percentage there is no significant difference among combinations of summer + dura, summer + maize and winter + dura ($P<0.01$).

For egg weight DMRT showed a highly significant difference among the four combinations of summer + dura, summer + maize, winter + dura and winter + maize. ($P<0.01$).

As far as the feed intake is concerned DMRT showed that there is significant difference between the combinations of summer + dura and summer + maize ($P<0.01$).

Concerning FCR, the DMRT showed no significant difference among the four combinations ($P<0.01$).

With respect to mortality rate the DMRT showed no significant difference among the combinations of summer + dura, summer + maize wand winter + maize ($P<0.01$).

Due to the fact that, the layers being used in the experiment were reared at temperature above the thermal comfort zone (15°c – 25°c) and also above the thermal acceptable zone (25°c – 30°c) cooling of birds housing by different means could increase layers performance.

ملخص الأطروحة

هدف الدراسة الحالية هو بحث بعض العوامل البيئية على معاملات الأداء للدجاج البياض مثل نسبة انتاج البيض، وزن البيض، كمية الغذاء، نسبة تحويل الغذاء و نسبة النفوق.

البيانات المستخدمة فى البحث الحالى تم الحصول عليها من تجربة اجريت فى المزرعة الإيضاحية لمحطة كوكو لابحاث الأنتاج الحيوانى فى الفترة من 8/25/ 2005 الى 2005/12/14.

نظام الايواء المستخدم فى التجربة هو بطاريات متدرجة فى نظام ايواء مفتوح. الدجاج البياض المستخدم هو سلالة Hisex بعمر اربعة شهور. نوعان من علف الدواجن (ذرة شامية وذرة رفيعة) التى روعى ان يكونان موزنان من ناحية الطاقة والبروتين تم استخدامهما فى غذاء الدجاج البياض. مدى درجة الحرارة داخل النظام الايواء خلال الصيف هو 33°c – 38°c بينما للشتاء هو 29°c – 35°c.

عموماً اوضحت النتائج لكل معاملات الأداء التى تمت دراستها ان الشتاء متفوق على الصيف والذرة الشامية متفوقة على الذرة الرفيعة.

اختبار DMRT اوضح فيما يختص بنسبة انتاج البيض انه لايوجد فرق معنوى بين التوفيقات، صيف + ذرة رفيعة، صيف + ذرة شامية وشتاء + ذرة رفيعة (P<0.01).

بالنسبة لوزن البيض اختبار DMRT اوضح ان هناك فرق معنوى كبير بين التوفيقات الأربعة صيف + ذرة رفيعة، صيف + ذرة شامية وشتاء + ذرة رفيعة وشتاء + ذرة شامية (P<0.01).

فيما يخص كمية الغذاء اوضح اختبار DMRT ان هناك فرق معنوى بين التوفيقات صيف + ذرة رفيعة، وصيف + ذرة شامية (P<0.01).

من ناحية تحويل الغذاء (FCR) اوضح اختبار DMRT انه لايوجد فرق معنوى بين التوفيقات الأربعة (P<0.01).

فيما يختص بنسبة النفوق اوضح اختبار DMRT انه لايوجد فرق معنوى بين التوفيقات، صيف + ذرة رفيعة، صيف + ذرة شامية وشتاء + ذرة شامية(P<0.01).

نسبة لحقيقية ان الدجاج البياض الميتخدم فى التجربة تم تربيته عند درجة حرارة اعلى من منطقة الإرتياح الحرارة (15°C – 25°C) وايضاً اعلى من منطقة القبول الحرارة (25°C – 30°C) فان التبريد لمأوى الطيور بعدة وسائل بمكن ان يزيد من آداء الدجاج البياض.

CHAPTER ONE

INTRODUCTION

Poultry farming is a very versatile agro–business, because of its high return compared to production and due to its advantage of high feed efficiency (high feed conversion ratio). It can be adapted to widely varying conditions to provide many employment opportunities with fast return on investment. Beside the economic returns, poultry farming serves food satisfaction for protein in human diet. The income received from poultry products, which is assumed to spread throughout the year from egg or broiler production, to feed equipment manufacture, etc. give poultry farming more economic importance.

Poultry production in Sudan has stepped from the primitive system of back-yard rearing in 1956 when specialized exotic breeds were introduced to establish small size farms with an improved traditional method and techniques (Ali, 2000).

Although superior Genoa-types of bird were used but they showed a low production efficiency. This was due to the fact that the traditional open houses systems which were widely used in production were designed to protect birds from direct sun radiation and provide them with natural ventilation. Such housing system therefore exposes the birds to the high prevailing air temperature with all of its detrimental effect on productivity. For this reason poultry production in the existing operating traditional farm is concentrating on table eggs rather than producing broilers because of low production efficiency and high mortality rate during the hot summer months. However broiler production in the traditional sector is limited to two cycles per year, mainly during the winter season i.e. from November to February. During the remaining part of year which is considered as summer season i.e.

from March to October no broiler production is practiced due to the fact that most of farms suffer from heat stress attributed to high temperature which consequently result in low production and. efficiency and high mortality rate.

The actual and excepted of egg production in Arab countries is shown in Table 1.1 for years 2003 and 2010

Table 1.1 Egg Production In Arabic Countries for Years 2003 and 2010 (Million Eggs).

Years / Contrary	2003		2010	
	Actual Production	Annual Percapita	Excepted Production	Annual Percapita
Algeria	2950	93	3816	100
Comors	9	12	14	15
Eygypt	2565	3.6	3453	40
Lypia	1000	180	Ss	190
Moritania	92	32	122	35
Morocco	3840	126	4768	130
Sudan	830	25	1210	30
Tunisia	1306	133	1652	140
Bahrin	36	50	43	50
Western Bank and Gasa	651	183	854	200
Iraq	720	29	1511	50
Jordan	432	79	657	100
Kwait	440	175	545	180
Lebenon	637	174	833	190
Oman	148	38	114	40
Qatar	90	148	92	150
K.S.A	1955	81	2615	90
Syria	2782	156	3418	160
U.A.E	319	107	395	100
Yemen	442	22	600	25
Sum of Arabic Countries	21244	68	27978	90
World	913575	145	-	-
% of Arabic World	2.3			

Source : Poultry Magazine (Middle East and North Africa) V.181 April 2005.

Objectives:

The objective of the present study is to investigate the effect of some environmental factors on layers performance parameters with regard to egg production, egg weight, feed intake, feed conversion ratio (F. C. R) and mortality of layers.

CHAPTER TWO

LITERATURE REVIEW

2.1 Poultry Industry:

A primary function of poultry industry is the conversion of feed to a form that is prized for human food (Oluyemi, 1979). Poultry production is increasingly an important agricultural industry in the world. Poultry meat and eggs account for about 10% of the total weight of all meat, milk and eggs produced in the world each year (Rose, 1997).

The production of poultry throughout the world is carried out by a highly specialized, efficient poultry industry that has been a leader in trends of scale and industrialization over the past half century (Nesheim *et al.*, 1979).

Africa has 9.6 % of the world population, it produced only 4.7 percent of the world poultry meat and 3.4 % of its egg (Kuit *et al.*, 1986).

The per capita per human consumption of poultry products in the Sudan was estimated to be 1.5 kg meat and 1.3 kg eggs (Yassin, 1987).

2.1.1 Poultry Industry in Sudan:

The history of exotic breeds in the Sudan is very old. Desia (1962) showed that, the first model of modern poultry farm was established in Khartoum North in 1951 to serve as a research center for development of local breeds. Following the modern way, a proper central research unit (CRU) was established in Kuku village in 1962.

Mustafa *et al.* (1997) estimated the poultry population in the Sudan as 13 millions birds.

No reliable data is available to show poultry production. This is evident by records of the Ministry of Animal Resources (1995/96) which show that, poultry population is about 45.3 million while the estimate presented by the FAO (1995/96) about 38 million. Other estimates by AOAD (1997) stated that, the population in the modern sector about 4.434.000 broilers and 355000 layers.

The per capita consumption mean of poultry products were estimated to be 1.1 kg meat and 1.2 kg (24 eggs/year) as shown in Table 2.1.

Table 2.2 shows egg production in Sudan in comparison with some Arab and African countries. It is clearly seen that, Sudan comes in the fourth rank after Egypt, Saudi Arabia and Libya, while Somalia comes in the fifth rank.

Egg production in Sudan is shown in Table 2.3, number of eggs produced and consumed during 1993, 1994 and 1995. Production of poultry meat in Sudan in comparison with Egypt, Libya, Somalia and Sandi Arabia is given in Table 2.4. Production of poultry meat in Sudan was higher than Somalia only.

Table 2.1: The per capita consumption means of products (kg).

Year	Population(1000 hens)	Poultry meat	Eggs
1993	39715	0.1	1.1
1994	42423	1.1	1.2
1995	45317	1.1	1.2

Source: Statistics of Ministry of Animal Resources (1997)

Table 2.2. Production of poultry eggs in the Sudan in comparison with some Arab and African countries (1000 m.t).

Country	Year		
	1993	**1994**	**1995**
Sudan	32.80	35.00	36.00
Egypt	122.76	128.00	130.00
Libya	36.83	38.00	44.05
Somalia	1.588	1.53	1.30
Saudi Arabia	112.32	114.99	115.16

Source: Arab Organization for Agricultural Development (AOAD).Yearbook, volume 16, Khartoum December 1996.

Table 2.3. Production of eggs in Sudan (1000 m.t)

	Year		
	1993	**1994**	**1995**
No eggs produced	655689	701761	749620
No eggs consumed	596677	638602	682134

Source: Statistics of Ministry of Animal Resourses (1997).

Table 2.4. Production of poultry meat in Sudan in comparison with some Arab countries (1000 m.t.)

.Year / Country	1993	1994	1995	1996
Sudan	27.70	29.00	31.00	37.00
Egypt	172.16	275.00	317.00	357
Libya	72.00	83.80	102.80	100.00
Somalia	1.88	1.81	1.36	1.14
Saudi Arabia	224.42	232.5	390.00	397.00

Source: AOAD Arab Agricultural Statistics Yearbook, volume 17, Khartoum December 1997.

2.2. Poultry Housing:

According to Nesheim *et al.* (1979) housing serves two major functions for poultry. First it permits the organization and concentration of the flock into one management unit and secondly and more importantly, provides a physical environment that is conducive to optimal egg or poultry meat production. In general, the chicken that is comfortable and free from stress is most likely to perform at its maximum potential. A successful poultry house will protect the animals from extremes of temperature and other unfavorable weather conditions. In such house of layers the environment temperature and light can be controlled. Humidity maintained at a moderate level and circulated air can be kept free of excessive dust and ammonia gas (Ashton *et al*. 1972).

2.2.1. Layers housing systems:

According to Bengston and Whitaker (1988), there are five major systems used in housing of poultry:

i- Semi intensive.

ii- Deep litter.

iii- Slatted or wire floor.

iv- Combination of slatted floor and deep litter

v- Cage or battery systems.

2.2.1.1. Semi-intensive Systems:

Semi-intensive systems are commonly used by small producers and are characterized by having one or more openings in which the birds can feed on natural vegetation, Fig.2.1. It is desirable to provide at least two runs for alternating use to avoid build up of disease. Each run should allow at least 10-15 m^2 per hen and will be fenced, but a free- range allowing 40 to

80 m^2 per hen will be required where the hens are expected to obtain a substantial part of their diet by foraging. A small, simple house which allows 0.3 to 0.4 m^2 per bird, and which has a thatched roof, a littered earth floor and slatted or chicken wire walls at least three sides will provide protection from inclement weather.

