ENERGY AND PROTEIN REQUIREMENTS OF GROWING INDIGENOUS CHICKENS OF KENYA

WENDOT CHEMJOR

1998

THESIS

Submitted to the Graduate School, Egerton University in partial fulfilment of the requirements for the degree of Master of Science in Animal Production (Animal Nutrition option).

NJORO, KENYA

EGERTON UNIVERSITY

THE SENATE

APRIL, 1998

THIS THESIS IS MY ORIGINAL WORK AND HAS NOT BEEN PRESENTED FOR A DEGREE IN ANY OTHER UNIVERSITY.

WENDOT CHEMJOR

Signature........... Date. 7/05/98.....

Thesis Supervisors

(1) Dr. James K. Tuitoek

Signature.............. Date. 7th May 1998.

(2) Dr. Jared M. Ottaro

Signature................ Date. 11/5/98.......

COPYRIGHT

ABSTRACT

Indigenous chickens contribute significantly to the poultry industry in Kenya. Their contribution to meat and egg production can be enhanced further by improving their nutrition and management. Research geared towards these aspects is inadequate. This study was therefore carried out to determine energy and protein requirements of growing indigenous chickens of Kenya. A knowledge of energy and protein requirements will facilitate ration formulation for indigenous chickens kept in confinement. Indigenous chickens were categorised into 3 weight classes: Heavy, Medium and Light. Semen from males of each category was used to inseminate hens of the respective classes and the resulting eggs were collected and incubated. The hatched chicks were used as experimental material in two experiments. A free choice (cafeteria) feeding system was employed in experiment one to estimate energy and protein requirements of indigenous chicken from the 5th to 21st weeks of age. Maize and soyabean meals were offered as choice diets. Feed and water were provided *ad libitum,* and weekly data on weight gain, feed intake and feed: gain ratio (FCR) were collected. In this experiment, 242 chicks were transferred from the brooder into floor pens, after sexing on the 28th day. Each weight class was represented by 4 replicates of both sexes. From the daily feed intake, energy and protein requirements were also computed on weekly basis. In experiment two, twenty four, 21 week old indigenous chicken were used to determine apparent metabolisable energy (AMEn) values of maize and soyabean. Droppings were collected quantitatively, homogenised and oven dried. The experimental design was completely randomized design with four replicates of 3 chickens each. Gross energy of diets and droppings was determined using an adiabatic bomb calorimeter. In experiment 1, the results obtained showed significant differences ($P<0.05$) in feed intake between the sexes in all the three classes. There were also significant differences ($P<0.05$) in crude protein intake among the weight classes but not between sexes. There were no significant differences ($P>0.05$) in the other parameters measured except in growth rates where significant differences between the sexes and among the weight categories were observed between 13th and 21st weeks. The AMEn values obtained in experiment 2 for maize and soyabean meals were 2692±339 and 2786±331 kcal ME/Kg, respectively. Information on energy density obtained in experiment 2 was used in estimation of AMEn intake in experiment 1. Heavy birds consumed significantly ($P<0.05$) higher metabolisable energy (kcal/ day) than both the medium and light ones except in the 15th and 17th weeks. There were however no significant differences ($P>0.05$) between the medium and light birds. AMEn consumed by female birds was lower than those for males ($P<0.05$), except in the 5th, 6th and 7th weeks.

The results also showed that between the ages of 5-8 weeks, a CP level of 18 % and approximately 3000 kcal/kg ME, should adequately cover the protein and energy requirements of 'heavy' indigenous chickens , whereas 'light' indigenous chickens would require a CP level of 17% but the same density of ME during the same growth period. From 8-14 week period, 'heavy' and 'light' indigenous chickens require diets containing 16 % and 14 % crude protein, respectively, and approximately 2600kcal/kg ME. Thereafter, the CP-levels in the ration for the 'heavy' and 'light' birds may be decreased to 14 and 12 %, respectively, with an energy density of approximately 2400 kcal/kg ME for both diets. These findings may be used in formulating complete rations for indigenous chickens where necessary.

ACKNOWLEDGEMENTS

I am grateful to Egerton University for awarding me a scholarship to undertake my MSc studies. This work was carried out under the supervision of Drs. J. K. Tuitoek and J. M. Ottaro, two gentlemen who were very generous with their professional knowledge and time, to a large extent beyond the call of duty. To them I say, thank you. The success of this study is their reward.

The research work would not have been possible without the support of Kenya Agricultural Research Institute (KARI). I owe a debt of gratitude to the Centre Director KARI - Naivasha, Mr. S. Ole Sinkeet and through him, the Director KARI for approving the collaborative effort between Egerton University and KARI. I am also grateful to Mr. Sinkeet for facilitating and availing a condusive atmosphere within KARI - Naivasha for carrying out this work. I also acknowledge with appreciation the financial support given by the Centre, through the Centre Director.

I am aware that the work carried out at Naivasha would have been very difficult without the centre's support, participation and encouragement of all the staff at the Poultry Research Unit KARI - Naivasha led by the head of Section Mr. J. M. Ndegwa. To all of them I say thank you very much. I am particularly indebted to Mr. Ndegwa with whom I worked closely and who was a source of inspiration and strength.

The ladies, Betty Nyakira and Lucy Gaita were of immense help in the Computer Section and taught me all I needed to know, more so, for their assistance in data analysis. I also thank Catherine Kimani for her assistance in data analysis. Special thanks and gratitudes to Mrs Naomi Meja for her tireless efforts in typing this thesis. Finally, I am very grateful to my wife, Rebecca Jebichii and son, Duncan Kipchirchir, for their encouragement, patience and many sacrifices during my graduate programme.

DEDICATION

This work is dedicated to my parents Benjamen Kimosso and Rael Teriki Chemjor and all people who may benefit from this thesis.

TABLE OF CONTENTS

DECLARATION....................ii

COPYRIGHT....................iii

ABSTRACT....................iv

ACKNOWLEDGEMENTS....................vi

DEDICATION....................vii

1. INTRODUCTION....................1

2. LITERATURE REVIEW....................3

2.1 General....................3

2.2 Indigenous chickens in the world....................4

2.3 Indigenous chickens in Kenya....................7

2.4. Methods of determining energy and protein requirements of poultry....................11

2.5 Characterization of the Kenyan indigenous chickens....................17

3. ENERGY AND PROTEIN REQUIREMENTS OF GROWING INDIGENOUS CHICKENS...21

3.1 Introduction....................21

3.2. Materials and methods....................22

3.3 Results....................27

3.4 Discussion....................42

4 DETERMINATION OF METABOLISABLE ENERGY OF MAIZE AND SOYABEAN USING INDIGENOUS CHICKENS 47

4.1. Introduction....47

4.2. Materials and methods....48

4.3 Results and discussion....50

5. CONCLUSIONS AND RECOMMENDATIONS....51

6. REFERENCES....52

7. APPENDICES....61

LIST OF TABLES

Table 1. Characteristics of Indigenous Chickens Observed in Nakuru and Baringo Districts of Kenya 19

Table 2. Mature Body weights of Indigenous Chickens of Kenya 20

Table 3.1 Experimental Set up 22

Table 3.2 Feed Ingredients and Nutritive value of diets.... 24

Table 3.3 Classification of indigenous chickens according to body weight.... 25

Table 3.4 Body weights of heavy, medium and light indigenous chickens from 5 - 21 weeks of age 28

Table 3.5 Body weights of male and female indigenous chickens from 5 - 21 weeks of age........ 29

Table 3.6 Growth rates of heavy, medium and light indigenous chickens from 5 - 21 weeks of age........ 30

Table 3.7 Growth rates of male and female indigenous chickens from 5 - 21 weeks of age. 31

Table 3.8 Feed intake of heavy, medium and light indigenous chickens from 5 - 21 weeks of age 33

Table 3.9 Feed intake of male and female indigenous chickens from 5-21 weeks of age. 34

Table 3.10 Feed conversion ratios of heavy, medium and light indigenous chickens from 5 - 21 weeks of age 35

Table 3.11 Feed conversion ratios of indigenous chickens of both sexes from 5 - 21 Weeks of age 36

Table 4.1 Apparent metabolisable energy (AMEn) values of maize and soyabean 50

LIST OF FIGURES

Figure 1 Crude protein intake of heavy, medium and light indigenous chickens from 5-21 weeks of age..38

Figure 2 Crude protein intake of male and female indigenous chickens from 5-21 weeks of age..39

Figure 3 Dietary metabollisable energy concentrations intake of heavy, medium and light indigenous chickens from 5-21 weeks of age..40

Figure 4 Dietary metabollisable energy concentrations intake of male and female indigenous chickens from 5-21 weeks of age..41

1. INTRODUCTION.

Poultry is an important source of cheap and valuable protein for many people in Kenya. The poultry industry in Kenya comprises of subsistence and commercial production sectors. The subsistence sector is based on indigenous chickens, which is estimated to be about 87% of the total poultry population of twenty five million birds (Ministry of Agriculture, livestock development and marketing (MOALD&M),1993). The commercial sector is virtually composed of exotic chickens. The commercial hybrid layer and broiler stock are reared on commercially manufactured feeds. The indigenous chickens which are found across the country but mainly in the rural areas of Eastern, Nyanza, Coast, Western and Rift Valley Provinces, in flocks of about 10 birds per household (Stotz, 1983; Mbugua, 1990), are extensively raised. No particular attention is paid to their nutrition.

The indigenous chicken contributes significantly to the poultry industry in Kenya. These birds have remained important in the rural areas of Kenya, and many other developing countries, where they are kept under free range system which is usually characterized by minimum inputs in terms of feeds, housing and health (Stotz, 1983; Aini, 1990; Abegbola, 1990; Mbugua 1990; Ibe, 1990). Indigenous chicken account for 60% of the total egg production in Kenya and contribute about 88% of the total poultry meat production of eleven thousand metric tonnes (MOALD&M,1993). They also provide rural households with additional income in addition to improved nutrition.

The nutrient sources for indigenous chicken are earthworms, a variety of insects, young shoots of grasses and fruits which they scavenge in the course of the day. They are also given household wastes and offals. These nutrient sources, apart from insects, provide mainly energy. Studies on the Ethiopian indigenous chicken indicate that energy is likely to be deficient throughout the year and protein supply inadequate in the dry season (Dessie, 1996). Similar trends are likely for Kenyan indigenous chicken since they scavenge on virtually the same feed resources.

The contribution of indigenous chickens to white meat and egg production can be enhanced by improving their nutrition and management. Research geared towards these aspects is inadequate although results obtained so far in Kenya indicate that indigenous chicken respond to improved feeding and management (Ndegwa et. al, 1991). Nutritional requirements of exotic commercial chickens, turkeys, quails, pheasants and related poultry stock have been estimated (Woodard et al.,1977; Blum et al., 1975; Potter and Shelton, 1979; Yamane et al., 1980; NRC, 1984). Three levels of protein have been adopted from day old to the point of lay both locally and in temperate countries (Leeson and Summers, 1982; NRC, 1984; Keshavarz, 1984) for layer pullets.

Information on the nutrition of indigenous chicken is still limited. Hence, due to their significant contribution to egg and meat production in the Kenyan economy as a whole, there is need to determine their nutrient requirements.

The current study simultaneously attempts to establish energy and protein requirements of growing indigenous chickens from 5th week of age to point of lay using the free choice (cafeteria) feeding system. The investigation was based on the assumption that birds have the ability to regulate nutrient intake when offered a choice of diets containing these nutrients.