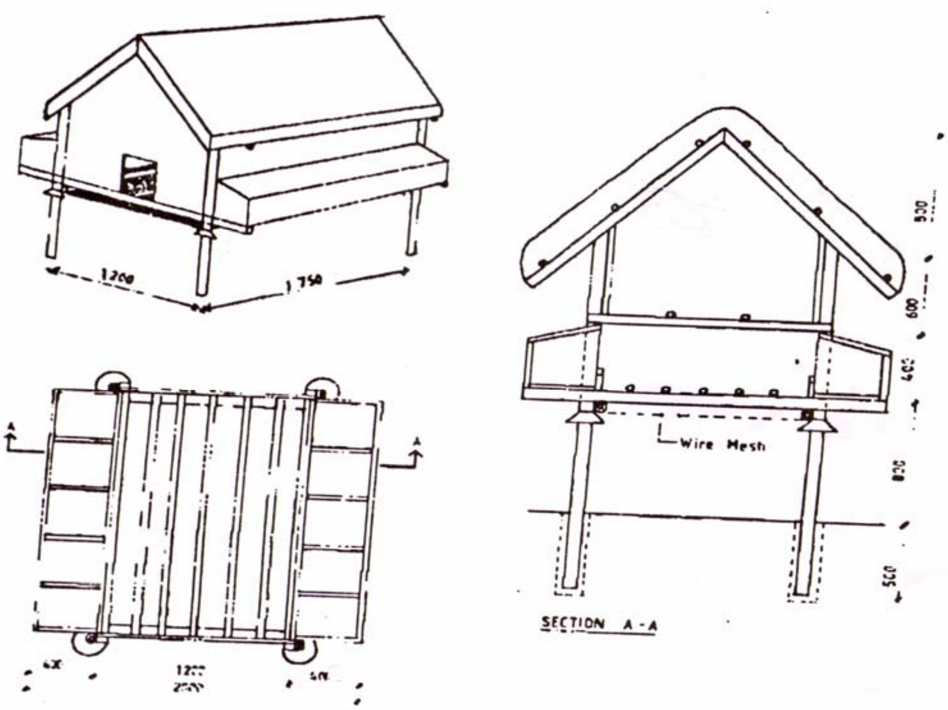


Fig . 2.1 semi intensive system

2.2.1.2. Deep litter systems:

Deep litter systems confine the birds in a building that offers good protection with reasonable investment. If well designed with low masonry wall set on a concrete floor and wire mesh completing the part of the walls and then building will exclude rats and birds. The principal advantages of this system are easy access for feeding, watering and egg gathering, good protection and reasonable environment. The principal disadvantage is the need for high quality litter. The deep litter house can be designed up to 9 m in width and any length that is needed. Approximately 4 to 5 birds/m^2 of floor area is a satisfactory density, Fig.2.2.

2.2.1.3. Slatted or wire floor system:

Alternatively wire mesh can be used for the floor. It is built on treated wooden piers 0.8 to 1 m above the ground. No litter is required and bird density can be 6 to 8 birds/m^2. Either double pitch thatch roof or a single pitch corrugated steel roof may be installed with the areas about 1.5 m above the floor. The width of this type of building should be limited to about 2 m. The building should be oriented east and west and may be of any length. However, if it is more than 5 m long, nests will be needed to be put on the sides, Fig.2.3.

2.2.1.4. Combination of slatted floor and deep litter:

This type offers some advantage over a simple deep litter house, but with some increase in investment. Approximately half of the floor area is covered with small gum pole slats or with wire mesh. This area is raised above the concrete floor 0.5 m or more so that clearing under the slatted portion may be done from the outside. This type of house is limited in width to 3 to 4 m so that feeders and waterers can be handled from litter area. The bird density can be increased from 5 to 7 birds per m^2 .Ventilation is important due to slatted floor, Fig.2.4.

2.2.1.5 Cage or battery systems:

According to Whitaker (1979) a number of different cages and housing systems have been developed, Fig.2.5. Although there are variations in equipment and design, cage systems may be classified by the number of levels of cages. The introduction of the two-tier, stair –step cages as shown in Fig 2.6, greatly improved accessibility to the birds. With the advent of controlled–environmental housing, cage designs continued to be improved until 3 and 4 tiers . The four-tier system introduces some problems relating to air movement, ease of observation and light distribution for the birds. Although all of these systems are in use, the three-tier is the most common. Also the layers houses can be classified into three types as follows:

1. Open housing with little more than a roof and roll-up curtains on the sides.
2. Window house, which depends on natural ventilation particularly in mild weather.

3. Windowless, environmentally controlled houses which are well ventilated, warm throughout the year, depending on automatic fan ventilation.

2.3 Environmental factors affecting layers performance:

Factors affecting layers performance include genetic and environmental. The environmental factors are:

1- Temperature.
2- Relative humiditiy.
3- Light (photoperiod).
4- Ventilation.
5- Feed.

2.3.1 Temperature effect on poultry performance:

The environmental requirements for poultry vary with age. Information on the effects of temperature on performance by poultry is still being accumulated and the final answers are far from being known. The effects of temperature on performance may well be occurring through the effects of temperature on energy and therefore, nutrient consumption. These two effects have been separated where possible below.

As young birds grow their surface area in relation to their body weight decreases and therefore, they are less fully in contact with the surroundings. The development of feathers and, to lesser extent, the laying down of fat under the skin, increases their insulation as they grow.

Earlier it wawidens and falls pointed out that the need for energy by laying hen was markedly affected by environment. The heat loss, and therefore, the energy need of non-laying hens at varying temperature is shown in Table 2.5 and the figures in this table are just intended as guides (MAFF1970) .

Table 2.5 Heat loss of non-laying hens at varying temperature:

Temperature (°C)	4.4	10	15.6	21.1	26.7
Heat loss Kcals/day	195	169	147	129	115

In addition, energy is needed for weight gain and egg production. The energetic efficiency of egg production is about 50 percent so that to get 1 Kcal into eggs 2 Kcals need to be supplied of which 1 is lost as heat. A hen producing at 80 percent, with eggs of 60 g average weight puts 80 Kcals of energy into eggs and loses 80 Kcals as heat per day making a total extra energy need of 160 Kcals/day. Also this shown in Table 2.5.

If diet A as shown in Table 2.6 were fed to birds at 26.7°C it would be grossly deficient and reduced egg numbers, egg size and shell quality would be found. This in fact, was what happened in experiments on temperature in the past. A diet adequate at low temperatures was fed to birds at high temperatures and the reduced performance that was found, attributed to the increased temperature and not, as was in fact the case, to the inadequate diet. With the diets used in the past, performance began to fall off beyond 10°C - 15°C and for this reason 12.8°C was widely recommended as being a temperature at which hens should best be kept (MAFF1970).

Table 2.6 Temperature effect on performance of layers being fed with balanced diet

	Diet A 4.44 oz/day	Diet B 3.44 oz/day
Percent protein	13. 5	17.4
Percent Ca	2.95	3.8

Attempts have been made to combine the advantages of high temperature-good egg numbers and low food intake with that of moderate temperatures-good egg size-by cycling temperature during the day.

In cycling temperature, some hours of the day are kept at a high temperature and the rest at a moderate temperature. The exact details of temperatures and when and for how long these should be given have not yet been worked out. However, the possibilities seem to be good as some cycling temperature regimes have given better performance than constant temperatures.

It is not possible to be specific as to the temperatures at which laying hens should be kept. A simple answer would be as high as possible (up to 29.4°C) providing the diet is adequate, no artificial heating is given and ventilation is adequate.

Other effects of temperature include those on egg quality and feathering. It has been found that in general as temperature declines the proportion of eggs with cracks and internal faults increases. Birds kept at higher temperature and fed adequate diets can lay eggs of better quality.

Chicks should be started at 35°C .After one week the temperature is reduced gradually to 24°C by the fifth week. Broilers and young turkeys, reared at ambient temperatures below 18°C, are heavier than similar stock reared within the 18°C to 35°C range, but their feed conversion efficiency will be less. Layers produce the greatest number of eggs and the largest sized eggs at 13°C to 24°C. The best feed conversion efficiency is achieved between 21°C to 24°C. With increasing environmental temperature there is a decrease in feed intake and alterations in behavior. Within the temperature range of 5°C to 30°C there is a reduction of about 1.6% in feed intake for every 10°C increase in ambient temperature. Above 24°C there is a reduction in egg production and size. A continued rise in temperature to 38°C or more may prove lethal (Bengston and Whitaker, 1988).

Adult birds can withstand a rather wide temperature range if the change is not too sudden, but the zone of the thermal neutrality has been reported to be in the range of 14 C^{o} to 26 C^{o}, which is known as the thermal comfort zone .The housing temperature maintained with this range is conducive for maximum production and growth rate. However, as shown by scientific studies and practical experience when the temperature is raised to vary between 25°C to 30°C (known as the acceptable zone), its effect on weight gain and production in general tends to be minimal and not more than 3% (Ali, 2000).

Air temperature higher than 30°C tends to increase the physiological thermoregulatory effort exerted by birds in order to maintain their homoeothermic conditions. Fig 2.7a. Due to the reduced rate of sensible heat dissipated from the body, respiration rate tends to increase to facilitate more latent heat dissipation through water evaporation from the respiration track, Fig. 2.7b.

Homeothermy is defined as the ability of warm blooded animals to maintain a rather constant body temperature in spite of wide environmental extremes. This is achieved through a dynamic physio-thermal regulatory system that controls the rate of heat production (q_m) and the rate of heat loss or dissipation (q_d) to the environment.

According to Albright (1990), the energy balance ought to be quantified with respect to other required conditions such as air temperature and insulation. For the sensible heat produced by animals to be dissipated, ambient air temperature must be lower than body temperature. The first priority of homeostasis is to maintain body temperature, which for poultry is fairly constant at approximately 40°C±0.1°C.

Therefore, the mutual effect between ambient thermal environment and animal housed within a building is described by steady state energy balance equation as follows:-

Heat produced (q_m) = Heat dissipated (q_d)

i.e. the metabolic heat (q_m) produced by animals must be equal to the heat dissipated (q_d) to the surroundings, in the from of sensible and latent heat (MAFF,1970).

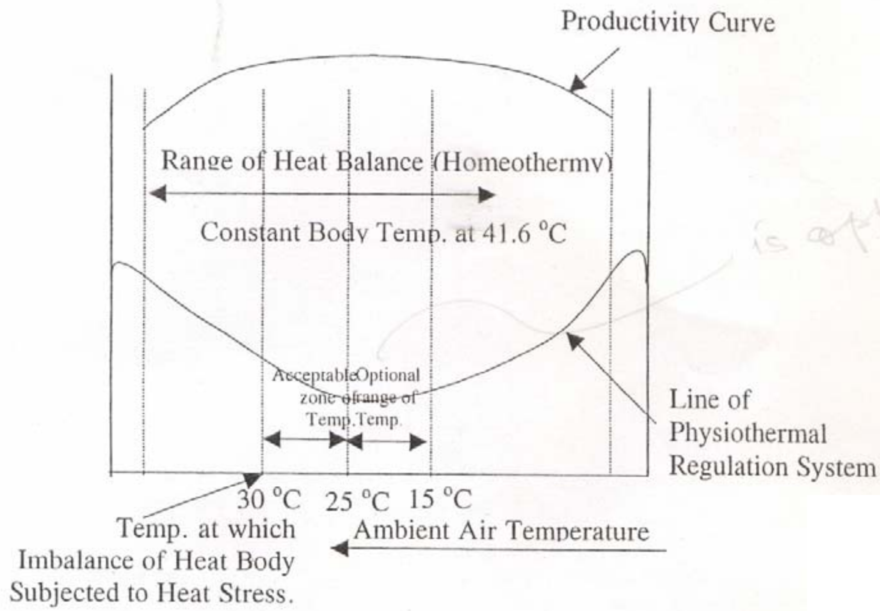


Fig 2.7 a **Range of body heat balance** (Source: Abdalla [1])

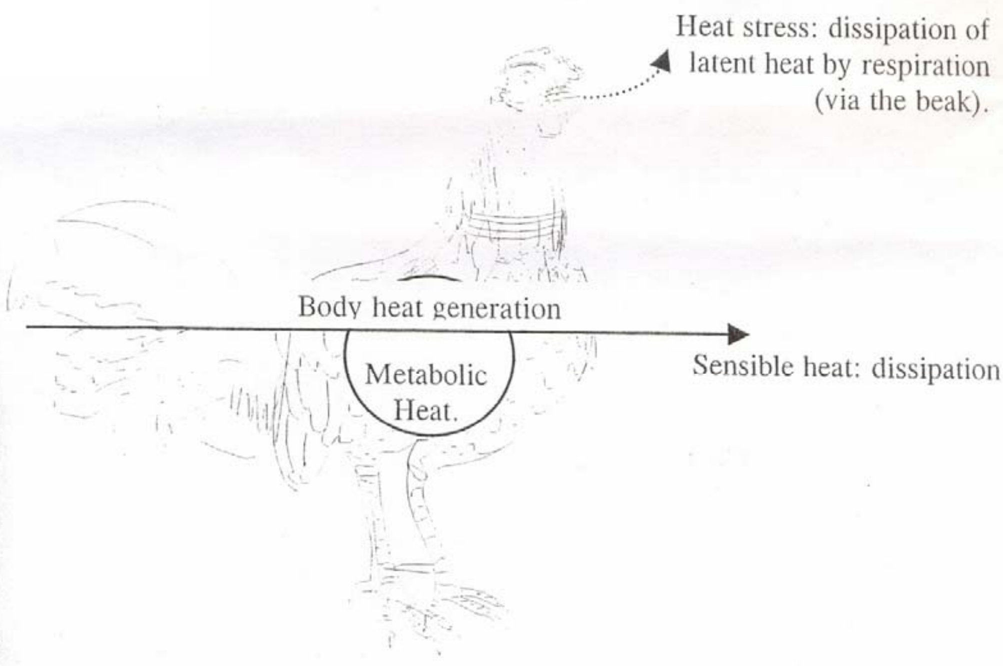


Fig 2.7 b **Physiothermal system and body heat balance** (Source: Abdalla [1]).

Gates *et al*. (1993) stated that, for thermal energy balance of sensible and latent heat production is evaluated as a function of bird age and mean room temperature.

Hellickson and Walker (1983) provided the principal base for understanding the importance of interactions between the animal and the thermal environment in terms of energy balance. Most of reported calorimetery data where taken when the animals were at thermal equilibrium (thermo-regulatory zone) when the metabolic heat production (MHP) equals to total heat loss (THL). Simultaneous direct and indirect calorimetery has been limited to very few studies. It is not necessarily true that the optimum thermal environment for production is synonymous with the optimum environment for thermoregulation. Other factors might be considered in the system approach such as economics, hygiene, labor, disease etc. together with thermal environment in order to specify the optimal environment. The conclusions, were as follows:-

(a) Heat loss is approximately proportional to the temperature difference between the animal and the environmental temperature.

(b) The evaporation heat loess (EHL) at low environmental temperature is minimal and is determined by the need for respiration and by diffusion of water vapor through the skin. Therefore (MHP) must decrease in order to maintain homeothermy under relatively warm conditions. Fig.2.8 illustrates the relationship between (MHP), sensible heat loss (SHL), and body temperature (t_b) as a function of environmental temperature.

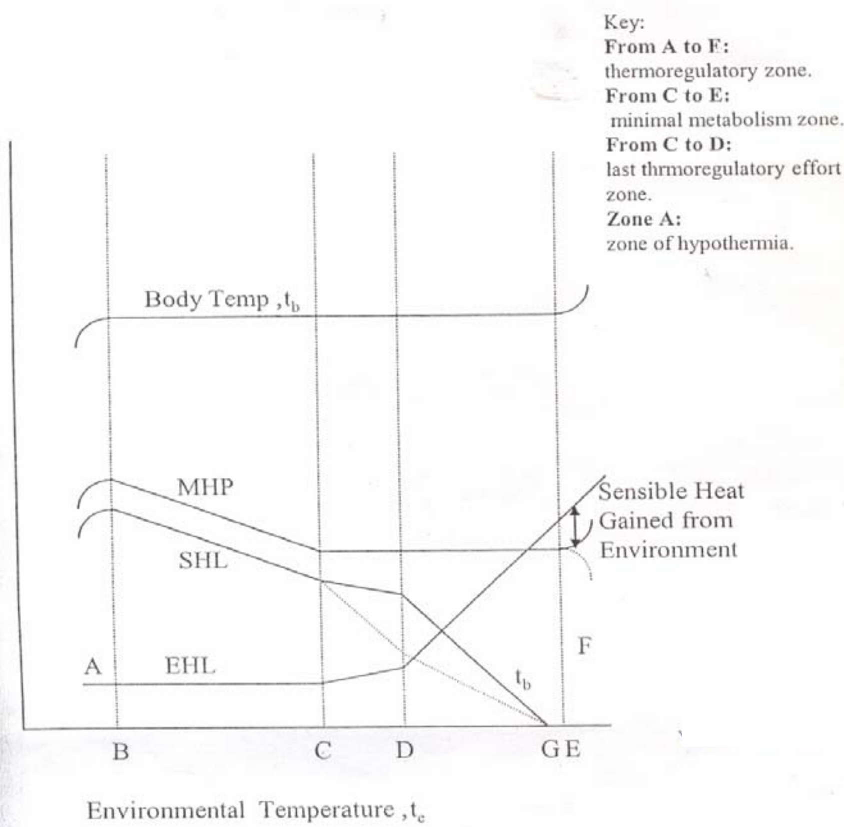


Fig 2.8 **Generalized schematic diagram illustrating the partitioning of energy exchange of an animal as a function of environmental temperature.** *Adopted from Mount, 1974.*

Abdalla (1996) concluded that, from agricultural practices, the different ranges at of temperature zones between 15°C-25°C in relation to production, growth rates and mortality could be considered as thermal comfort zone, while the range between 25°C and 30°C could be considered as economically acceptable zone. For temperature greater that 30°C, birds start to exert physiological effort and the heat balance of the bird would be directly affected. When temperature reaches 38°C, birds are subjected to heat stress in which the rate of growth and production is decreased. In warm climates and as air temperature reaches the body temperate (41.0°C), birds will be subjected to heat exhaustion. In this stage the rate of production is decreased considerably and high rate of mortality experienced.

Birds gradually enter in the heat stress condition in which production rate drops remarkably and mortality rate increases considerably, Fig 2.9 (Ali, 2000).

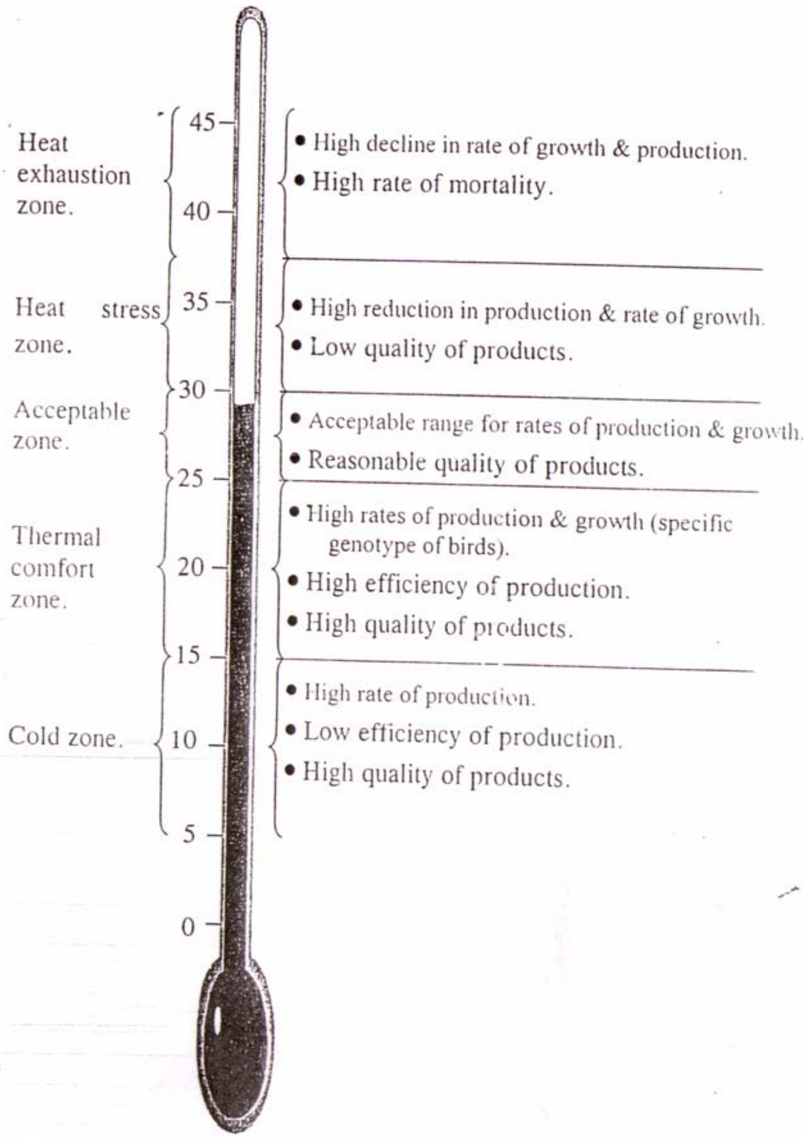


***Fig 2.9** Effect of Thermal Condition on Poultry (source: Ali 2000)*

2.3.2 Relative humidity effect on poultry performance:

Evaporative heat loss is virtually constant for a given bird over a wide range of temperature. At a high temperatures, however, evaporative heat loss becomes the main way in which a bird loses heat and humidity of the surrounding air is of importance. The lower the relative humidity the higher the air temperature that can be tolerated. Table 2.7 shown conditions of temperature and humidity thought to be equivalent for laying hens (MAFF 1970).

Table 2.7: Equivalent conditions of temperature and humidity of laying hens

Air temperature (°C)	Relative humidity (percent)
32.8	30
31.1	50
27.8	75

On studying the effect of humidity on poultry, it was recommended that the relative humidity in poultry sheds should range between 40% to 60% (Singh, 1981). In meantime chickens, subjected to temperature between 40.5°C to 42°C will find it difficult to dissipate much heat through conduction, convection and /or radiation.

Generally humidity is important in only two circumstances. Very low humidity tends to cause objectionable dusty condition while high humidity combined with very high temperature interferes with birds natural cooling mechanism and contributes to high mortality (Whitaker, 1979).

Lei (1993) showed that, the suitable environment for hens is confined as 7.2°C to 24.4°C dry bulb temperature and 50% to 80% relative humidity. The operational ranges of testing were set as 32°C,35°C and 38°C dry bulb temperature and 40%, 60% and 80% relative humidity respectively for local climate consideration. The test results showed that, neither dry bulb temperature nor relative humidity could reach the comfort zone for forced ventilation. The effective cooling temperature of evaporative cooling system could be 10.2°C and this could bring air temperature within the comfort zone, but the relative humidity would be too high for the comfort zone.

2.3.3 light and air speed effect on layer performance:

Light however greatly affects the behavior and productive performance of poultry, so its control is a second major advantage of the use of controlled environment poultry houses. Natural light intensity and day length variations are not always suitable for poultry production systems throughout the year (Ros, 1997).