The objectives of this study were therefore to:

1. Estimate the amount of energy required by growing indigenous chicken in confinement.
2. Estimate the amount of crude protein required by growing indigenous chicken in confinement.
3. Determine metabolisable energy of maize and soya bean meals using indigenous chicken.

2. LITERATURE REVIEW

2.1 General

The significance of the agricultural sector to the Kenyan economy cannot be overstated as it is important in terms of food security, employment generation, household incomes, foreign exchange and national economic growth (GOK ,1986). Sixty per cent of Kenya's foreign earnings come from agricultural exports, while 46% of the government's budget resources come from agriculture. Seventy five to eighty per cent of the country's population lives in rural areas, and 65% of all employment is in the farm/rural sector and related agro-industries (Norton, 1994). Within the agricultural sector, permanent, temporary and cash crops contributed 73% of the gross marketed production in 1990, while livestock contributed the remaining 27% (Norton,1994). Crop production outstripped livestock production by almost three times. In 1990, the agricultural sector's share of the Gross Domestic Product (GDP) was 30%, which was a decline from 34% in 1984. In addition for the third year running, the agriculture sector recorded a negative growth of -4.1% in the year 1993 (GOK, 1994), probably due to the drought locally and world economic recession.

Poultry keeping is practised widely in the country both as a source of income and food, especially protein. The poultry industry in Kenya is mainly based on chickens, other related poultry stock like ducks, geese, turkeys being very limited in numbers. The keeping of other poultry species like guinea fowls, pheasants, quails has been reported in insignificant proportions in Kenya. The chicken industry has two important sectors. The large subsistence traditionally village based sector, which is little affected by increasing prices of farm inputs such as feed and drugs, and the small but fast growing sector which is characterized by use of highly intensive units (Gichohi and Maina, 1992). The numbers of exotic birds tended to fluctuate due to the high costs of commercially compounded feeds. There was a drop in the total chicken population in the years 1992/1993. This was attributed to shortage of day old chicks and increased prices of inputs that resulted in many farmers abandoning the enterprise. The prices of poultry inputs, particularly drugs and feeds, rocketed in 1993 due to devaluation of the Kenya shilling leading to a serious inflation (MOALD&M, 1993). This phenomenon is often observed in other livestock enterprises. In the pig industry, farmers tend to abandon the enterprise when prices of inputs, such as feed, drugs are high, and that of the products are low. The total exotic chicken population for the years 1983 to 1994 is given in Appendix 7.1. In 1993, there were 21 million chickens in Kenya with approximately 1.9 million exotic layers, 0.7 million broilers and 18.4 million indigenous chickens.

The indigenous chickens make up approximately 87% of the total chicken population. The indigenous chicken remained almost constant in numbers, whereas those of the exotic birds fluctuated greatly over the period of 1987 - 1994 (Appendix 7.2).

Various other reasons have been advanced for this inconsistent growth of poultry industry. These include diseases, lack of an organized market for poultry farmers (Gichohi et al.,1988 ; Gichohi and Maina, 1992;). Lack of good quality feeds, lack of appropriate technical know - how and capital for investment have also been cited as further causes of fluctuations in the poultry industry (Mburu, 1994). Shortage and high prices for day old chicks are also major problems in the poultry industry development (Appendix 7.3). Unavailability of day old chicks, particularly layers, has remained a bottleneck among small-scale farmers. This necessitated importation of 385,000 day old chicks from Zimbabwe, United Kingdom, Netherlands, France and Germany in 1993 (MOALD & M, 1993). Generally, in Kenya the fluctuation of the poultry output is due to unstable feed prices and fluctuating feed quality which are precipitated by economic and political factors (MOALD&M, 1993).
The fluctuating quality of feeds is due to unavailability of essential feed ingredients like maize and soyabean (Qureshi, 1994). Among the two sectors of the poultry industry in Kenya, the traditional village based sector is least affected by the problems hindering the industry.

In the year 1990, the per capita consumption of eggs and poultry meat for the whole country was estimated at 37 eggs and less than 1 kg, respectively. The greatest per capita consumption of eggs and meat is currently in the urban areas with estimates of 84 eggs and 2.5 kg, respectively (Gichohi et al.,1988). There is a general decrease in per capita consumptions of chicken products, not only in Kenya but also for most African nations. This is due to slow growth of poultry production accompanied by increased human population currently estimated at 3.1% annually. (Qureshi, 1994) The consumption of poultry meat in Kenya is still lower than in many African countries such as Botswana, estimated at 1.5 kg; Zambia , 2.1 kg; Libya, 15.36 kg and Tanzania 8.86 kg (Qureshi, 1994).

2.2 INDIGENOUS CHICKENS IN THE WORLD

Population:

Indigenous breeds of chickens are found in many African countries and other developing countries, mainly in the South East Asia. FAO (1986) estimated the population of chickens in Africa to be 772 million.

Of the 21 countries reported, rural chickens contributed more than 70% of the total chicken population in 18 of them. In Cote d'Ivoire, rural flocks account for 53% of the total population while in Zimbabwe the total rural proportion is only 30% (Sonaiya, 1990) and in Ethiopia up to 98% (Dessie, 1996). In Peninsular Malaysia nearly 1 million families out of a population of 13.7 million keep small flocks of indigenous fowl in their backyards (Aini, 1990). The standing population of indigenous chicken in Peninsular Malaysia is 6.56 m, about 15.3% of the total poultry population while in Thailand and Indonesia, the number of indigenous chickens were estimated as 130 and 120 million, respectively.

Breeds/Types:

The systems, in addition to flock size, dictate the breeds, management systems and productivity of the farm. The free range system uses almost exclusively local breeds, as it has been found that the exotic birds do not survive under this system (Sonaiya, 1990). Distinct local breeds have been reported in Egypt, Morocco, Sudan and Cameroon, although they have been given names, the names seem not to be representing true breeds but they are more of phenotypic descriptions. Ten different types of local chicken have been identified in one small location in Nigeria (Sonaiya,1990).

In South East Asia, indigenous chicken, *Gallus gallus domesticus* is said to have descended from South East Asian Red Jungle, *G.gallus spadiceus* through natural mating and selection (Aini,1990). In Malaysia, the original Malayan fowls are said to have spread widely in villages before the arrival of Europeans in the late 1800's. However, the present Malaysian indigenous chicken are said to have resulted from cross breeding of red jungle fowl with mixed exotic domestic breeds introduced to that country by Europeans. The breeding system among indigenous flocks is usually one of unplanned multiple matings of various domesticated breeds introduced into an area and this has made it difficult to standardize their characteristics and performance.

Production Systems

There are three distinguishable systems for indigenous chicken production in Africa, South East Asia and other developing countries. These are free range, backyard and small-scale systems. The free range system is termed "traditional" or "village" system in which poultry are partly confined within a fenced area or merely within an overnight shelter.

It is also referred to as family or subsistence in some reports. In the small-scale intensive system, small numbers usually 50 - 100 are reared along commercial lines (Sonaiya, 1990).

The types of owners for the three systems are usually peasant, family and individual cooperatives, respectively (Sonaiya, 1990). In the free-range system the birds used are mainly the local breeds while in the other systems the local breeds are kept together with the exotic birds. The flock size varies from 5-10, 10-20 and 20-100 for the free range, backyard and small - scale systems respectively. In the free range the birds are rarely supplemented with any feed but in the backyard, they are always provided with cereal grains . In the small scale system the birds are provided with the commercially compounded feeds. The mean egg production/hen/year varies from 10-40, 30-60 and 80-150 for the three systems, respectively (Sonaiya, 1990). The intensive system of rearing indigenous chicken has been reported only in Malaysia (Aini, 1990).

Socio - economic importance

Indigenous chickens represent a significant part of the rural economy in particular and of the national economy as a whole in most developing countries. In Burkina Faso, Ouadaogo (1990) reports that, the 25 million indigenous chickens produce 15,000 tonnes of meat, out of which 5,000 are exported, adding US $ 19.5 m to annual export earnings.

Similarly Diambra (1990) reports that Cote d'Voire imports 37,000 local chickens from Burkina Faso at a cost price in Abidjan of CFA 43.90/kg and 32,000 tonnes of eggs at a cost of 540 CFA/doz every week. Indigenous chickens in Africa as a whole represent an asset value of US $ 5.75 b. Besides provision of employment, cheap source of protein and petty cash for small-scale farmers, particularly in the off - seasons, rural poultry integrates well into other farming systems as it requires very little time and investment. Appendix 7.4 shows the socio - economic importance of rural poultry in 5 selected African countries.

In Malaysia the annual indigenous chickens production was about 17,000 metric tonnes of poultry meat, which had ex-farm value of M $ 85 million. This accounted for 12% of the total annual broiler production of M$ 740 million in 1986 while 152 million eggs (5% of the total egg production) value at M $ 27 million were locally produced from small - scale and backyard systems. In 1984 Indonesia had about 120 million indigenous chickens which accounted for 60% of the total poultry population in the country (Aini, 1990). This number contributed about 25% (15700 metric tonnes) of the total meat production of the country, and 11% (27.9 tonnes) of the national egg consumption.

2.3 INDIGENOUS CHICKENS IN KENYA

Production systems:

Generally, poultry management systems practised in Kenya are similar to those of other countries in the world and can be categorised into; intensive, semi-intensive and free range systems. In the semi-intensive systems the birds are provided with sheds enclosed within a fenced area. Though the chicken are led out during the day to scavenge, they are still confined within a limited area. At night they are usually confined in sheds for safety.

The traditional 'farmyard' poultry production is practised by virtually every rural family in Kenya. According to Stotz (1983), the average small holder keeps about 10 birds primarily for home consumption purposes but the actual flock size varies from region to region. The stock consists of 10 % cocks, 30 % hens,and 60 % young stock with an annual turnover of 0.62, 0.15 and 1.32, respectively. In a survey carried out in Kakamega District, an average of 14.4 birds per household was recorded (Okitoi, 1997). Under the traditional system, the birds are not confined at all. Some farmers provide small, poorly constructed sheds which chicken rarely use. During the day, they roam freely over wide areas scavenging for food and at night they usually return to their owners' houses and in some few cases, they perch on tree branches overnight. The sheds are provided for safety reasons, to protect the birds from predators. In areas where there are many predators, raised sheds are the most convenient. This type of production is characterised by minimum input, with birds scavenging for most of their food and no investment beyond the birds, apart from the simple sheds occasionally provided.

Feeds and feeding systems:

The traditional system of keeping indigenous chicken is free range in which the birds are allowed to scavenge for themselves during the daytime, picking weeds, grasses, worms and a variety of insects (Ndegwa et al, 1991). Sometimes they are given household leftovers and occasionally, during the harvesting season, supplements such as wheat and maize are offered once or twice a day. The type of feed supplement varies from zone to zone depending on availability. The grains when provided are broadcasted near the farmer's house. No special feeding and watering equipment are provided to indigenous chicken under the traditional system. Sometimes junks of anthills harbouring termites (termitaria) are brought home from fields.

It is believed by some farmers that the consumption of termites protect the birds against certain diseases, although this belief has not been scientifically proven.

The contribution of indigenous chicken to egg and white meat production can be enhanced by improving their nutrition and management (Ndegwa et al, 1991). Ndegwa et al. (1991), studying indigenous chicken, evaluated the effect of scavenging with and without supplementation. The results obtained indicate that birds left to scavenge without supplementation put on less weight than those on supplementation. In the same study, it was observed that those supplemented with maize performed better than those on either wheat or millet. In another study, the effect of varying protein levels on the performance of indigenous chicken of Kenya was studied (Ndegwa et al, 1991). The average feed intake of the birds during the rearing period of 16 weeks ranged from 52.6 to 64.2 grams/bird/day with a feed conversion ratio range of 4.3 - 5.7. These results are similar to those for growing Malaysian village based fowl. The average feed intake of growing Malaysian indigenous chickens up to 16 weeks was 53.0 g/bird/day with feed conversion ratio of 4.6 (Ramlah, 1996). In another study on Malaysian indigenous fowl , the daily feed intake was found to be 83.8 g for males and 76.7 g for females in the production cycle.