Other factors include, air speed and relative humidity It was found that not only air temperature affects heat loss. Convective heat loss is also affected by air speed, radiative heat loss by the mean radiant temperature of the surroundings and evaporative heat loss by the humidity of the air.

Increasing air speed, has the same effect as reducing temperature. Table 2.8 shows the conditions of temperature and air speed which seemed to be equivalent for birds at different ages.

Table 2.8: The equivalent conditions of temperature and air speed for birds at different ages

Age	Local temperature (°C)	House temperature (°C)	Air speed m/min	
			Sleeping birds	Active birds
Day old	32.2	15.6	-	12.192
	32.3	21.1	-	21.336
	32.3	29.9	-	30.48
4 weeks old	15.6	-	16.764	18.288
	21.1	-	30.48	33.528
	23.9	-	45.72	60.96
10 weeks old	15.6	-	18.82	21.336
	21.1	-	45.72	64.008
	23.9	-	-	152.4

With high air speeds much higher air temperature are needed to reduce heat loss to the same level as with low air speeds. It follows that under conditions of low air temperature it is particularly important to limit the air speed over the birds.

In a well-insulated house the temperature of the house surfaces will be close to that of the air inside the house. In a poorly insulated house surface temperature can be considerably lower, causing radioactive heat loss to be increased. In winter the inside of a glass window may be at 5.6°C lower temperature than the air in a house (MAFF 1970).

2.3.4 Effect of ventilation on poultry performance:

The advantage of ventilation in an animal shelter is to maintain a healthy environment for animals and workers. Excessive dusts, odors, and harmful gases may threaten the health and safety of animals and humans. Extremes temperature reduce animal and workers productivity (Porter, 1998).

A ventilation system for poultry shelter accomplishes one or more of the following:

1- Provides desired amount of fresh air, without drafts to all parts of the shelter.
2- Maintains temperature within desired limits.
3- Maintains relative humidity within desired limits, and
4- Maintains ammonia level below specified level (to assure water safety).

However, ventilation rates are designed to balance sensible heat (dry heat) gains and losses, as well as latent heat (moisture) gains and losses. Sources of sensible heat gain in poultry and livestock shelter include animal sensible heat (body heat), mechanical heat from light, motors, etc; supplemental heat from furnaces or lamps, and solar heat gain. Sensible heat losses include heat removed by ventilating air, building heat losses through doors, walls, etc; and sensible heat used to evaporate water (Porter, 1998).

Ventilation of structures can be accomplished naturally, mechanically, or a combination. Natural ventilation system move air through adjustable and fixed openings (vents, windows, doors, eave and ridge slots, etc.). Natural ventilation is usually more economical than mechanical systems for mature animals.

Mechanical ventilation systems include fans, controls and air inlets and/ or outlets. Mechanical ventilation systems include positive pressure, neutral pressure, and exhaust systems. They have over more control on room temperature and air movement than natural ventilation systems. Emergency natural control, back up power generation, and/or alarms are necessary to provide ventilation in the event of power failure.

Design of ventilation systems is based upon four major considerations as stated below:

1. Hot weather condition: Under hot weather conditions, ventilation requirements are high. Sensible heat balance is likely to be the determining factor in ventilation design.
2. Cold weather conditions: Under cold weather condition, ventilation requirements likely will be much lower than under hot weather condition. However, ventilation is still very important. Animals still generate heat and moisture, gases, odors and dusts will still be generated.
3. Humidity: Especially under cold weather condition, the ventilation rate needed to remove excess moisture may be higher than the rates needed to remove excess heat. If moisture production is high, consider increasing winter ventilation rates and adding insulation and/or supplemental heat.
4. Odor control: A minimum "cold weather" ventilation rate is recommended to remove odors and harmful gases. Some example, cold weather rates are as follow; layers, pullet, breeder, and broiler require 0.5 cubic feet per minute (cfm).

Maximum and minimum Ventilation rates:

When determining airflow rates in an animal shelter, it is common to employ a conservation of energy equation. The two forms of the equation are used for a such calculations; one for latent heat balance and the other for sensible heat balance leaving the shelter which include sensible heat produced by animal, equipment (motors, lights etc), and heat entering from the outside. These two equations were described to determine the maximum and minimum ventilation rate as fallows:

(a) Maximum ventilation rate:

$$Q_s = \frac{V^* \{q_{shb} - AU(t_i - t_o)\}}{\{C_p\,(t_i - t_o)\}}$$

Where:

Q_s = ventilation rate necessary to remove the available sensible heat m^3/s

V = Specific volume of air, evaluated at inside conditions for exhaust systems and outside conditions for pressure systems, m^3/kg.

q_{shb} = Sensible heat load balance, W/kg.

AU = heat loss factor determined from building specification, kW/°C.

t_i and t_o = indoor and outdoor temperature respectively, °C.

C_p = Specific heat of dry air (1.0035), kJ/kg°C.

(b) Minimum ventilation:

$$Qm = \frac{V^* m_w}{(w_i - w_o)}$$

Where:

Q_m = ventilation rate for moisture (latent heat) m^3/s.

V = specific volume, evaluated at conditions for exhaust systems and evaluated at outside conditions for pressure systems; m^3/kg of dry air.

M_w = rate of water vapor production with in the shatter,

W_i and W_o = Humidity ratios of inside and outside air kgH_2O/kg dry air.

On the other hand, for such facilities, the Midwest Plan Service (MWPS) reported in 1980 the generally recommended ventilation requirement to become standardized.

2.3.5 Egg production as affected by environmental factors:

The egg production potential was investigated by many workers in tropical and sub-tropical countries. Among the genetical factors which affect egg production potential are the breed and strain. Under intensive management the average annual egg production of the Sudanese native fowl type such as *Bare Neck*, *Large Baladi*, *Betril* and *Baladi Singa* was 106, 78, 86 and 90 eggs, respectively (Desai and Halbroek, 1961).

Mohammed Ahmed (1994) found that, the average hen-day egg production of Lohman, and Hisex strains under Sudan conditions were 53.1 and 52.9 percent, respectively.

The influence of high and low temperature on laying performance is of particular importance in the tropic and sub-tropics. Temperate breeds of poultry showed poorer performance under tropical conditions, which might be due to stress effect of high temperature (Cowman and Michie, 1980). Deaton *et al*. (1981) observed no significant differences in egg production of hens kept in an environment cycling from 21.1°C to 35°C or from 15.6°C to 35°C or kept at a constant temperature of 25°C. David *et al*. (1983) studied the effect of cyclic and constant temperature on egg production of group of hens of 230 days of age housed in three climatic chambers. Results of two weeks observation period, indicated that no significant differences in percentage of hen-day production.

The effect of photoperiod and lights regimes on productivity had been reviewed by many authors. Sharma *et al* (1985) studied the performance of White Leghorn pullets 10 weeks of age, and subjected them to five lights regimes during rearing and laying periods up to 240 days. Egg production per-hen varied for the five light regimes.

El-Husseini and El-Naib (1990) allocated Hisex brown hens with light regimes of 16 hours light during the day or night. They observed that night lighting improved significantly egg production ($P < 0.05$). The effect of two lighting programs on the performance of egg production of commercial layers at two different photoperiods were studied. No significant change in peak hen-day or hen-housed production was observed (Tai *et al.* 1992).

The effect of housing systems in egg production has been reported by many investigators. El-Amin (1988) compared the performance of Hisex White egg layers under Sudan conditions and ideal temperature range from 22°C-38°C. It was observed that the average hen-day was 63% where as for hen-housed a 54.5% egg production per season was given under Sudan condition.

Rangaredly *et al*. (1989) compared deep litter and cage housing systems in private poultry farms. No significant differences were observed in hen-day egg production 67.9% and 69.5%, respectively. Mench *et al*. (1986) found that, egg production was not affected by various floor space allowances. Lee (1989) stated that, decreasing floor space allowance per bird and increasing group size per pen had no significant effect on hen–day egg production.

Khati *et al*. (1986) studied five groups of White Legnhorn fowls at the age of 3-5 weeks during November, January, March, June and September. Results showed that egg production decreased during December to February and increased during March to June and during September to October. Highest production was achieved by birds that started laying in March, May and June. Perez (1989) concluded that, egg production performance of layers and broilers hen was highest in April to June and lowest in July to September.

El-Faki (2000) compared the performance of five groups of layers. Four of the five groups were *Large Baladi* native fowl and the fifth was

White Hisex under relatively improved environmental conditions. For *Large Baladi* groups it was found that, the average egg production was 30.81-39.82% and 24.62- 39.31% for hen-day and hen–housed respectively, while for White Hisex the average egg production was 27,57-34,71 %.

2.3.6. Egg weight as affected by environmental factors:

There is a great variability in the size of hen's egg. Large egg size has economical advantage over small size eggs. The size depends on genetical and environmental factors mainly temperature (North, 1984).

The weight of the egg is equal to the sum of weight of its components, and any factor affecting the weight of its parts may be expected to have some effect on the entire egg's weight.

A significant decrease in egg weights was observed at high environmental temperature.

Deaton *et al*. (1986) demonstrated that, laying hens exposed to linear cyclic temperature of 24°C-35°C-24°C laid eggs with significantly lower weight than those exposed to 21°C constant temperature. David *et al*. (1983) indicated that, egg weight of hens housed at 29.4°C cyclic temperature was significantly depressed compared to hens housed at constant of 23.9°C or 26.4°C cyclic temperature. However, egg weights were significantly lower in the 29.4°C cyclic than in the 26.7 cyclic temperature.

Hitoshi (1980) observed that, egg weight was made heavier by increasing light length from 12 to 24 hours.

Tai *et al*. (1992) studied the effects of two lighting programs on the performance of commercial layers, the first extended the photoperiod by one hour and the second by half hour per week, respectively. However, no significant change was observed in the average egg weight.

Mohan *et al*. (1991) reported that, egg weight of local Nigerian fowl, exotic and their cross when managed in cages were higher than on deep litter from first to 12 months of laying. Egg weight of White Leghorn pullets housed in cages were significantly higher than that reared on litter floor system (Venugobal *et al*. 1982). An average egg weight of White Hisex layers under Sudan and temperate conditions was given when housed in deep litter as 56.0 and 60.7 g respectively (El-Amin, 1988). While an average egg weight of white and Brown Hisex reared on battery cages was recorded to be 57.8 and 60.5g respectively (Vovesny, 1989). Dulta (1993) studied the egg weight of White Leghorn, local AssamMiri chickens and their cross managed on deep litter, cages and free- range system up to 56 weeks. He found that, the egg weight averages were 49.67- 41.36 and 45.89 g, respectively.

The season of the year had been found to affect egg weight. Poraz (1988) compared the performance of Konya, Danish and White leghorn fowls in April, May, and June. He found the egg weight of the three types averages were 54.1, 57.3 and 51.2 g respectively. Pandey *et al*. (1989) also stated that, season of the year has a significant effect on egg weight.

El-Faki (2000) compared the performance of five groups of *Large Baladi* native fowl and White Hisex under relatively improved environmental conditions. He found that, the average egg weight for the *Large Baladi* groups was 46.75 g. A significant difference at (p<o.o5) was observed for both *Large Baladi* and White Hisex and among *Large Baladi* groups in egg weight.

2.3.7 Feed intake as affected by environmental factors:

Different breeds and strains as well as their crosses have different rates of feed intake. Lee and Huang (1988) stated that, the average feed intake of indigenous and broiler fowls of Taiwan up to 8 weeks of age was 2091 and 4662 g, respectively. Vovesny (1989) also reported that, the average feed intake for Hisex White and Hisex Brown as 108.7 and 104.1 g/hen/day, respectively. However, Suleiman (1996) found the average feed consumption per bird per day for the indigenous Sudanese fowls as 89.49 g.