Diseases and Pests:

The major cause of economic loss on indigenous chicken production is disease, as disease control is relatively low. Although Gumboro disease, fowl typhoid and fowl pox have been brought under control as a result of availability of vaccines for these diseases, the challenges of other poultry diseases remain (MOALD & M, 1994). The major threat relates to the occurrence of diseases such as Newcastle, Mareks, Coccidiosis and respiratory disease because disease control is not practised. The times of the year with the highest mortality are between November- December dry season and during August, dry and cool season (Okitoi, 1997). Mortality in local birds results mainly from predators and Newcastle disease. The major predators for the mature and young birds are feral cats and birds-of-prey such as eagles . It is estimated that about 15% and 40% adult and young stock respectively are lost annually (MOALD & M, 1993).

The problem of pests such as lice, chicken mites, fowl tick and stick tight fleas is also prevalent among the village based domestic fowl. This problem of diseases and pests may be attributed to lack of technical know-how on managerial aspects of poultry keeping and to a smaller extent the farmer's ignorance.

Morphological Characteristics.

The local (indigenous) chickens form a very heterogenous population. They exhibit a wide variation in size, plumage colour, comb-type, skin colour and many other characteristics (Nwosu et al., 1985; Mbugua, 1990).

The plumage colour varies widely with black, brown and white main colours. Nwosu et al (1985) observed that the commonest plumage patterns of native chicken of Nigeria were black, red, brown with various laced colours and mottling. Some have rare colour patterns such as light orange, yellow, grey, white and also laced and mottled with others (Ndirangu et al., 1991). Cocks are generally heavier than hens at maturity. Ndirangu et al. (1991) reported average liveweight of 2570 g and 1810 g for males and females, respectively. It has been observed that the naked-neck birds tend to be heavier than the feathered ones (Ndirangu et al, 1991).

There is also considerable variation in comb-type, length and colour; wattles, ears and beaks. The overall comb length and height for cocks is 6.36 and 4.88 cm, respectively, as compared to 3.64 and 1.63 for hens (Ndegwa et al, 1991). Almost all combs and wattles, irrespective of plumage colour, are red. Some proportions, however, are mottled red with white and black spots. The majority of indigenous chickens have red earlobe, other earlobe colours include white and mottled red occurring in small proportions. Black tends to be the most common beak colour. Nwosu et al (1985) also observed black as the main beak colour for Nigerian indigenous chickens. Most eggs are white in colour except for the naked neck layers whose eggs are predominantly brown. The colour of skin is generally white, yellow, yellow - red with most of them having a cream skin. Black and cream are the main feet and toe colours (Ndegwa et al, 1991).

Egg Production :

Studies carried out at NAHRC, Naivasha indicate that, at the traditional farm level, average egg production of indigenous chickens is about 40 eggs per year (Ndegwa et al., 1991). A similar report by the Ministry of Agriculture, Livestock Development and Marketing, (1994) gives a range of 40 - 60 eggs. Under improved conditions this can be raised to as high as 150 eggs (Ndegwa et al., 1991). The average egg-weight for local birds was found to be 47 g (MOALD&M, 1994). Ndirangu et al. (1991), studying the characteristics of indigenous chicken of Kenya, obtained an average egg weight of 49.3 g. Average egg weights as low as 25 - 27 g have been reported for Kenyan indigenous chicken kept under farm conditions (Stotz, 1983).

It has further been observed that naked neck hens lay larger eggs, weighing 52.3 g on average (Ndirangu et al., 1991).

The hatchability of the eggs ranges between 80 and 90% (MOALD&M, 1993). These figures, seem to be rather high compared to those reported in the literature. Scientists at Kenya Agricultural Research Institute, (K.A.R.I)., Naivasha (1991) compared the hatchability of eggs of indigenous chickens obtained from three districts (Nyeri, Kericho and Taita) and obtained a range of 50 - 60%.

Broodiness is a common feature with local chickens. The hens lay a batch of 10 - 12 eggs, then become broody and sit on the eggs. This is repeated 3 or 4 times in a year. Broodiness is the main cause of low egg-production and is a feature which has been eliminated in hybrid birds through breeding and selection. Broodiness is, however, essential for the farmer to increase his flock under the prevailing conditions. Nearly half the lifetime of a good laying hen is spent sitting on the eggs and brooding her chicks. To increase egg production broodiness should be suppressed.

This may be achieved by isolating the hen in a small cage fixed about a metre high above the rest of the flock. Feed and water is then provided *ad libitum*. Broodiness normally disappears after 3-4 days. In the traditional village based systems, the broody hens are either immersed in cold water or have their vent feathers pulled out. These measures seem to be too harsh for the purpose and may actually stop egg production completely.

However, despite the broodiness problem and the small number of eggs produced per hen annually, indigenous chicken contribute significantly to the national egg-production. They account for 60% of the total egg-production in Kenya, the other percentage being contributed by exotic layers (MOALD&M, 1994). The apparently high contribution of local chicken to egg-production, despite low production, is attributed to their large numbers (MOALD&M, 1994).

Meat Production :

Information on the meat production potential of indigenous stock is limited. Indigenous chicken are mainly kept for meat, as illustrated by the fact that almost 60% of the farmers do not collect the eggs but leave them for hatching. Most of the birds are sold between 5 and 6 months (MOALD &M, 1993). At this stage, individual birds weigh about 1.5 to 2 kg. The average cold dressed weight of indigenous chickens is estimated at 1.3 kg as compared to 1.2 and 1.5 kg for broilers and culled layers, respectively (MOALD & M, 1994).

The indigenous chickens account for about 85% of the total poultry slaughtered in Kenya, the other percentage being contributed by broilers (8 %) and culled layers (7 %). As a result they are the major source of poultry meat production in Kenya.

Marketing :

Although the production of indigenous chicken is low , the birds and eggs are sold to generate income for the household. To a large extent the marketing of indigenous chickens and their products is carried out by individuals. However, in some parts of the country, particularly in Coast and Eastern Province, formation of informal poultry groups facilitates the marketing of poultry products. Collecting agents gather large numbers of eggs for sale at markets in major towns and cities. Most eggs are fertile, although there is often marked deterioration in their quality, where distances to the markets are long. The price of eggs tends to be the same, regardless of size, shell colour and quality. Partly due to their pronounced yolk colour, for which there is a distinct preference, eggs from native stocks are usually sold at the same price as larger eggs from exotic birds. The current average price per egg is Kshs 5. However, the average current price of eggs per tray (30 eggs) is Kshs 90 as compared to Kshs 130 for the exotic layer eggs.

Poultry meat from local birds is preferred, especially, in rural areas, where they are sold at liveweights ranging from 0.75 to 2.5 kg (MOALD &M, 1994). The demand for dressed chicken, both indigenous and exotic in the urban centres is increasing. The current average price per bird is Kshs.150 and 120 for cocks and hens, respectively, in Nakuru district. In comparison to the broiler this is almost half the price.

2.4. METHODS OF DETERMINING ENERGY AND PROTEIN REQUIREMENTS OF POULTRY.

Nutritional requirements of exotic chicken (layers and broilers), turkeys, pheasants, guinea fowls and other related poultry stock have been established and used in ration formulation of feeds by animal feed manufacturing industries. An apparent species difference exist among poultry breeds as established by several authors (Appendix 7.7). The basic nutrients required by poultry for maintenance, growth and production include energy, protein, minerals and vitamins All classes of poultry have specific requirements of these nutrients.

The methods commonly used in the determination of nutrients for growth include factorial, empirical and free choice (cafeteria) feeding methods.

Factorial Methods:

This is a method commonly used to estimate nutrient requirements of animals. It is based on use of models to calculate nutrient requirements. Nutrient requirements of animals are functions of other variable components, which are included in the models. For example, protein and amino acid requirements of laying hens are functions of egg production rate, egg weight, body weight and body weight gain (Hurwitz and Bornstein, 1976).

Two models for calculation of protein and amino acid requirements of laying hens have been presented (Hurwitz and Bornstein, 1973). The requirements for energy and amino acids of growing animals vary as functions of the rate of growth determined by the genotype, age and environmental factors. The variables are resolved into a linear equation in an attempt to estimate energy requirements (Hurwitz et al., 1977). Both models utilize the maintenance requirements and gain in body protein due to weight gain, as determined by average tissue composition. Trials are conducted under different set of conditions, in order to test the applicability of such models for calculating nutrient requirements. The target performance for calculating the requirements by means of these models is based on previous results obtained at the experimental farm under similar circumstances. To devise models for calculation of nutrient requirements, the most useful initial approach seems to be to resolve the requirements into a linear equation. The equations are then used to calculate the nutrient requirements. The calculated requirements are compared with the literature values and tested empirically.This method despite being used extensively is expensive and time consuming.

Empirical Method:

Empirical method of nutrient determinations is the most commonly used. It is based on feeding trials data. The birds are fed on varying levels of any nutrient and the optimum level with respect to growth, egg production and the economy of feeding is determined. Normally, a growth trial involves *ad libitum* feeding of a diet and knowing the rate of gain and total feed consumption, feed required per unit gain or units of gain per unit of feed.

The diets that promote a higher rate of gain at a low cost are preferred. This method allows accumulation of relatively large amounts of data at reasonable costs and animals can be maintained under conditions that are at least similar to normal environmental situations, whether hot, cold or windy. One principle disadvantage with this method, is that growth is one of the more variable biological parameters that can be measured. It also requires a large number of animals for valid estimate of dietary effect. Such variation requires 12 to 15 animals per experimental unit per treatment (Church and Pond, 1988). However, most genetic variation in chicks can be ruled out since many if not all could be full sibs. Another problem is getting an accurate weight due to human error in reading and recording weights. It is also expensive and time consuming.

Cafeteria or Free Choice Feeding System:

This method of feeding is becoming popular among the poultry farmers. The basic principle of choice feeding of poultry is that individual birds reared in a flock are able to select from various feed ingredients offered. In this method, the birds are allowed a free choice of mashed, pelleted or feed grains.

It is claimed that the variety of feeds maintains the birds appetite and helps to keep the birds amused (Ivan,1959). Under this system of feeding, it appears that the birds compose their own diets according to their maintenance and production needs as described by Karunajeewa, (1978); Huqhes, (1984) and Forbes and Shariatmadari,(1994).

Choice feeding can be viewed as a flexible feeding technique that is able to meet the wide variety of needs of individual birds within various types of stock and under different climatic conditions while having both practical and economic advantages (Forbes and Covaza, 1995). Successful choice feeding of poultry using whole cereals has been reported by several authors, (Emmans, 1977, Leesons and Summers, 1978, Forbes and Shariatmadari, 1984) while Robinson (1985) failed to demonstrate the success of the choice feeding system.

Failure to select satisfactorily may often be explained in terms of incorrect experimental design or failure to meet the principles and conditions of diet selection paradigm. When single-fed birds are compared with choice-fed birds a significant improvement in growth rate is often expected for the choice-fed birds. The principles of diet selection and the behavioural factors involved in the process of adaptation to choice feeding, indicate that growing and laying birds benefit from a period of adjustment or experience of choice feeding.

In case of broilers they should be introduced to the diets from the first week of life, although it appears that their intake of grains/diets during the first 3 - 4 days is mainly based on the intake pecking behaviour of chick rather than nutritional wise selection (Forbes and Covasa, 1995). The ability of birds to select a choice of feeds depends on training, social interactions, nutritive value of feed and form.

There are arguments that birds need to be accustomed to the diets to be selected. Training the birds by accustoming them to whole grains \ diets at an early age appears to confer benefits at later stages of growth by improving their ability to select feed to meet nutrient requirements. Mastika and Cumming (1987) 'trained' one group of broilers from 10 to 21 days after hatching by giving them whole sorghum and protein pellets. While there was no difference in weight gain between complete-fed or untrained choice-fed birds, the trained birds were significantly more efficient , especially as far as protein utilization was concerned .This was because the protein pellets were more similar to the starter food which they were offered up to 21 days. It is therefore necessary for birds to be given the opportunity to learn the difference between two or more feeds on offer and their nutritional characteristics. Covasa and Forbes, (1995) suggested that birds should be introduced directly to the choice feeding system at an early age in order to familiarize them with the appearance of the foods and their metabolic effects.

Group-housed birds seem to be more successful in selecting a diet which meets their requirements than those caged singly. Rose et al. (1986) found no difference in diet selection in broilers kept in groups of 20, 40 and 60. At least eight birds per group has been suggested by Forbes and Covasa, (1995). Putting the birds together seems to encourage feed intake and eliminates the use of experienced birds ('teachers') to accelerate learning process of the so-called slow learners. Certain individuals in groups of 10 birds seem to consistently initiate choice feeding in the group.

The type, form and nutritive value of various poultry feed stuffs play a significant role in the choice feeding system. Certain feeds are more acceptable than others. The effect of type of feed used in free choice feeding was investigated by Karunajeewa (1978) who offered layers either whole triticale, whole wheat, triticale + wheat or plus oats each with a protein concentrate containing 29.1 % CP. The birds consumed 17.6% more triticale per day than whole wheat and maintained same level of protein concentrate intake, while the consumptions of grain mixture and the protein concentrate were similar for both the grain and the concentrate intake. The higher consumption of triticale than wheat was associated with lower metabolisable energy of the former.

Generally the production performance of birds is not affected by the type or form of the grain used in free choice feeding. However, grain type or form influences to some extent the protein concentrate intake which may lead to inefficient utilization of protein and other nutrients. Both growing and laying birds exhibit an ability to adjust their grain intake when offered free choice between grain and concentrate, apparently using energy and protein as key nutrients regulating their intakes.

There is little doubt that the form of the protein concentrate has a substantial effect on selection of feed as demonstrated by Rose et al (1986). In the study broilers were offered a choice of a high protein feed in pelleted or mash forms, together with either ground or whole wheat. While there were no differences in total feed intake or weight gain between treatments, there were preferences on feed selection. Physical form presumably influences gizzard development as whole grain or pelleted feed increases the ability of birds to grind food and ease digestion. The preference of chickens for maize and wheat over barley has been reported by Janssen (1994). Complete diets based on each grain type with a protein concentrate were offered from 22 to 62 weeks of age. Laying pullets offered free choices performed as well as those given complete feed and ate increasingly more grain as the energy content of grain decreased. Studies comparing the effect of feeding whole wheat and a protein concentrate with that of feeding whole barley and a protein concentrate have shown that the consumption of barley varies according to the age of birds. Egg-type pullets fed barley grains from 7 to 18 weeks of age consumed less grain and more protein than did those fed wheat grains (Cowan et at, 1978). As the content of protein concentrate increased so did the proportion of whole grain selected by the birds, and no difference in food intake or growth between the choice- fed and complete-fed birds were noticed. When a similar experiment was performed using older birds (25 - 73 weeks of age) the choice-fed birds receiving whole barley consumed more grain and less protein concentrate than those receiving whole wheat, (Karunajeewa, 1978). Those offered a free choice of grain and concentrate ate 11% less feed, converted feed into eggs more efficiently and laid larger eggs than those fed the complete food.

In principle, diet selection by laying birds does not differ from that of broilers. However, because of their type of nutrient requirements, particularly calcium, the pattern of food selection is likely to be different. The differences between layers and broilers in terms of calcium selection were reviewed by Hughes (1984). Layers have a strong appetite for Calcium. This strong appetite seems to be the determining factor in their food selection (Leeson and Summers, 1978; Classen and Scott, 1982).

Laying hens quickly detect Calcium deficiency in their diets and are able to correct this in a matter of hours if offered appropriate choices (Holcombe et al.,1975).

Free choice feeding system involves birds composing their own diets from available feed resources. This will result in a bird exactly meeting its nutrient requirements hence can be used to estimate the energy and protein requirements of the various poultry species. The birds are offered a choice of diets of known nutrient concentrations and from their daily or weekly consumption, the amounts of nutrients consumed per bird may be computed and used to estimate requirements. The results obtained are satisfactory, but rate of consumption of various choice feeds should be closely monitored. This method seems to be more accurate, less expensive, labour and time saving, and requires fewer number of birds. In addition,large gravity feed hoppers that require infrequent attention can be used.

Factorial method involves the use of models to calculate nutrient requirements of poultry. The models are resolved to equations, composed of several factors and constants. Trials are conducted under different set of conditions , in order to test applicability of such models for calculating nutrient requirements. The calculated requirements are compared with the literature values and tested empirically. On the other hand empirical method is based on feeding trial data, where the birds are fed on varying levels of any nutrient and the optimum level with respect to growth, egg production and the economy of feeding is determined. The diets, that contain varying levels of a particular nutrient, that promote higher growth rate and maximum egg production, for example, at a low cost are preferred.

In the free choice feeding system, the birds are offered a choice of diets of known nutrient concentrations and from their daily or weekly consumption, the amounts of nutrients consumed may be computed and used to estimate requirements. Free choice feeding method was used in this study to estimate energy and protein requirements of growing indigenous chicken because its advantages tend to outweigh those of factorial and empirical methods.

2.5 CHARACTERIZATION OF THE KENYAN INDIGENOUS CHICKENS:

A preliminary Trial

Over the past years the poultry sub-sector has been greatly neglected by extension and research workers. Consequently information on their phenotypic features, and production performance is still very scanty. It has been reported that the local chickens in Tanzania and Nigeria, present a very heterogeneous population, with a wide variation in size, feather colour and many other characteristics (Nwosu et al 1985; Mbugua, 1990; Katule, 1990). Therefore defining the various characteristics of Kenyan indigenous chickens will generate baseline information that could be used in future work to map strategies to improve their productivity. A preliminary trial was conducted in late 1995 and early 1996 to characterise the indigenous chickens of Kenya. A total of eight hundred and thirty two mature birds (302 cocks and 530 hens) from different locations of Nakuru and Baringo districts were selected and weighed. The selection was random. In addition, the morphological characteristics (feather colour, comb-type and colour, skin and feet colours, egg shell colour) were observed and recorded for each bird. The selection and weighing was based on the assumption that crowing cocks and laying hens were mature birds.

The results indicate that there is a wide variation in morphological characteristics, egg features and mature body weights (Table 1 and 2). Similar morphological characteristics, egg features and body weights were observed on a composite of indigenous chickens originating from Kisii, Embu and Naivasha at the Poultry Research Unit of National Animal Husbandry Research Centre, Naivasha (Ndirangu et al, 1991). This was also observed in indigenous chickens originating from Kericho,Taita and Nyeri. These results imply that the indigenous chickens of Kenya have varied morphological characteristics (Table 1). The body weights of indigenous chickens from other districts of Kenya were lower than those observed in this trial. This was probably due to inaccuracy in estimating the age of the birds in the field as compared to those which were taken under confinement. The differences may also be attributed to machine (Spring balance) used in the field. The spring balance could only weigh to an accuracy of .5 kg. Body weights for the birds under confinement at Naivasha, were measured using an electronic scale to an accuracy of 0.1 g.

Based on the results of the preliminary trial, morphological characteristics and egg features may not be the best criteria to use in classifying indigenous chickens owing to the wide variation in these characteristics.

However, the basic biology of indigenous chickens and other related poultry stock is similar but differences in mature body weight and rate of maturity may have a marked influence on the application of basic nutrition principles to a wide range of environmental and management conditions. For this reason, mature body weight may be considered the best criteria in calculating nutrient requirements of indigenous chickens.

TABLE 1. Characteristics of Indigenous Chickens Observed in Nakuru and Baringo Districts of Kenya

Morphological features	N	%
Plumage colour:		
Brown	239	28.7
Black	210	25.2
White	87	10.5
Comb type :		
Single upright	385	46.3
Single tilted	199	23.9
Single twisted	136	16.4
Comb colour :		
Red	602	72.4
Yellow	30	3.6
White	200	24.0
Egg shell colour :		
White	407	76.8
Brown	123	23.2
Neck, Type :		
Naked	146	17.5
Feathered	686	82.5

TABLE 2. **Mature Body weights of Indigenous Chickens of Kenya**

Source	Sex	Age (wks)	n	Average mature Bodyweight in Kg. x ± S.D	Range (kg)
Current study	Males Females	Mature	530 302	2.21 ± 0.6 1.66 ± 0.4	1 - 3.0 1 - 2.5
Ndirangu et al (1991)	Males Females	Mature	19 211	2.57 ± 0.4 1.79 ± 0.3	2.5 - 3.0 1.63 - 1.85
Naivasha indigenous Stock	Males Females	22 - 28	118 134	1.72 ± 0.7 1.49 ± 0.5	1 - 2.5 1 - 2.0

3. ENERGY AND PROTEIN REQUIREMENTS OF GROWING INDIGENOUS CHICKEN.

3.1 Introduction

Nutritional requirements of exotic commercial chickens, turkeys, quails, guinea fowls, pheasants and related poultry stock have been established but similar information for indigenous chickens is still very limited. Hence due to their significant contribution to egg and meat production there is need to determine their nutrient requirements. The nutrients required by all classes of livestock, in large proportions are energy and protein. In the current study, energy and protein requirements of growing indigenous chicken from the 5th week of age to the point of lay, were simultaneously estimated.

A feeding trial was carried out for seventeen weeks from 28th January to 27th May, with the following objectives:

1. To estimate the amount of dietary energy required by growing indigenous chicken under confinement,
2. To estimate the amount of dietary crude protein required by growing indigenous chicken under confinement.

The feeding trial was carried out at the poultry unit of National Animal Husbandry Research Centre, (NAHRC), KARI, Naivasha. The crude protein content of the diets was determined at the Animal Science laboratories of Egerton university in accordance with the standard procedures as outlined in AOAC (1995).

3.2. MATERIALS AND METHODS

Experimental Set up:

The experimental design used was completely randomised design (CRD), with a 3 x 2 factorial arrangement with four replications per treatment. This represented 3 classes of indigenous chicken and 2 sexes. Based on the results of the preliminary trial (section 2.5), 3 classes of indigenous chicken were formed on body weight. Both sexes were included. The experimental set up is shown in Table 3.1..

Table 3.1 Experimental Set up

Weight Class	Sex	
	Male	Female
Heavy	****	****
Medium	****	****
Light	****	****

* = Experimental Units(Replicates)

Housing:

The chicken house measured 8 x 16 m with two rows of floor pens separated by a middle corridor. Each row had 16 pens, each measuring 1 x 3 m. Each pen was provided with two round feeders with a capacity of up to 20 kg of feed and one drinker placed at an equidistant point from each feeder. Normal light from florescent tube lights was provided 24 hours a day.