Mohammed Ahmed (1994) recorded feed intake for two exotic layer strains (Lohman and Hisex) under Sudan condition as 123.1 and 112.6 g/day, respectively.

Feed intake can also be affected by temperature levels. Deaton *et al*. (1986) studied the effect of temperature on the performance of laying hens at constant temperature of 21°C and 24°C to 35°C to 24°C cyclic temperature. The results showed that laying hens exposed to cyclic linear temperature, consumed significantly less feed. David *et al*. (1983) also studied the effect of cyclic and constant ambient temperatures on feed consumption of layers. The feed consumption of hens was not significantly different when housed at constant temperature of 23.9°C or at 26.7◦C, but was significantly reduced for hens at 29.4°C cyclic temperature.

Hitoshi (1980) stated that, feed intake increased with increasing light length from 12 hours light to 24 hours light. Kriz and Skareclkly (1989) conducted a trial on White Leghorn hens at different light regimes, and found, no significant difference in feed consumption. Kansal and Bhatti (1995) reared a group of broiler chicks on slatted and wire floor from 2 to 8 weeks of age and exposed them to different light regimes. The result had no significant effect on feed consumption.

The seasons of the year were found to affect feed intake. Ahuja *et al*. (1977) reported that, the average voluntary intake of 3 to 10 weeks old chicks reared in winter, rainy and summer seasons were 108, 93 and 86 kcal/chicks/day respectively. Prasad *et al*. (1989) studied the different seasons, to find that feed consumption up to 10 weeks of age was significantly lower for birds reared in April –June.

The housing system as well as the number of chicks per specific unit area were found to affect the amount of feed consumed per bird per unit time. Caushi (1985) housed lines of White Leghorn and their line– crosses on deep litter system. The average food consumption per bird ranged between 220 and 342 g, respectively. El-Amin (1988) compared the performance of Hisex White layers under Sudan conditions and ideal temperate conditions on deep litter system. The average feed consumption/bird/day was 102 and 109 g respectively, while by Kriz and Shareckly (1989) no significant difference was rcorded in feed consumption of White Leghorn housed on a deep litter or cage. Najib (1991) housed two groups of broiler on cage system and on a deep litter. The feed intake was lower in fowls reared on the floor than in those in cages. Sharma (1994) also studied the effect of three types of floor systems on the performance of White Leghorn pullets. Here the daily feed intake did not differ among the three groups.

El-Faki (2000) compared the performance of five groups of *Large Baladi* native fowl and White Hisex under relatively improved environmental conditions. The *Large Baladi* has the highest feed intake (506.27± 88.70 g /bird/week), while the exotic breed recorded the lowest feed intake (442.66± 277.38 g /bird/week). Contrast between *Large Baladi* and White Hisex revealed a significant difference at ($P < 0.05$), whereas there is no a significant difference among the *Large Baladi* groups.

2.3.8 Feed conversion ratio as affected by environmental factors (feed efficiency):

The breeds, strains and the breeding methods have been reported to affect feed efficiency of poultry. Suleiman (1996) reported an average feed efficiency per a dozen egg of indigenous Sudanese fowl under relatively improved conditions as 2.2 kg/dozen egg. Vovesny (1989) recorded the feed consumption per dozen eggs for White Hisex and Brown Hisex as 2.36 and 2.25 kg respectively. Trujillo and Pampin (1988) reported an average of 2.17 to 2.28 kg feed consumption per kg gain of broiler obtained from three genotypes up to 7 weeks of age.

Deaton *et al.* (1981,) observed no significant difference in feed efficiency of hens kept in environment cycling from 21.1°C to 35.0°C or from 15.6°C to 35°C of hens kept at constant 25°C or cycling between 15.6°C and 35°C. David *et al.* (1983) indicated no significant difference in grams of feed per grams of egg mass. Proudfood and Hulan (1987) reported that, temperature had no effect on feed conversion.

Nickolas and Charles (1988) reported that the kg feed/kg egg of New Hampshire breed housed in floor pens for 57 weeks of age and exposed to temporary 28 hours ahemeral lighting or hemeral lighting was 4.01± 0.09 and 4.11± 0.14, respectively.

Tai *et al.* (1992) studied the effect of two lighting programs on the performance of commercial layers. A non significant change in kg feed per kg eggs was reported . Kansal and Bhatti (1995) exposed broiler chicks to three different light regimes, which proved to have no significant effect on feed conversion efficiency.

Musharaf (1992) studied the effect of season on the performance of commercial broilers up to 8 weeks of age during April–May, where the maximum and minimum ambient temperature averages of 38°C and 23°C were attained respectively. The average feed conversion was 2.19 ± 0.09.

Lopez and Antomarchi (1988) reported that, the average feed consumed per kg gain of three broiler hybrid strains hatched between January and September to be 2.41, 2.41 and 2.49 kg in winter and 2.51, 2.54 and 2.63 kg in summer, with significant differences between the two seasons. Prasad *et al*. (1989) observed that, feed conversion did not differ significantly among groups of broilers reared in different climatic conditions. Taboada *et al*. (1991) studied the performance of broiler chickens hatched in winter and summer, and they found that the amount of feed per kg gain was 2.46 and 2.76 kg, respectively.

Reddy *et al*. (1981) reported that, significant difference in feed conversion among three groups of egg type chickens was observed when housed on slatted floor, deep litter or in cages. El-Amin (1988) observed the average feed conversion ratio (kg feed/kg eggs) of White Hisex Under Sudan conditions and temperate conditions, the ratio reported as 2.09 and 2.30 respectively. Sharma (1994) stated that, the efficiency of egg production (kg feed/kg egg) of White Leghorn hens was lower on deep litter than on slatted floor. The effect of housing system on the performance of the four laying strains. They found that battery system was significantly better in feed conversion efficiency than the floor and free-range systems (Moster *et al*., 1995).

El-Faki (2000) compared the performance of five groups of *Large Baladi* native fowl and White Hisex under relatively improved environmental conditions, where the average feed efficiency calculated from gram feed consumed per gram egg produced for *Large Baladi* and White Hisex was 8.83± 3.23 and 6.06± 2.51, respectively. This result indicates a significant difference at ($P < 0.05$) level between *Large Baladi* and White Hisex.

2.3.9 Mortality rate as affected by environmental factors:

Suleiman (1996) found the mortality rate of the Sudanese indigenous fowl (*Large Baladi*) under improved conditions up to 8 weeks of age was 1.9% and 11%, respectively. Tibin and Mohamed (1990) for up to 11 weeks of age reported mortality rate as 1.5% for the same Sudanese chicken. Atabani (1989) reported mortality rate of locally produced Brown Hisex up to 4 weeks of age as 11.7%.

Musharaf (1992) studied the performance of broiler chicken up to 8 weeks of age in hot climate. He reported 20 percent mortality rate, and suggested that broiler reared in the hot climate should be slaughtered at 6.7 weeks of age.

Kriz and Skarecky (1989) observed no significant difference in mortality of White Leghorn hens under different lighting regimes.

Bannar and Ogunsan (1987) recorded mortality rate of neonatal chicken of Nigeria during cold dry, hot dry and rainy seasons as 15% , 3.5% and 5.5% respectively. Lopez and Antomarchi (1988) stated that, the viability of three broiler hybrid strains during winter and summer was reported to range from 94.86% to 95.97% and 93.49% to 93.36 %, respectively.

Vovesny (1989) reported that, the mortality rate of White and Brown Hisex when housed in battery cage reached 11.4% and 5.4% respectively. Gill and Sharma (1992) observed significant higher mortality rate on deep litter than on slatted floor system.

Lee (1989) however stated that, decreasing floor space while keeping the number of birds per pen constant resulted in a significant increase in mortality rate of White Leghorn layers.

Bahtti and Aggarwal (1989) also studied the effect of stocking density on the performance of White Leghorn pullets when housed in cage with floor area of 9 or 4.5m^2 per bird from 20 to 52 weeks of age. They found higher mortality at 9 than at 4.5 m^2/bird.

El-Faki (2000) compared the performance of five groups of *Large Baladi* native fowl and White Hisex under relatively improved environmental conditions. He found that, the average mortality rate during the experimental period ranged from 8.83 to21.51% in local groups and 25 .84 % in the exotic group.

CHAPTER THREE

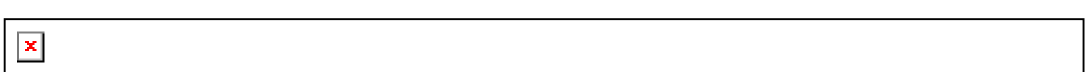
MATERIALS AND METHODS

3.1 Materials:

The experiment was conducted at The Demonstration Farm of Kuku Animal Research Station, ARC, Khartoum North in 2005. of the site (latitue is 15-40^{o} N", Longitude is 32–32^{o}E), and "381.4 meters above see level. The climate of the site is tropical with seasonal annual rainfall of 150-180 mm from July to September. The mean maximum and minimum temperatures are as high as 36.8°C during the summer and as low as 21.5°C during winter (Shambat Meteorologic-al Station, 2005)

The housing system used was the battery one, which was placed insided an open- sided house system (Plate 3.1). The dimensions of the house were 21m long, 3 m high and 7.7 m wide. The floor is made of red bricks and concrete. The roof is made of corrugated iron sheets. The north and south sides of the house were made of wire netting with 50 cm from the ground. The western side built with red bricks while the eastern is made of wire netting. The supporting pillars were made of angle iron.

The battery is graded, and there are 20 cages in each battery. The dimensions of each cage were 50cm long, 40cm high, and 40cm wide (Plate 3.2).