The house was washed and disinfected one week before chicks were allocated from the brooder. After furnishing the floors with wood shavings, the house was disinfected again. Wood shavings were used for litter material at about 5 cm thickness.

Feeds:

Soya bean cake and milled white maize were the main ingredients each comprising of 98.2% of the diets, the other percentage being contributed by vitamins and minerals. The birds were offered vitamin supplements in drinking water. The feed ingredients were mixed mechanically. The feed were analysed for Energy and Protein at the start of the experiment using the standard procedures outlined in AOAC (1995). The feed ingredients and the nutritional value of the diets are shown in Table 3.2.

Table 3.2: Feed Ingredients and Nutritive value of diets.

Ingredients	Diets	
	1	2
Maize	98.2	-
Soyabean	-	98.2
Bone meal	0.7	0.7
Limestone)	0.6	0.6
Common Salt	0.3	0.3
Layers premix	0.2	0.2
Total	100	100
Analysed Composition:		
AMEn (Kcal/Kg)	2692	2786
% Crude protein	7.5	32.0

Experimental Birds :

Two hundred and fifty two chicken originating from a composite of indigenous chicken from Kericho, Taita and Nyeri districts were used as the parent stock for the experimental chicks. The initial stock were obtained in 1993 (Kimani et al 1997, unpublished). The birds were weighed at the point of lay and categorised into three classes according to weight, with each class further split into male and female sexes (Table 3.3).

Table 3.3: Classification of indigenous chicken according to body weight.

Classes	Mature body weight (kg)	
	Cocks	Hens
Heavy	2.02 (range = 1.89-2.14)	1.84 (range = 1.66-2.01)
Medium	1.77 (range = 1.65-1.89)	1.54 (range = 1.42-1.66)
Light	1.33 (range = 1-1.65)	1.21 (range = 1-1.42)

All hens were artificially inseminated with semen collected from cocks of their respective weight classes. Hence, semen from heavy cocks were inseminated with heavy hens. Eggs from the three classes of indigenous chicken were collected for a period of 10 days and then incubated in an automatic electric incubator. When chicks were hatched they were wing banded using conventional wing bands with serialised numbers and weighed with an electronic scale whose accuracy was 0.1 g. All chicks were vaccinated against Marek's disease on day one. The chicks were vaccinated against New Castle disease at the age of 21 days using the eye drop method and again on the 9th and 17th weeks. The birds were also vaccinated against Gumboro via drinking water at day 16 of age. They were also vaccinated against fowl typhoid on the 6th and 18th week and against fowl pox at the age of 12 weeks. They were offered commercial feed (chick and duck mash) for a period of four weeks from day one and thereafter the choice diets.

Feed and water were provided *ad-libitum*. Sexing was done on the 28th day of age using comb projections (length), feather growth and other physical attributes. The birds were then transferred to floor pens from the electric brooder and offered choice diets. Enough feed for one week was weighed into the feeders and total weight of feed plus feeder for each pen was recorded. The house corridor was swept every morning.

Data collection and Calculation:

The parameters measured were: body weight gain, feed intake and feed conversion ratio (FCR). The birds were weighed per pen at the start of the experiment and once every week thereafter. weekly body weight gains were calculated as the difference between final body weight and initial body weight per pen over a period of 17 weeks. Feed intake was determined as the difference between feed offered and feed balance. The average body weight, feed intake or gain over a whole week, were obtained by dividing the total body weight, intake or gain for a particular pen with the total number of birds for that week. The amount of energy and crude protein consumed were computed every week as the amount of feed consumed x energy and protein concentrations in each diet. The total energy and protein consumed per pen was obtained by adding the two figures computed from the two choice diets. The average energy and protein consumed per bird was computed by dividing by the number of birds/pen. Mortalities were recorded as they occurred.

Statistical Analysis :

All data collected were subjected to analysis on weekly basis for a period of 17 weeks. The data on average body weight gain; feed intake, feed conversion ratio, energy and protein consumed per day over the experimental periods were subjected to Analysis of Variance appropriate for a 3 x 2 factorial experiment. The GLM procedures of SAS (1988) were used in the analysis. When the F test was significant ($P<0.05$), then LSD method was used to separate means (Steel and Torrie, 1980)

3.3 RESULTS

The experiment progressed as planned with mortalities averaging 9.2% over the whole period. The mortalities were random but 2 pens of heavy females were most affected during the 8th week. These two pens were however, included in the statistical analysis hence the poor feed conversion ratio during the week especially on the heavier birds. Following the appropriate statistical analysis, no significant ($P>0.05$) interactions were detected between sex and body weight categories. Therefore, only main effects of sex and body weight are reported.

Body Weights

The average body weights at 5 and 21 weeks for all categories of the indigenous chicken were 102.7 g to 1318.4 g respectively. The body weights were not significantly different ($P>0.05$) in any week among the weight categories (Table 3.4).

Significant differences in body weights were observed between the sexes. The males attained 1496.4 g and females, 1061.7 g in 21 weeks ($P<0.05$). The body weight differences were 7 g in the 5th week 109 g in the 13th week and 235 g in the 21st week (Table 3.5). The body weight of the two sexes started being significantly different ($P<0.05$) from the 7th week of age. These results are also presented graphically in Fig. 7.1 and 7.2

Growth Rates (grams/bird/day)

The growth rates ranged from 5.3 to 20.6 grams per bird per day during the period of 5 - 21 weeks. (Tables 3.6 and 3.7). The average daily gain increased with age and the highest growth being attained between 16th and 19th weeks. There were no significant differences in growth rates among the weight classes and also between the sexes ($P>0.05$). However, the males showed slightly better growth rates than females through out the 17 weeks of study. The same results are represented graphically in Fig. 7.3 and 7.4.

TABLE 3.4 BODY WEIGHTS OF HEAVY, MEDIUM AND LIGHT INDIGENOUS CHICKENS FROM 5 - 21 WEEKS OF AGE

WEEKS	N	HEAVY (g)	MEDIUM (g)	LIGHT (g)	SEM
5	8	110.6	107.2	102.7	2.95
6	8	148.4	150.0	141.9	5.22
7	8	204.6	194.8	192.3	6.68
8	8	238.8	237.0	234.3	7.48
9	8	300.0	288.9	283.4	6.22
10	8	362.2	353.4	353.7	10.74
11	8	419.8	418.2	412.6	13.49
12	8	500.6	481.5	464.7	14.39
13	8	584.3	573.4	569.1	17.83
14	8	629.2	642.0	644.0	21.82
15	8	711.0	710.2	703.8	22.08
16	8	774.8	778.7	809.5	31.41
17	8	891.5	869.9	855.1	29.13
18	8	1012.4	993.2	965.0	45.40
19	8	1161.4	1098.7	1051.7	34.86
20	8	1245.8	1238.3	1234.6	34.77
21	8	1305.1	1318.4	1213.7	26.78

TABLE 3.5 BODY WEIGHTS OF MALE AND FEMALE INDIGENOUS CHICKENS FROM 5 - 21 WEEKS OF AGE

WEEKS	N	MALES (g)	FEMALES (g)	SEM
5	12	110.6^a	103.5^a	0.83
6	12	151.1^a	140.9^a	4.26
7	12	206.7^a	187.7^b	5.46
8	12	246.7^a	225.0^b	6.11
9	12	308.9^a	272.6^b	5.08
10	12	375.6^a	330.2^b	8.77
11	12	446.2^a	392.0^b	11.01
12	12	514.3^a	452.3^b	11.75
13	12	626.1^a	519.5^b	14.55
14	12	703.6^a	562.0^b	17.82
15	12	796.9^a	620.0^b	18.03
16	12	874.6^a	717.0^b	25.64
17	12	975.6^a	768.7^b	23.79
18	12	1098.7^a	862.0^b	37.07
19	12	1246.9^a	960.9^b	28.47
20	12	1402^a	1062.2^b	28.9
21	12	1496.4^a	1061.7^b	21.86

^{ab} means in the same row with a common superscript are not significantly different ($p > 0,05$)

TABLE 3.6 GROWTH RATES OF HEAVY, MEDIUM AND LIGHT INDIGENOUS CHICKENS FROM 5 - 21 WEEKS OF AGE.

WEEKS	N	HEAVY (gm/day)	MEDIUM (gm/day)	LIGHT (gm/day)	SEM
5	8	6.2^{a}	5.3^{a}	5.3^{a}	0.54
6	8	8.9^{a}	7.2^{a}	6.9^{a}	0.37
7	8	6.3^{a}	6.2^{a}	6.2^{a}	0.39
8	8	7.9^{a}	7.5^{a}	6.5^{a}	0.64
9	8	9.6^{a}	9.2^{a}	9.2^{a}	0.73
10	8	10.3^{a}	8.4^{a}	7.6^{a}	0.40
11	8	11.1^{a}	10.7^{a}	8.1^{a}	0.89
12	8	11.4^{a}	12.7^{a}	12.2^{a}	1.39
13	8	12.0^{a}	9.9^{a}	11.3^{a}	0.86
14	8	11.4^{a}	13.4^{a}	10.4^{a}	1.15
15	8	12.2^{a}	11.4^{a}	9.7^{a}	0.96
16	8	19.0^{a}	13.0^{a}	13.0^{a}	2.50
17	8	19.8^{a}	17.6^{ab}	15.7^{b}	1.31
18	8	21.3^{a}	16.2^{ab}	13.6^{b}	1.54
19	8	20.6^{a}	19.5^{a}	18.8^{b}	2.15
20	8	14.7^{a}	14.9^{a}	14.9^{a}	1.76
21	8	14.1^{a}	16.1^{ab}	12.2^{b}	1.82

^{ab} means in the same row with a common superscript are not significantly different (P>0.05)

TABLE: 3.7 GROWTH RATES OF MALE AND FEMALE INDIGENOUS CHICKENS FROM 5 - 21 WEEKS OF AGE.

WEEKS	N	MALES (gm/day)	FEMALES (gm/day)	SEM
5	12	6.2^{a}	5.3^{a}	0.44
6	12	8.1^{a}	6.7^{a}	0.30
7	12	6.9^{a}	5.5^{a}	0.32
8	12	8.4^{a}	7.1^{a}	0.53
9	12	10.2^{a}	8.5^{a}	0.60
10	12	9.1^{a}	8.4^{a}	0.33
11	12	10.3^{a}	9.7^{a}	0.73
12	1	12.4^{a}	12.2^{a}	1.14
13	12	12.2^{a}	9.7^{b}	0.17
14	12	13.7^{a}	10.1^{b}	0.94
15	12	12.2^{a}	10.0^{a}	0.78
16	12	11.8^{a}	13.8^{b}	0.64
17	12	12.3^{b}	13.1^{a}	1.07
18	12	18.5^{a}	15.3^{b}	1.26
19	12	24.1^{a}	15.1^{b}	2.14
20	12	16.1^{a}	13.6^{b}	1.44
21	12	16.8 ^{a}	11. 4^{b}	1.32

^{ab}means in the same row with a common superscript are not significantly different (P>0.05)

Feed Intake (grams/bird/day)

The mean daily feed intake per bird during the experimental period increased from an average of 23.7 g in week 5 to 90.4 grams in week 21 (Table 3.8 and Table 3.9). The differences in daily feed intake among the weight classes of indigenous chicken were very small. Heavy birds consumed more feed than the medium and light ones. The medium birds correspondingly consumed more that light birds but the values were not significantly different (P>0.05).

There were significant differences (P<0.05) between the sexes in feed intake. Generally, cocks consumed more than the pullets throughout the experimental period. The daily feed intake of cocks was 5 grams higher than that of females in week 5. This difference increased to 30 grams per day in week 21 (Table 3.9).

The results are also represented graphically in Fig. 7.5 and 7.6.

Feed Conversion Ratio (FCR)

The FCR during the experimental period increased from 3.3 in the 6th week to 9.7 in the 8th week. Generally, the light birds appeared to have a better feed conversion efficiency than the heavy and medium birds, while medium birds also showed a better efficiency in feed utilization than the heavy ones. The best feed conversion ratio (3.3) among the weight classes was obtained in the 6th week by the light birds and the poorest (9.7)shown by heavy birds in the 8th week. The poorest feed conversion efficiency for medium and light birds was obtained in the 21st week of growth. Generally, FCE deteriorated with age but the FCR values were not significantly different (P>0.05) among the weight categories (Table 3.10). There were no significant differences (P>0.05) between the sexes, although females appeared to show a slightly better feed conversion efficiency than the males (Table 3.11). The results are also shown graphically in Fig. 7.7 and 7.8.

Table : 3.8 FEED INTAKE OF HEAVY, MEDIUM AND LIGHT INDIGENOUS CHICKENS FROM 5 - 21 WEEKS OF AGE

WEEKS	N	HEAVY (gm/day)	MEDIUM (gm/day)	LIGHT (gm/day)	SEM
5	8	26.4	23.5	21.2	1.36
6	8	27.2	26.6	25.6	1.37
7	8	30.8	30.8	28.9	1.38
8	8	33.2	32.7	31.6	2.21
9	8	44.3	41.4	40.6	1.61
10	8	48.3	47.1	44.5	2.42
11	8	45.0	45.0	43.3	1.81
12	8	55.4	50.1	53.1	2.52
13	8	59.7	54.2	56.7	2.76
14	8	59.7	62.6	57.4	2.98
15	8	66.8	65.1	60.7	2.68
16	8	66.4	63.8	66.1	4.17
17	8	81.1	78.1	94.3	5.98
18	8	83.5	81.7	75.1	4.56
19	8	94.4	83.3	75.0	4.35
20	8	78.5	90.0	80.2	4.56
21	8	88.4	97.4	85.5	3.95

Table 3.9: FEED INTAKE OF MALE AND FEMALE INDIGENOUS CHICKENS FROM 5-21 WEEKS OF AGE.

WEEKS	N	MALES (gm/day)	FEMALES (gm/day)	SEM
5	12	26.4^{a}	21.1^{b}	1.11
6	12	28.5^{a}	24.0^{b}	1.12
7	12	33.4^{a}	27.5^{b}	1.13
8	12	35.6^{a}	29.4^{b}	1.81
9	12	45.4^{a}	38.8^{b}	1.13
10	12	48.7^{a}	44.5^{a}	1.98
11	12	47.9^{a}	41.5^{b}	1.48
12	12	57.9^{a}	47.9^{b}	2.06
13	12	62.9^{a}	50.7^{b}	2.25
14	12	67.9^{a}	53.3^{b}	2.44
15	12	72.3^{a}	56.1^{b}	2.19
16	12	73.0^{a}	58.3^{b}	3.41
17	12	87.7^{a}	65.9^{b}	4.88
18	12	87.8^{a}	70.9^{b}	3.72
19	12	92.5^{a}	76.0^{b}	3.55
20	12	98.0^{a}	67.1^{b}	3.72
21	12	106.5^{a}	74.4^{b}	3.22

^{ab} Means in the same row with different superscript are significantly different ($P<0.05$)

Table 3.10: FEED CONVERSION RATIOS AS FEED/GAIN OF HEAVY, MEDIUM AND LIGHT INDIGENOUS CHICKENS FROM 5 - 21 WEEKS OF AGE

WEEKS	N	HEAVY	MEDIUM	LIGHT	SEM
5	8	5.1	4.8	3.8	0.29
6	8	3.3	3.7	3.7	0.20
7	8	5.4	5.0	4.6	0.37
8	8	9.7	6.9	4.0	0.51
9	8	4.8	4.5	4.5	0.29
10	8	7.4	5.4	4.8	0.45
11	8	5.6	4.9	4.1	0.74
12	8	5.2	4.2	4.8	0.40
13	8	5.1	5.8	5.5	0.49
14	8	5.7	4.7	6.0	0.48
15	8	6.7	5.7	5.6	0.54
16	8	4.1	5.6	5.7	0.91
17	8	5.4	4.6	4.2	0.45
18	8	5.6	5.4	4.2	0.38
19	8	4.5	4.3	4.4	0.41
20	8	5.2	5.9	5.5	0.56
21	8	6.4	7.0	7.7	0.87

Table 3.11: FEED CONVERSION RATIOS AS FEED/GAIN OF MALE AND FEMALE INDIGENOUS CHICKENS FROM 5 - 21 WEEKS OF AGE

WEEKS	N	MALES	FEMALES	SEM
5	12	4.3[a]	4.2[a]	0.23
6	12	3.6[a]	3.6[a]	0.17
7	12	5.2	4.9	0.30
8	12	4.5	4.4	0.42
9	12	4.6	4.5	0.24
10	12	5.5	5.2	0.37
11	12	5.0	4.1	0.60
12	12	4.7	4.7	0.32
13	12	5.5	5.4	0.40
14	12	5.6	5.3	0.39
15	12	6.2	5.8	0.44
16	12	5.7	5.1	0.74
17	12	5.4	4.1	0.36
18	12	5.1	5.0	0.31
19	12	4.7	4.0	0.34
20	12	6.5	4.7	0.46
21	12	7.8	6.3	0.71

Crude Protein (CP) Intake (%)

The crude protein intake expressed as a percentage of the total diet, decreased linearly during the experimental period (5 - 21 weeks) for the 3 weight categories of indigenous chicken with actual values ranging from 22.9% CP for heavy birds during the 5th week to 12.3% for the medium birds during 21st week. Significant differences ($P<0.05$) were observed among the weight classes, with the heavy birds consuming more protein than the light birds. Slightly higher crude protein intakes were observed in light than in medium birds but the values were not significantly different ($P>0.05$). The CP intake from the 5th to the 21st week decreased from 22.9% to 12.8%; 20% to 12.3%; 18% to 13.8% for heavy, medium and light categories, respectively.

The crude protein intake (%) for the males was consistently higher than that of females by about 1% throughout the study but the actual values were not significantly different ($P>0.05$), (Figures, 1 and 2; Appendices, 7.20 and 7.21).

Energy Intake (Kcal. ME/bird)

Energy intake increased from 62.9 to 275.4 kcal ME/bird for medium birds and males on the 5th and 21st weeks, respectively(Appendix 7.22 and 7.23). The energy intake increased from 113.0-246, 62.9-254.6, and 74.5-224.6 Kcal ME/d for the heavy, medium and light categories, respectively. Significant differences were observed between the sexes except in the 5th, 6th and 17th weeks. Generally, males energy intake was higher than that of females. The daily energy intake for heavy birds was significantly ($P<0.05$) higher than for the medium and light birds. There were no significant differences ($P>0.05$) between the energy intakes of medium and light birds. The metabolizable energy (ME) concentrations were similar between the sexes and among the weight categories (Figures 3 and 4).