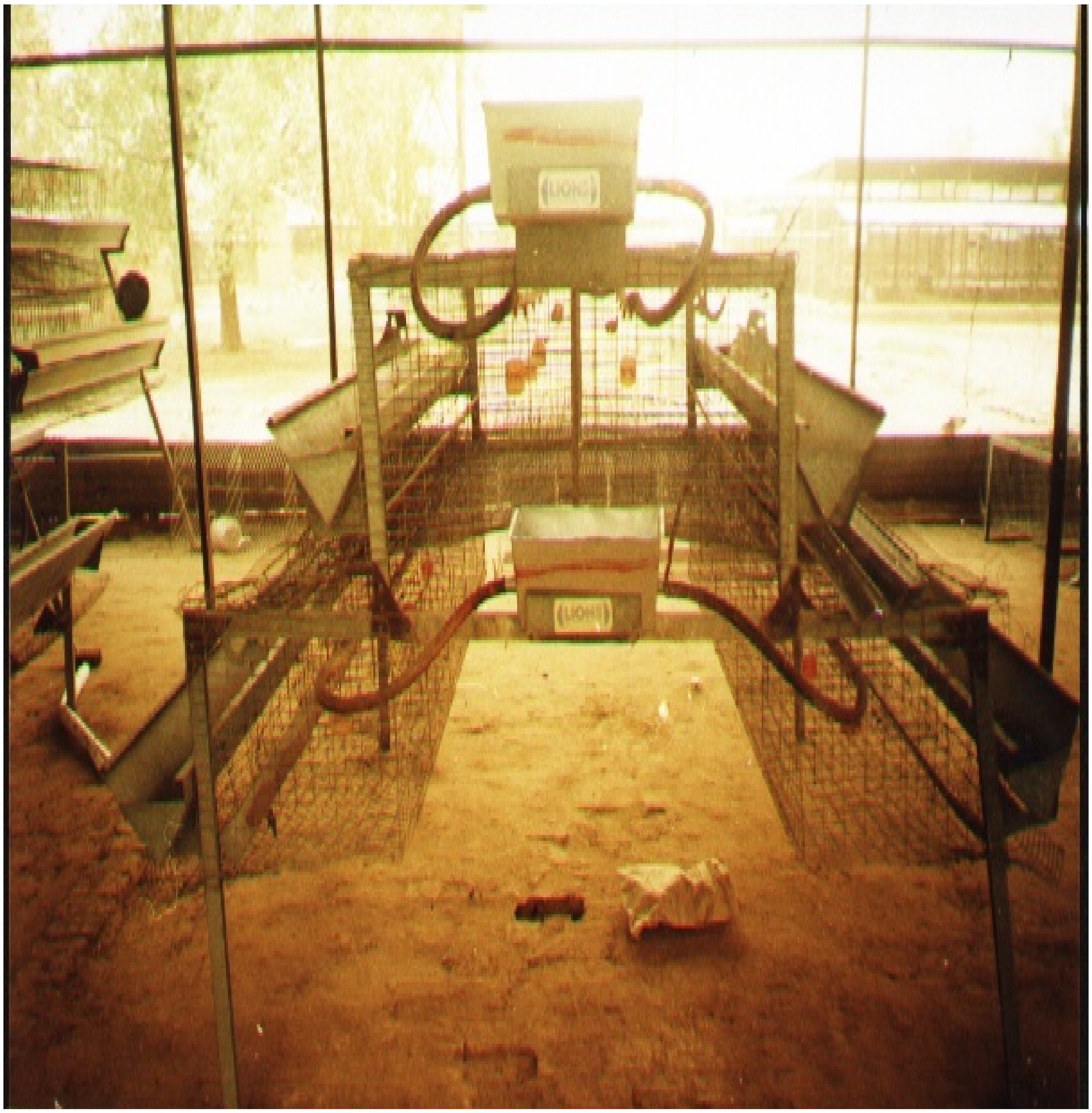


Plate 3.2. The type of batteries used in the experiment (step battery)

An experiment for measuring temperature in side the barn was carried out The measurements were taken at the middle height of the roof 1.5 m from the ground. Digital sensitive balance was used for weight recording the rations and the eggs.

3.2 Method:

A completely randomized design (CRD) with four replicates (R1, R2, R3, R4,) was used to execute the experiment. Six birds of five months age (Hisex breed) were used for the each replicate. The birds were placed in the battery cage, and each two cage represent one replicate (Plate 3.3).

Two treatments as feed type were used namely dura and maize for four months (from 25 August to 14 December). Twenty four birds were fed on dura and the other twenty four were fed on maize.

Feed was supplied two times/week. Clean fresh water was availed throughout the days. Long fountain as well as nipples for watering system were used. The feeder type is the longitudinal one.

3.3 Data Collection:

The data collected from the experiment was as follows:

3.3.1 Average weekly egg production:

The eggs were collected weekly to determine the percentage of egg production using the following equation

Plate 3.3. The distribution of birds inside the battery

$$\% \text{ Egg production} = \frac{\text{Total number of eggs produced} \times 100}{\text{days of production} \times \text{average number of birds}}$$

3.3.2 Mean egg weight (g):

Sixteen eggs from each treatment were chosen by the end of the week and weighed individually and the average weight of the egg was calculated as follows:

$$\text{Mean egg weight} = \frac{\text{Total egg mass}}{\text{number of eggs weighed}}$$

3.3.3 Average feed intake (g)/bird/wk.

The average feed intake was determined by subtracting the residual feed in the feeders for each replicate by the end of the week after being weighed by using the sensible balance. Then the consumed feed per each replicate was divided by the average number of birds for that time.

3.3.4 Feed conversion rate (FCR) in grams of feed/grams of egg obtained as follows:

$$\frac{\text{Quantity of feed consumed /week}}{\text{Average eggs weight / week}}$$

3.3.5 Mortality rate:

The dead birds were recorded daily, and at the end of the week the mortality percentage was calculated as follows:

$$\frac{\text{Died birds} + \text{removed birds}}{\text{initial number of birds}}$$

3.4. Statistical analysis procedure:

Collected data was analyzed using Statistical Package for Social Sciences (SPSS). Means were tested using one way analysis of variance (ANOVA), and then separated using Duncan's Multiple Range Test (DMART).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. Introduction:

The following layers performance parameters on weekly basis as being affected by seasons temperatures and feed type will investigated and these parameter include:-

1- Eggs production percentage.

2- Egg weight (g).

3- Feed intake.

4- Feed conversion ratio.

5- Mortality rate.

It was found that the summer temperature range inside the layer house is 33C° to 38C° while for winter temperature was 29C° to 35C°. The indicates that the birds where housed in an environment above the comfort zone (15C° to 25C°) and also the acceptable zone (25C° to30C°)

Graphical presentation and statistical analysis will be carried out for each of the above.

4.2. Egg production percentage:

Fig 4.1 shows that the effect of seasons temperature and feed type on egg production percent. Generally winter is superior to summer for both feed types (maize and dura) and maize is superior to durra for both season temperature (summer and winter).

Table 4.1 shows Duncan Multiple Range Test (DMRT) for the four combinations of seasons temperature and feed type. Its clear that combinations of summer + dura, summer + maize and winter+ dura with egg production percent of 83.233 , 86.844 and 86.047respectifly show no significant difference (P<0.01) where as the combination of winter + maize 91.306 is different from the other three.

This difference could due to decrease in temperature. The result agrees with those of Cowman and Michie (1980), Pereze (1989), Bengston and Whitaker, (1988) and Abd alla (1996).

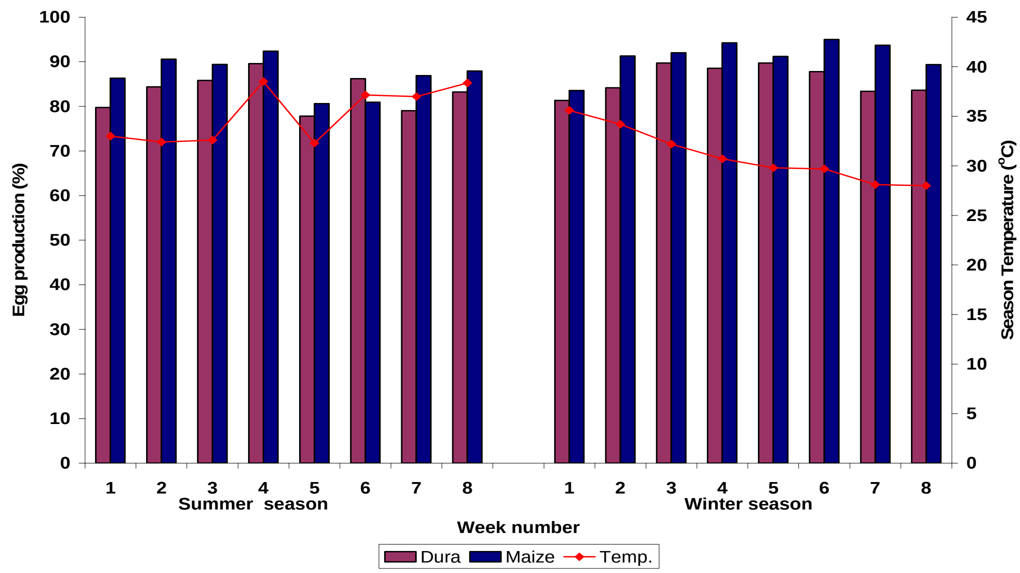


Fig.4.1 Egg production percent as affected by season temperature and feed type

Table 4.1. Egg production percentage

Treatments	% Egg production
Summer + dura	83.233 ± 4.07[b]
Summer + mazie	86.844 ± 4.24[b]
Winter + dura	86.047 ± 3.29[b]
Winter + maize	91.306 ± 3.63[a]
F-ratio	6.112*
C.V%	4.14%
$Lsd_{0.05}$	3.921

Means values having different superscript letters in each column differ significantly ($P \leq 0.05$).

n.s = Not significant

* = Significant

** = Highly significant

4.3. Egg weight:

Fig 4.2 shows that maize is superior to durra for the temperature of summer and winter seasons. And winter season is superior to summer for both feed types (maize and durra).

Table 4.2, shows (DMRT) which indicate that a highly significant difference in egg weights for the four combinations *i.e.* summer + durra, summer + maize, winter + durra and winter +maize. was observed. The egg weights for these combinations were 46.89g, 50.12 g, 52.97 g and 55.77 g respectively. This difference is attributed to the effect of both temperature and feed type on egg weight.

The results in agreement with those of Deaton *et al* (1986), Pandey *et al* (1989), and Bengston and Whitaker, (1988)

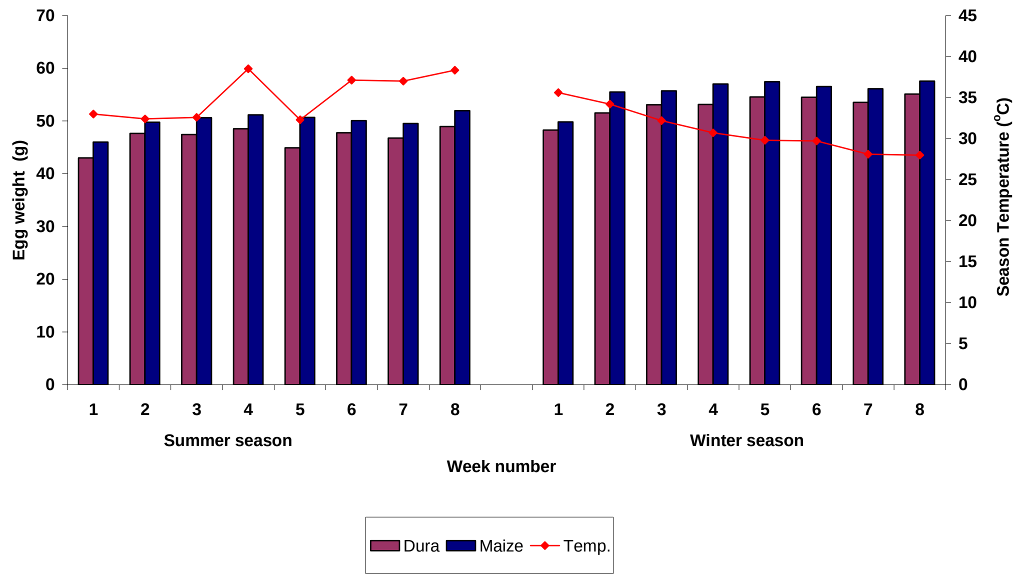


Fig.4.2 Egg weight as affected by season temperature and feed type

Table 4.2. Egg weight

Treatments	Egg weight
Summer + dura	46.882±1.98[d]
Summer + mazie	50.125±1.80[c]
Winter + dura	52.974±2.21[b]
Winter + maize	55.722±2.50[a]
F-ratio	25.227**
C.V%	4.566%
$Lsd_{0.05}$	2.189

Means values having different superscript letters in each column differ significantly (P≤0.05).

n.s = Not significant

* = Significant

** = Highly significant

4.4. Feed intake:

Fig 4.3 shows that maize is superior to dura for the temperature of both summer and winter seasons, while winter is superior to summer for both feed types (dura and maize). Table 4.3 shows the DMRT which indicates that for feed intake the first two combinations show a significant difference between them (summer+ dura and summer + maize) with a feed intake of 566.300 and 607.239 respectively. This result, for some extent, agrees with those of Vovesny (1989). The results show that the feed intake increases in winter rather than in summer. This might be due to the decrease in temperature for both types of feeds (dura, maize). The results agrees with Deaton *et al*. (1986), Ahuja *et al*. (1977), Prasad *et al.* (1989) and Bengston and Whitaker (1988).