Fig.11 CRUDE PROTEIN INTAKE OF HEAVY, MEDIUM AND LIGHT INDIGENOUS CHICKEN FROM 5 - 21 WEEKS OF AGE

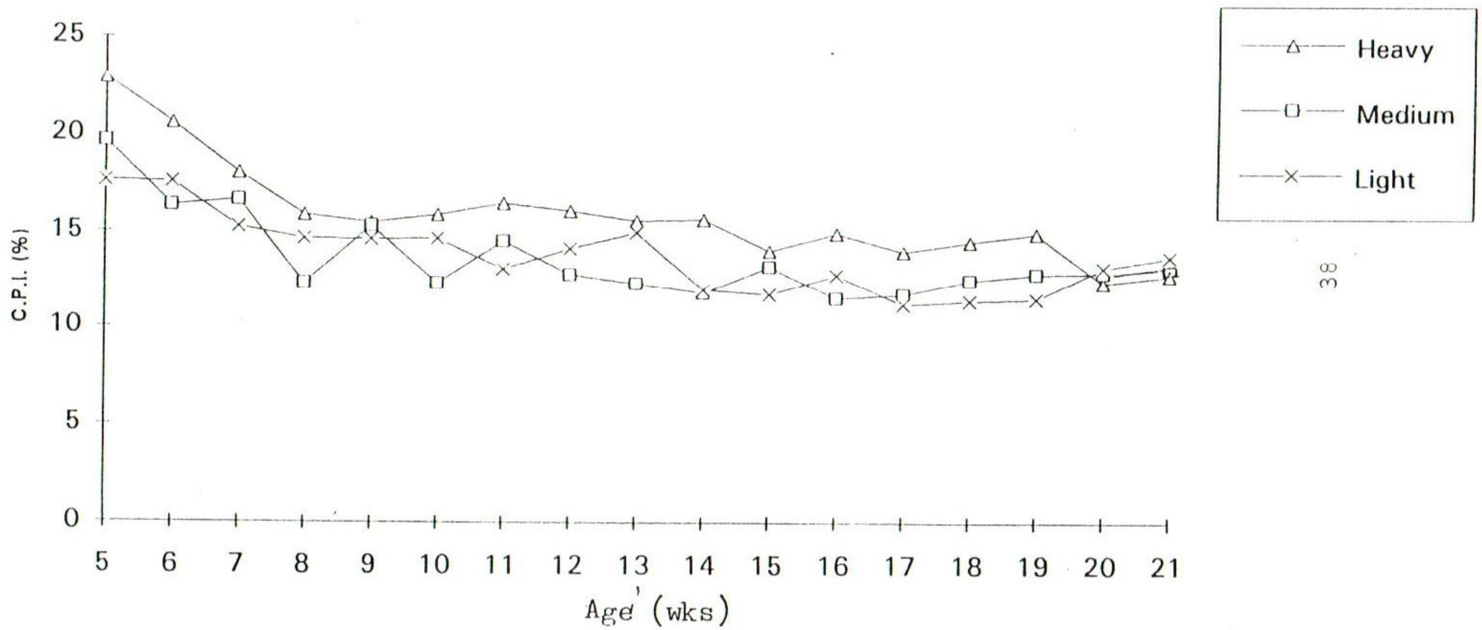


Fig.2 CRUDE PROTEIN INTAKE OF MALE AND FEMALE OF INDIGENOUS CHICKEN FROM 5 - 21 WEEKS

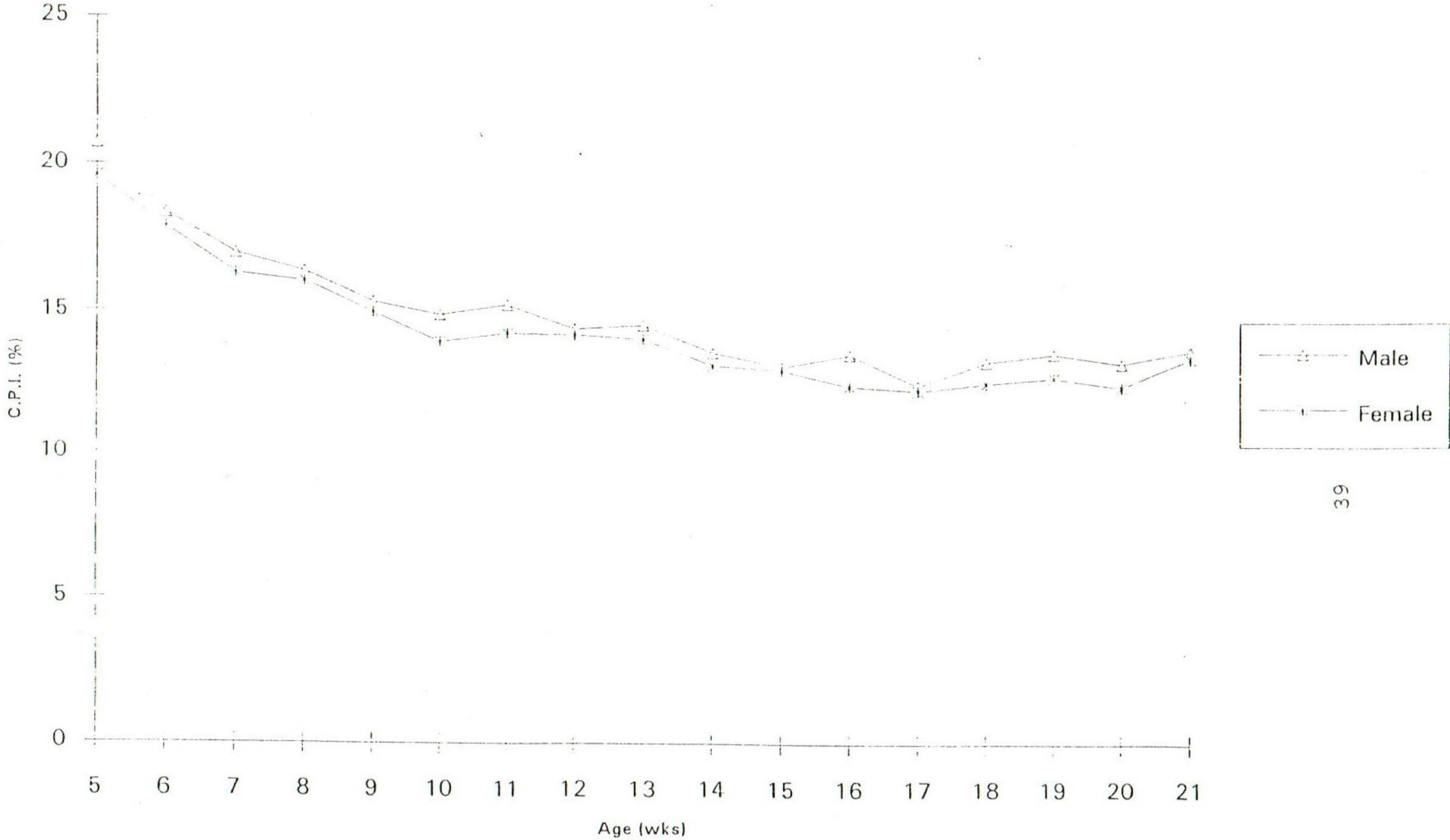


Fig. 3: DIETARY METABOLISABLE ENERGY CONCENTRATIONS INTAKE OF HEAVY, MEDIUM AND LIGHT INDIGENOUS CHICKENS FROM 5-21 WEEKS OF AGE.

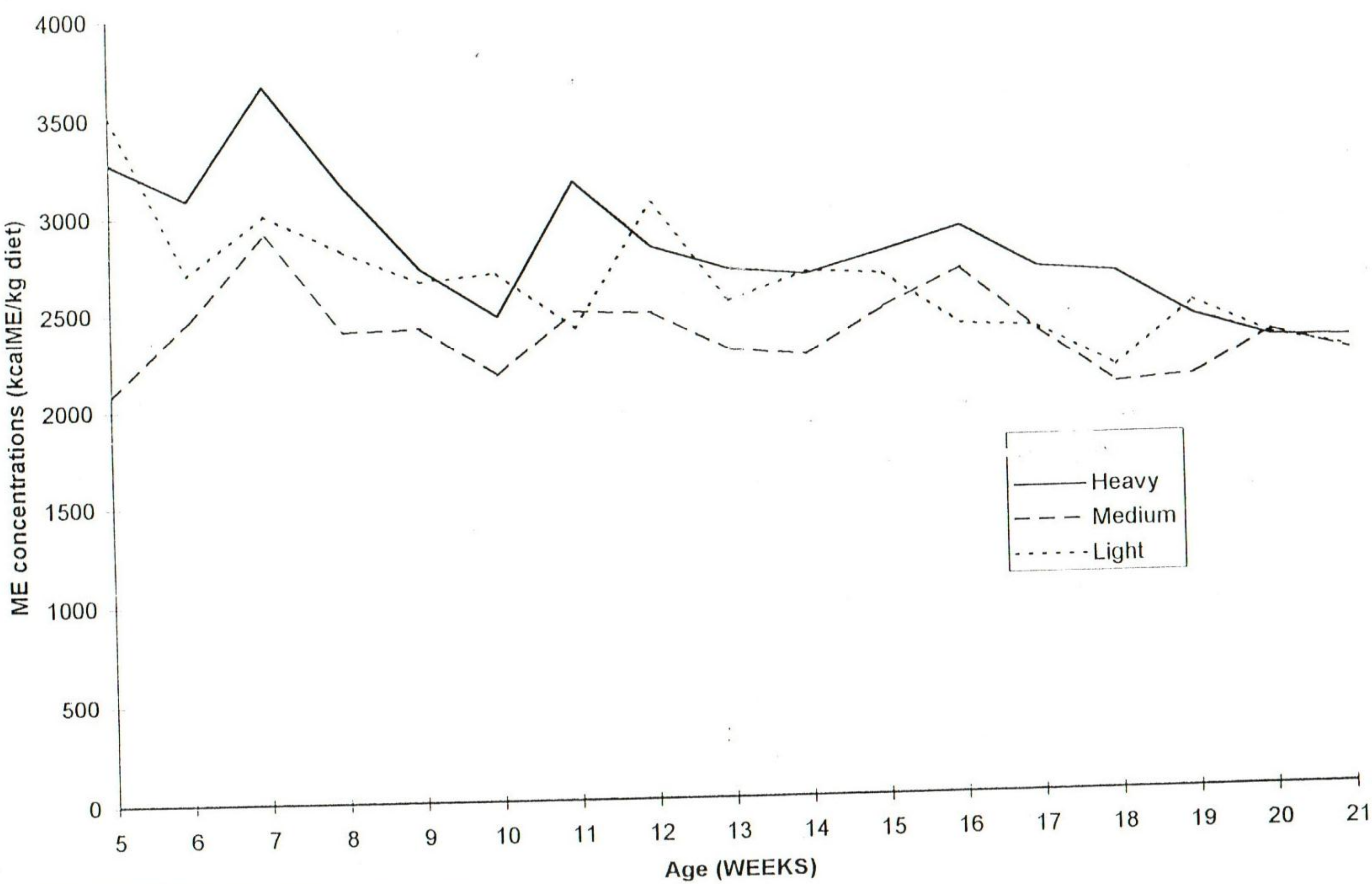
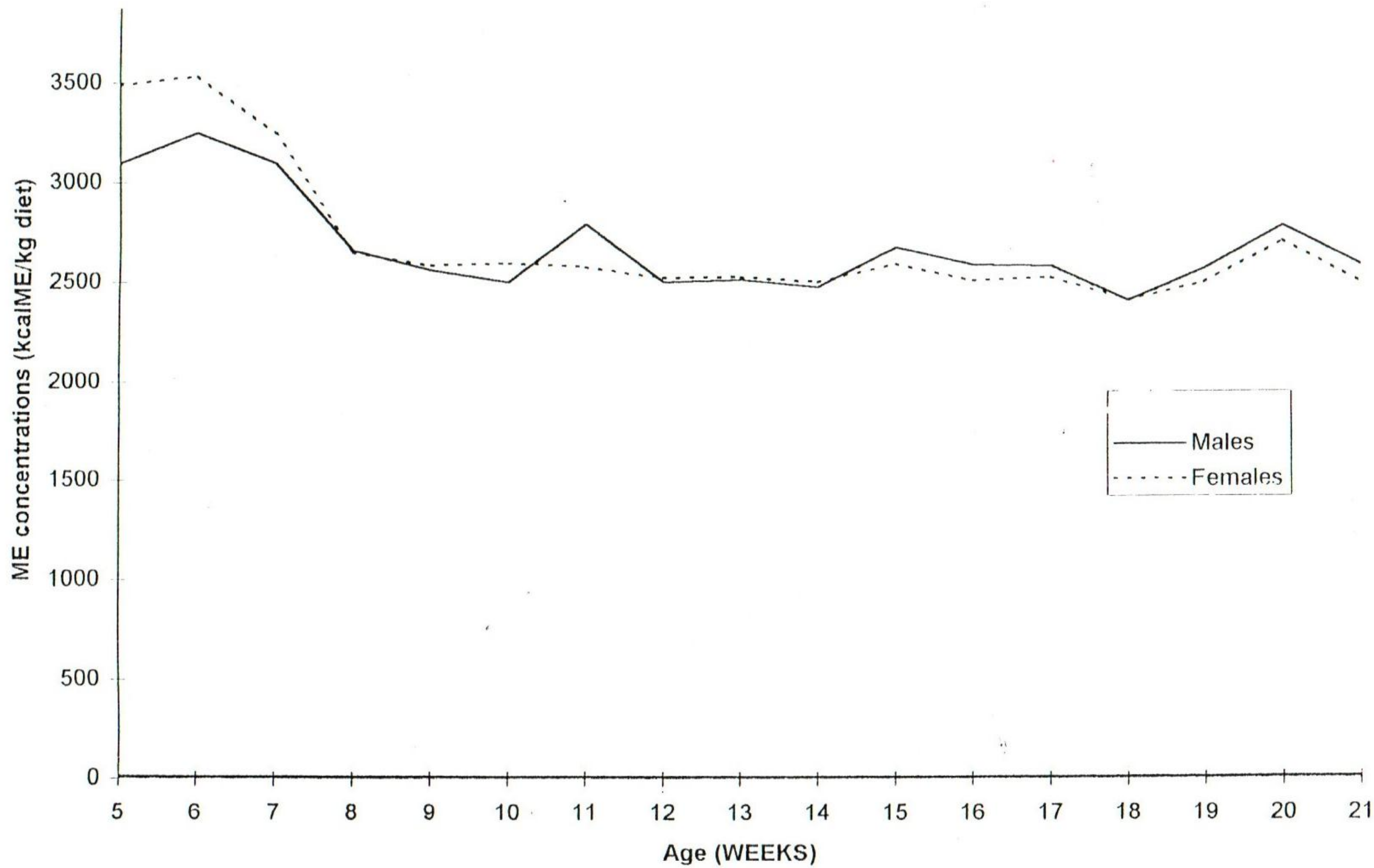


Fig. 4: DIETARY METABOLISABLE ENERGY CONCENTRATIONS INTAKE OF MALE AND FEMALE INDIGENOUS CHICKENS FROM 5-21 WEEKS OF AGE.



3.4 Discussion

The pullets from which eggs for this study were collected, were categorised according to body weights at 22 weeks, shortly before they started to lay. The ages at first egg ranged from 154 to 196 days with approximately 60 % of the pullets laying their first eggs between 162 and 168 days. The ages at first egg were within the range for indigenous chicken previously reported in other studies (Nwosu et al., 1985 ; Gunaratne et al., 1993 ; Dessie, 1996). The ages at first egg were also reported to range from 167 to 195 days for Ethiopian indigenous chickens (Dessie, 1996). The body weights of pullets and cocks averaged 1490 and 1710 grams, respectively at this age.