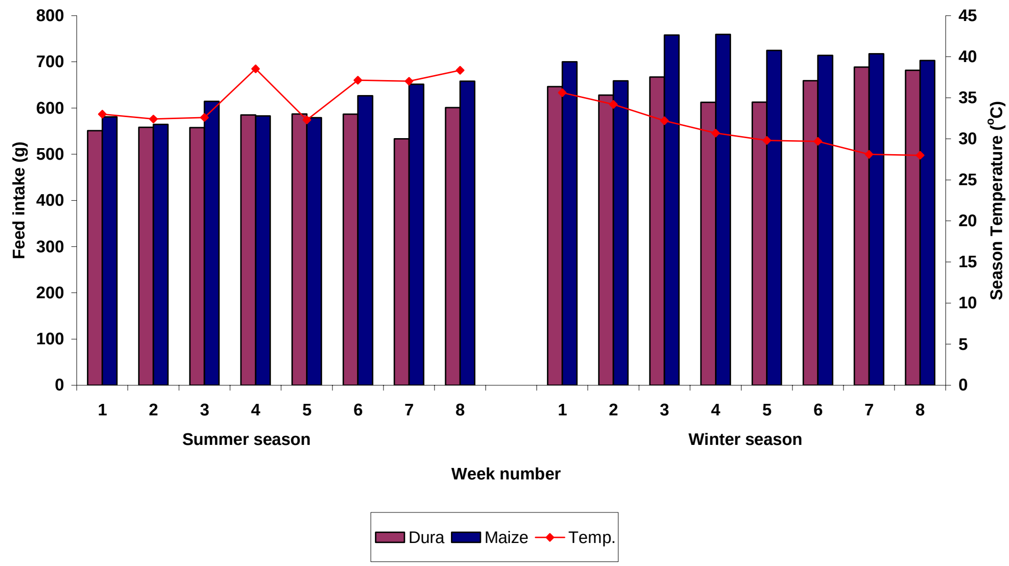


Fig.4.3 Feed intake as affected by season tempearture and feed type

Table 4.3. Feed Intake

Treatments	Feed intake
Summer+dura	566.300±27.35[c]
Summer+mazie	607.239±35.59[b]
Winter+dura	686.821±44.19[a]
Winter+maize	712.855±32.36[a]
F-ratio	29.697**
C.V%	5.50%
$Lsd_{0.05}$	36.26

Means values having different superscript letters in each column differ significantly ($P \leq 0.05$).

n.s =Not significant

* = Significant

** = Highly significant

4.5. Feed conversion ratio (feed efficiency)(FCR):

Fig 4.4 generally shows that maize is superior to dura for temperature of both summer and winter seasons. Table 4.4 shows (DMRT) which depicts that there is no significant differences as for as the feed conversion ratio is concerted among the four combinations. i.e. summer +durra, summer + maize, winter + durra and winter +maize with FRC of 2.194, 2.039 , 2.201 and 2.026 respectively. The result agrees with those of Denton *et al*. (1981), Proudfood and Hulan (1987), Prasal *et al*.(1989) and Dived *et al.* (1983).

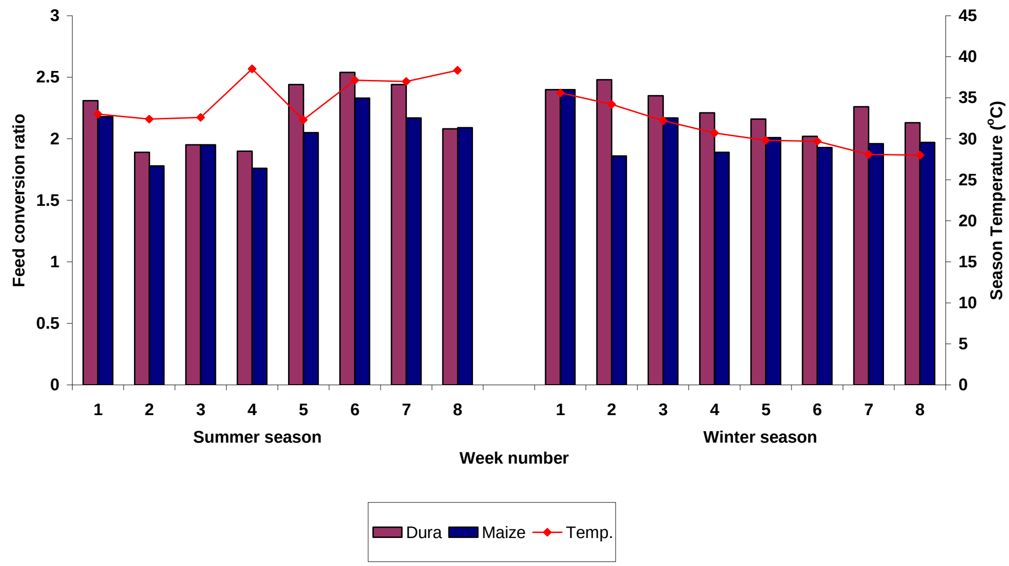


Fig.4.4 Feed conversion ratio as affected by season temperature and feed type

Table 4.4. Feed conversion ratio (feed efficiency) (FCR):

Treatments	FCR
Summer+dura	2.194±0.27[a]
Summer+mazie	2.039±0.20[a]
Winter+dura	2.201±0.13[a]
Winter+maize	2.026±0.18[a]
F-ratio	1.788n.s
C.V%	9.56%
$Lsd_{0.05}$	0.07159

Means values having different superscript letters in each column differ significantly ($P \leq 0.05$).

n.s = Not significant

* = Significant

** =	Highly significant

4.6. Mortality rate:

Fig 4.5 shows that generally mortality rate is higher in summer than in winter.

Table 4.5 shows the (DMRT) which depicts that there is no significant difference among the second, third and fourth combinations with mortality rate of 0.097, 0.000 and 0.169 respectively whereas significant difference between the first combination with mortality rate of 2.189 and other three. This confirms that mortality rate is higher in summer than winter and this result agrees with Musharaf (1992), Banner and Ogusman (1987) and (Ali, 2000).

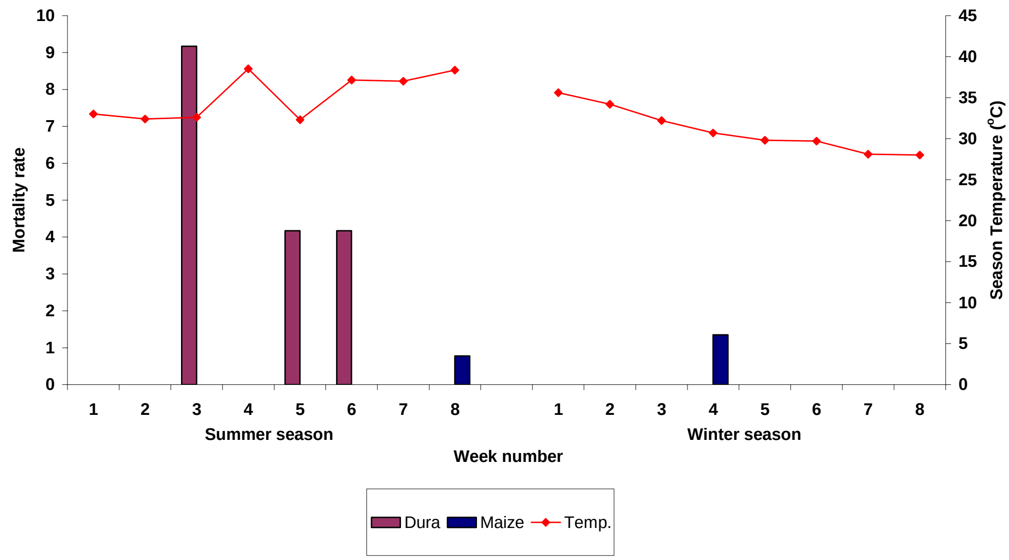


Fig.4.5 Mortality rate as affected by season temperature and feed type

Table 4.5. Mortality Rate.

Treatments	Mortality rate
Summer+dura	2.189±3.39[a]
Summer+mazie	0.097±0.28[b]
Winter+dura	0.000±0.00[b]
Winter+maize	0.169±0.48[b]
F-ratio	3.000*
C.V%	279.96%
$Lsd_{0.05}$	1.760

Means values having different superscript letters in each column differ significantly (P≤0.05).

n.s = Not significant

* = Significant

** = Highly significant

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 **Conclusions** :

The following conclusions can be drawn from the present study :

1- The layers being used in the experimental work were reared at a temperature above the thermal comfort zoon (15C^{o}-30C^{o}) and also above the thermal acceptable zoon (25^{o}C- 30^{o}C), therefore cooling of birds housing by different means could increase layer performance .

2- For all layers performance parameters being investigated , winter season temperature proved to be superior to summer season temperature for both feed type whereas maize as a feed type is superior to dura for both season temperatures .

5.2 Recommendations :

1- Under Sudan conditions its recommended that, winter season temperature is suitable for layers to perform well. Also maize as a feed type is recommended for better performance .

2- Cooling of layer housing under Sudan conditions by different means could increase layer performance .

3- Further research is recommend to be conducted to investigate the performance of the layer breed throughout the year i.e. three seasons (winter, summer, outman).

REFERENCE

Abdalla A.M. 1996. Using of evaporative cooling system for poultry housing to maintain comfort zone of temperature for birds under hot summer in Arab World. 36th Education Week; Syria.

Ahuja, A. K.; Chawla, J. S. Lodhi, G. N and I chhponani, J. S. (1977). Effect of different levels of energy on the performance of starter egg-type chicken in rainy and summer seasons. Ind. J. Anim. Sci., 48 (7): 520-524.

Ali, O. A. E. (2000) Improvement of fan-and-pad Evaporatively cooled poultry houses and study of its effect an production, Ph. D thesis. Uni of Kart, Khartoum– Sudan.

Appelby, M. C.; Hogarth, G. S; Anderson, A.; Hughes, B. O. and Whittermore, G. T. (1988). Performance of deep litter system for egg production. Br. Poul. Sci., 29: 735-751.

Atabani, Y. (1989). Fattening Hisex Cockerels produced locally by chick production of project- Gebel Awillia, under Sudan condition. Leagve of Arab states. Arab Organization Development (AOAD), Khart. 16-17Oct. 1988, PP. 65.

Bahhti. G. A. and Aggarwal, G. K. (1989). Studies on the effect of stocking density and cage level on performance of White Leghorn. Anim. Breed. Abstr. 58(2):174.

Bannar, T. T. and Ogunsan, E. A. (1987). The effect of environment temperature on intensive poultry production in Sokoto state in Nigeria bull. of Anim. Hlth. and prod. in Afr., 35 (1): 39-45.

Bengston, L. P. and Whitaker, J, H. (1988). Farm structures in tropical climates, FAO, 1988. Web site: http://www.fao.org/waicent/pantal/virtralibraryn-asp.

Caushi, D. (1985). The effect of hybridization of fowls breeds on egg production. Poul. Abstr., 13(9):219.

Cowman, P. and Michie, N. (1980). Increasing environmental temperature later in lay and performance of the fowl. Br. Poul. Sci. 21: 339-343.

David; A. E. ; Vohra, P. and Ernst, R. A. (1983). The effect of cyclic and constant and ambient temperature on feed consumption, Egg production, Egg weight and shell, chickens of hens. Poul. Sci., 63: 2027-2035.

Deanton, J. W, Reece, F. N; McNaughton, J. L; and lott, B. D. (1981). Effect of differing temperature cycles on egg shell quality and layer performance. Poul. Sci., 60:733-737.

Deaton, J. W. Reece, F. W. and lott, B. D. (1986). Effect of summer cyclic temperature versus moderate temperature on laying hens performance. Poul. Sci. 65(9): 1649-1651.

Deaton, J. W; McNaughton, J. L, and Lott, B. D. (1982). Effect of heat stress on laying hens acclimated to cyclic various constant temperature. Poul. Sci. 61:875-878.

Desai, D. K. (1962). The status importance and development of poultry keeping. Sud. J. Vet. Sci., 65:1649-1631.

Desai, D. K. and Halbook, E. R. (1961). Egg production and mortality of various breeds crosses of chicken under Sudan condition. Sud. J. Vet. Sci. and Anim. Husb.,2(1): 51-55.

Dulta, K. K. (1993). Studies on egg weight, feed requirement per dozen of egg and yolk color of the Miri Birds of Assam, White Leghorn and their cross, managed on litter, cage and free range system of management. Ind. Vet. J. 70 (2) 142-144.

El-Amin. H. M. (1988). The observe the performance of the Hisex white egg layer under Sudan condition. Symbosium of exotic white and brown breeds under Sudan condition. League of Arab state, Arab organization for agricultural development (AOAD), Khart. 16-17 Oct. 1988. PP. 72-77.

El-Faki ,A.E.E . (2000) .Comparative study on the performance of five Large Baladi native fowl groups and White Hisex under relatively improved conditions . M.Sc Thises .Uni of Sinnar.

El-Husseini, D. H. and El-Naib, A. Y. (1990). Effect of lighting and feeding regimes on some productive parameters in laying hens during hot summer in Iraq. Anim. Breed. Abstra., 60 (1):82.

Gill, S. P. S. and Sharma, M. L. (1992). Effect of flooring systems and stocking density on the performance of broiler. Ind. J. poul. Sci. 27(1): 21-28.

Hitoshi; S. (1980). Effect of light length and intensity during the laying period on egg production. Characteristics of Japanese quail. Jap. Poul., Sci., 17(5): 279-286.

Kansal, M. L. and Bhatti, J. G. (1995). Effect of intermittent lighting on the performance of broilers under different housing systems. Ind. J. Anim. Prod. and manag., 11(3): 174-179.

Khati, D. S., Kumar, B. and Toshi, M. C. (1986). Influence of season on egg production in Kumaon Hills poul. Abstr., 13(5): 107.

Kriz, L. and Skarecky, V. (1989). The performance of White Leghorn-type hens reared on alternating light regime, Poul. Abstr., 16(7): 203.

Kuit, A.; Trasre, A. and Wilson, R. T. (1986). Livestock production in control Mali; Ownership, management and productivity of poultry in the traditional sector. Trop. Anim. Hlth. and production, 18:222-231.

Lee, K. (1989). Laying performance and fear response of White Leghorns as influenced by floor space allowance and group size, Poul. Sci., 68: 1332-1336.

Lee, Y. P. and Huang, H. H. (1988). Breeding of the Taiwan "country" chicken. Anim. Breed. Abstr., 68:1134.

Lopez. A. and Antomarchi, N. (1988). A comparison of the performance of difference stains of broilers hatched between January and September. Anim. Breed. Abstr., 58 (2): 174.

MAFF, (1970), Poultry Housing and Environment, London. HER MAJESTY'S STATIONERY OFFICE.

Mench, J. A.; Tienhoven, A. V.; Mach, J. A.; McCormick, C. C.; Cunningham, D. L. and Baker, R. C. (1986). Effect of cage and floor pen management on behavior, Production and physiological stress responses of laying hens, Poul. Sci., 65:1058-1069.

Mohamed Ahmed, H. H. (1994). Comparative study of the performance of two parent White Leghorn strains (Lohman. L. S. L. and Hisex White) under Sudan condition. M. Sc. thesis, Uni. Of Khart.

Mohan, B. ; Mani, V. and Nagarajan, S. (1991), Effect of different housing systems on the physical qualities of commercial chicken eggs Ind. J. poul. Sci., 26 (2):130-131.

Moster, B. E.; Bowes, E. H.; Walt-Jc-Van-der. and Van-der-Walt-Jc.(1995). Influence of different housing systems on the performance of hens of four laying strains. South afr. J. Anim. Sci., 25 (3): 80-86.

Musharaf. N. A. (1992). Broiler chicken production in the hot season. Trop. Anim. Hlth. And prod., 24(1): 14.

Mustafa, K. ; El-Amin, M. H. and El-Hag, M. N. (1967). Sudan, self – satisfaction from poultry products. Arkaweet conference: The way of Sudan for self –Satisfactions (AOAD), Kart. 16-17 Oct., 1988.

Najib, H. (1991). Response of broiler chicken to different housing systems and feeding frequencies. Ind. J. Anim. Res. , 24(1): 29-33.

Nesheim, M. C, Austic, R. E, Card, L. E.(1979). Poltary production, Lea and Febiger, Philadelphia USA PP. 1-2.

Nickolas, G. Z. and Charles, H. N. (1988) Temporary Ahemeral lighting for increasing egg size in maturing pullets. Poul. Sci., 68: 1624-1630.

North. M. O. (1984). Relationship between altitude and hatchability. Commercial chicken production manual (The AV) publishing company, Inc. (1972), P. 92-94.

Pandey, N. K. Panda, B. ; Maitra. D. W. and Mahapatra, C. M. (1989). Changes in quality characteristics and component yields of White Leghorn eggs due to strain and age of birds and season of the year. Ind. J. Anim. Sci., 59(9):1139-1143.

Perez, M. M. (1989). Past results for the production of eggs and meat in fowls. Poul. Abstr. 16 (9): 265.

Poraz, O. (1988). The effect of time of hatching on some production traits in White Leghorn hens. Poul. Abstr., 16(8):238.

Porter. D. O. (1998). Ventilation in poultry and Livestock shelters. West Virginia University. Web site: http://www.eng.iastate.edu/coe/abe/mups/pubs/index/bookind.html.

Prasad, C. M. Sinha, R. R. P.; Gupta, B. S. and Verma, S. K.(1989). The performance of commercial broilers in different climate condition of chhotanagpur, Ranchi, Bihar, Poul. Abstr., 16 (7) :1990.

Proudfood, F. G. and Hulan, H. W. (1987). Interrelationships among lighting, anbient temperature, and dietary energy and broiler chicken performance, poul. Sci. , 66(11): 1744-1749.

Rangaredly, P; Ulaganathan, V. ; Gopatakrishnan, C. A. and Kothandaraman, P.(1989). Comparison between production practices in eggs pockets of tamilnadu. Ind. J. poul. Sci. , 24(3):173-178.

Reddy, D. N. ; Varadarajulu, P. ; Siddigqu, S. M. and Reddy S. J. (1981). Production performance of egg-type chicken under different housing systems, Ind. J. Poul. Sci., 16 (4): 318-323.

Rose, S.P. (1997). Principle of Poultry Science. CAB INTER-NATIONAL UK PP. 1-2.

Sharma, D. P; Arora, V. K. ; Singh, H. N. and Shrivastava, R. K. (1985). The influence of egg weight on early chick growth. Ind. J. poul. Sci., 20:229-230.

Sharma, M. L. (1994). Effect of floor type on the performance of White Leghorn pullets. Ind. J. Poul. Sci., 29 (3): 278-280.

Suleiman, M. E. F. (1990). Egg characteristics, genetic and phenotypic relationships of body weight at various ages in indigenous chicken. M. Sc. Thesis, Uni. of Khart.

Taboada, P.; Linares, F. Quinones, R.; Lean, Y. and Perez, N. (1991). Performance of broiler subjected to nocturnal management under farm conditions in two different seasons. Ainm. Breed. Abstr., 61 (2): 132.

Tai, Y. S. Chew, S. H. and Soh, G. L. (1992). Lighting management programs for commercial layers in Singapore. Poul. Abstr. 19(7): 203.

Tibin, I. M. and Mohamed, K. A. (1990). The effects of breed and dietary protein level on the performance and carcass characteristic of exotic meat-type strain, Sudanese native chickens. Sud. J. Veb. Sci. and Anim. Husb. , 29: 13-23.

Trujillo, E. and Pampin, M. (1988). New paternal strains for the production of broilers. Anim- Breed. Abstr., 58 (2): 174.

Venugobal, K.; Kothandaraman, P.; Narahari, D. and Sethumadhavan, V. (1982). Influence of rearing system on egg quality and carcass traits in White Leghorn laying. Anim-Breed. Abstr. 58(4):333.

Vovesny, V. (1989) A comparison of Hisex White and Hisex Brown fowls. Anim. Breed. Abstr., 58(4):333.

Whitaker, J. H. (1979). Agricultural Buildings and structures. Reston - Virginia PP.414-416.,425.

Yassin, O. E. (1987). Poultry industry in the Sudan. First Arab conference on animal and poultry production, Rabat, Morocco (AOAD), Khart,16-17 Oct., 1988, PP:14-20.

Yousif, I. A. (1987). Phenotypic and genetic variation in body weight of the indigenous chicken. M. Sc. Thesis, Uni. of Khart.

Appendix – Data

Table. 1- Egg production%

Treatment	Weeks								
	1	2	3	4	5	6	7	8	Mean
Summer+Dura	79.75	84.36	85.84	89.59	77.83	86.22	79.05	83.22	83.23
Summer+Maize	86.30	90.59	89.41	92.38	80.60	80.95	86.92	87.62	86.84
Winter+Dura	81.31	84.17	89.76	88.57	89.76	87.80	83.38	83.63	86.04
Winter + Maize	83.57	91.31	92.03	94.27	91.19	95.00	93.70	89.38	91.30

Table.2-Egg weight

Treatment	Weeks								
	1	2	3	4	5	6	7	8	Mean
Summer+Dura	43.02	47.67	47.42	48.53	44.94	47.75	46.77	48.96	46.88
Summer+Maize	46.01	49.79	50.63	51.18	50.70	50.07	49.56	51.97	50.12
Winter+Dura	48.28	51.52	53.09	53.15	54.56	54.52	53.54	55.13	52.97
Winter + Maize	49.83	55.51	55.73	57.02	57.46	56.55	56.10	57.58	55.72

Table. 3-Feed intake

Treatment	Weeks								
	1	2	3	4	5	6	7	8	Mean
Summer + Dura	550.83	528.51	557.85	585	587.22	586.64	533.21	601.04	566.28
Summer+Maize	580.55	564.6	614.58	582.98	579.17	626.67	651.5	657.92	687.23
Winter+Dura	646.25	627.92	666.88	712.5	712.71	658.96	688.52	681.83	686.02
Winter + Maize	700	658.75	757.83	759.25	724.58	714.14	717.34	702.94	712.85

Table. 4-F.C.R

Treatment	Weeks								
	1	2	3	4	5	6	7	8	Mean
Summer+Dura	2.31	1.89	1.95	1.9	2.44	2.54	2.44	2.08	2.19
Summer+Maize	2.18	1.78	1.95	1.76	2.05	2.33	2..17	2.09	2.03
Winter+Dura	2.40	2.08	2.35	2.21	2.16	2.02	2.26	2.13	2.20
Winter + Maize	2.42	1.86	2.17	1.89	2.01	1.93	1.96	1.97	2.02

Table. **5-Mortality rate**

Treatment	Weeks								
	1	2	3	4	5	6	7	8	Mean
Summer +Dura	0	0	9.17	0	4.17	4.17	0	0	2.18
Summer +Maize	0	0	0	0	0	0	0	0.78	0.78
Winter +Dura	0	0	0	0	0	0	0	0	00
Winter + Maize	0	0	0	1.35	0	0	0	0	1.35