The mean weights of incubated eggs for the three weight categories were 44.8, 44.0 and 43.2 grams for heavy, medium and light, respectively. These values were lower than those reported by Kimani et al (1997) in a study on growth and laying performance of indigenous chicken of the same population. This difference may be attributed to the age of the birds from which eggs were collected since egg size increases with age. Eggs used in the study by Kimani et al (1997) were from much older hens (42 weeks old) than was the case (28 weeks old) in the present study. The hatchability of the incubated eggs was 40.6, 47.8 and 42.0% for heavy, medium and light weight categories, respectively. These hatchability values for the Kenyan indigenous chicken seem to be lower than expected. Dessie (1996) reported a value of 80.9 %, with a range of 44-100 % for Ethiopian indigenous chickens. The low hatchability values in the current study is most likely due to minor faults in the syringe used to artificially inseminate the hens which resulted in discarding a large number of infertile eggs at first candling on the 7th day of incubation.

In the current study, average weights for day old chicks were 31.6, 30.2 and 29.7 grams for heavy, medium and light categories of hens, respectively. This is a reflection of the size of the eggs incubated. Eggs used in the present study were rather small and as would be expected, produced lighter chicks as compared to those reported in the literature for Leghorns ((35.0 g), Creole (33.4 g), Creole x Rhode Island Red crosses (35.4 g) and indigenous chickens of Kenya (NRC,1984; Asiedu and Weever, 1993; Kimani et al.,1997). Similar chick weights have been reported for the Harco strain pullets (31.1 g), Kenyan (28.9 g) and Ethiopian indigenous chickens (29.0 g) (Essien, 1994; Ottaro, 1995; Dessie, 1996).

The birds showed similar trends of body growth with age as other chickens (NRC, 1984; Asiedu and Weever, 1993; Essien, 1994). The absolute body weight values at similar ages were however, lower than those reported by Essien (1994) for the Harco strain exotic pullets up to 21 weeks of age and those of the Shaver Starcross (Nwosu et al., 1984). These differences in the absolute body weights at corresponding ages are likely due to breed differences. For example, Leghorn type and Harco strain pullets at 20 weeks of age weigh approximately 1360 g (NRC,1984; Essien,1994), while indigenous chickens of Kenya and their crosses with Rhode Island Red ,at similar age weigh 1293 g (Kimani et al., 1997). At the same age, pullets in the present study, weighed 1062 g.

At the age of 147 days, pullets and cockerels in the present study averaged 1062 and 1496 grams, respectively. By extrapolation, pullets were expected to attain 1481 grams at the age of 182 days and cocks 1796 grams at the age of 203 days, as mature body weights. These mature body weights are similar to those of Sri Lankan indigenous chickens. Gunaratne et al. (1993) reported mean body weights of laying hens and mature cocks to be 1259±209 and 1778±310 g, respectively, for Sri Lanka indigenous chicken. The extrapolated values are also similar to those reported by Stotz (1983) and those earlier observed in this study during the preliminary trial (Section 2.5).
At 168 days of age unsexed indigenous chicken weigh an average of 1750 grams (Stotz,1983).

The body weight gains at the age of 112 days were 19.0, 13.0, and 13.0 grams for Heavy, Medium and Light birds, respectively. Ndegwa et al, (1991) obtained an average daily gains ranging from 12.8 to 14.2 g and 17.5 to 20.8 g using unsexed and sexed indigenous chickens at a similar age, respectively, which are similar to those obtained in the present study. The observed average daily gains for Harco strain pullets increased from 5 grams during the 5th week to 10.3 grams during the 20th week whereas Leghorn type pullets had highest average daily gain (12.9 g) on the 6th week and the lowest (4.6 g) on the 22nd week. The results by Essien (1994) and NRC (1984) depict that the pullets peak in their growth on the 20th and 6th week for the Harco strain and Leghorn type, respectively. These results suggest that Harco strain pullets and indigenous chickens peak almost at the same age but Leghorn type pullets peak at an earlier age. Indigenous chickens seem to peak in growth between the 18th and 19th week, at approximate weights of 1260 grams and 960 g for males and females, respectively.

Feed intake values from the 5th-21st weeks study period ranged from 29.4 g to 88.5 g and 24.2 to 66.7 g for male and female indigenous chickens, respectively. Average feed intakes for indigenous chicken and other improved breeds are given in Appendix 7.24.

These feed intake values observed in the current study are similar to those observed by Ndegwa et al (1991) in an earlier study, for the 5th to 16th week growth period using unsexed and sexed indigenous chickens. Similar results were also obtained by Asiedu and Weever, (1993) using Creole, Rhode Island Red and their crosses, and those by Ramlah (1996) using unsexed Malaysian indigenous fowl during a rearing period from day one up to 16 weeks.

The feed intakes were also similar to those of the Leghorn type pullets calculated for diets containing 2,900 Kcal/kg at similar ages (NRC, 1984) and those observed by Nwosu et al (1984) for local Nigerian chickens and Shaver Starcross (62.1 grams/bird/day). The feed intake values obtained by Essien (1994) using Harco strain pullets at similar ages are higher than those of the present study but lower than those obtained by Ndegwa et al (1992) using Essex brown egg layers. These differences in feed intakes may be due to breed differences

Feed conversion ratios (FCRs) in the current study for indigenous chickens ranged from 3.3 to 9.7. These values were observed among the heavy birds on the 6th and 8th weeks, respectively. These feed conversion ratios for indigenous chickens in the current study are poorer than those calculated for Leghorn type pullets and broilers (NRC, 1984), but similar to those obtained in another study of indigenous chickens in Kenya (Ndegwa et al.,1991). The calculated values for Leghorn type pullets ranged from 2.9 to 9.2 during 5th and 9th week, respectively. Ndegwa et al (1991) obtained average values of 3.7 and 4.3 for birds on 20% CP and 19% CP levels, respectively. In the same study, the feed conversion ratio at the age of 16 weeks averaged 4.9 (23.0% CP) and 5.7 (19.5% CP) for pullets and cocks, respectively. Ramlah (1996), in a study on unsexed Malaysian village based fowl obtained feed conversion ratios ranging from 4.3 to 5.7 for the growth period between 1st and 16th week. These feed conversion data are consistent with those obtained in the present study. The feed conversion ratios were also similar to those reported for local chickens of Nigeria and Harco Strain Pullets (Nwosu et al., 1984 ; Essien, 1994) but lower than those of Creole, Rhode Island Red and Creole x Rhode Island Red (Asiedu and Weever, 1993).

Again, differences with the Creole, Rhode Island Red and Creole x Rhode Island Red data may be attributed to breed differences. The similarity of feed conversion data among Kenyan, Malaysian and Nigerian indigenous chickens seem to suggest that indigenous chickens from the various countries may be similar genotypes.

The main objective of this study was to estimate energy and protein requirements for growing indigenous chickens. It is an established fact that the protein intake, expressed as a percentage of the diet, decreases with the age of chickens (NRC,1984). A similar trend was observed in the current study for growing indigenous chicken. Significant differences were observed between the weight categories with regard to crude protein (CP) intake. Heavy birds consumed significantly ($P<0.05$) more crude protein than the medium and light ones. CP intakes for medium and light birds were not significantly different ($P>0.05$). Levels of crude protein intake averaged 20, 16 and 14 % for the 5th-8th, 8th-14th and 14th-21st week periods, for the heavy birds. On the other hand, CP intakes for the medium and light weight categories averaged 17, 14 and 12 % during the corresponding growth periods. According to these results indigenous chickens may be conveniently categorised into two weight classes, 'heavy' (1.66-2.14 kg) and 'light' (1-1.65 kg) for the purpose of ration formulation. According to NRC (1984) recommendations, broiler CP requirements are 23.0, 20.0 and 18.0 % during the 0-3rd ,3rd-6th and 6th-8th week periods, respectively. According to the current study, CP requirements for indigenous chickens are approximately 16.0 % during the 6th-8th week growth period. At similar ages, CP requirements for indigenous chickens are lower than those of broilers. On the other hand, the CP requirements for Leghorn-type pullets are 18.0, 15.0 and 12.0 % during the 0-6, 6-14 and 14-20 growth phases, respectively. On average, indigenous chickens require approximately 18.5, 15 and 13 % CP in their rations, during 5-8, 8-14 and 14-21 growth phases respectively. Results obtained in the current study are similar to the CP requirements recommended for Leghorn-type chickens at corresponding ages. However, CP requirements for indigenous chickens were not estimated during the 0-4 growth phase. Nevertheless, the observations from the current study suggest that indigenous chicken are nutritionally closer to layers than exotic commercial broilers.

The absolute energy intake in chicken increases with age whereas the energy concentration in the diets decreases (NRC,1984). A similar trend was observed in this study with growing indigenous chicken (Figures 3 and 4; Appendices 7.22 and 7.23). Significant differences were observed in apparent metabolisable energy intake between the sexes. These differences which are normally observed in related poultry stock and animals of other species, were expected. The differences in energy intake, are due to the observed differences in feed intake. There were no significant differences in ME content of the diets with regard to the sexes and weight categories.

Dietary energy intake expressed in kcal/kg averaged approximately 3000, 2600 and 2400 ME for the 5th-8th, 8th-14th and 14th-21st week growth periods. These results suggest that a single energy level, as in the case of layer pullets, is inappropriate for growing indigenous chickens. For indigenous chickens one would require approximately 3000, 2600 and 2400 kcal/kg ME in rations for both 'heavy' and 'light' chickens during the three growth phases, respectively. NRC (1984) recommends 2,900 Kcal/Kg ME for the Leghorn-type chickens from day old up to the laying phase and during breeding. On the other hand, it recommends 3,200 kcal/kg ME for broilers from 0-8 weeks of age. The results obtained in the present study are generally lower than those recommended for broilers but, again, closer to those of layers.

These results suggest that between the ages of 5-8 weeks, a CP level of 20 % and approximately 3000 kcal/kg ME, should adequately cover the protein and energy requirements of 'heavy' indigenous chickens , whereas 'light' indigenous chickens would require a CP level of 17% but the same density of ME during the same growth period. From 8-14 week period, 'heavy' and 'light' indigenous chickens require diets containing 16 % and 14 % crude protein, respectively, and approximately 2600kcal/kg ME. Thereafter, the CP-levels in the ration for the 'heavy' and 'light' birds may be decreased to 14 and 12 %, respectively, with an energy density of approximately 2400 kcal/kg ME for both diets. These findings may be used in formulating complete rations for indigenous chickens where necessary.

4. DETERMINATION OF METABOLISABLE ENERGY OF MAIZE, SOYABEAN AND MASH USING INDIGENOUS CHICKENS.

4.1. Introduction

The apparent metabolisable energy (AME) of a number of poultry feed stuffs have been determined using chicks, roosters and laying hens of various poultry species. Variation in AME values associated with type of assay bird is usually small, however, it is a cause of concern because AME values obtained from the assays are used in the formulation of diets for poultry. Sibbald (1975) suggested that some of the variation in AME values associated with species, strain and age may be attributed to differences in metabolic faecal and endogenous energy losses.

The AME values for maize and soyabean meals have been established by several authors using different species of poultry. The AME values reported ranged from 3263 to 3831 with a mean of 3547 Kcal/Kg dry matter and 2241 to 2773 with a mean of 2507 Kcal/Kg for maize and soyabean meals, respectively (Sibbald,1976;Shires et.al.,1979 and Chami et.al.,1980).

The experiment described in this section was conducted to determine AME values of maize and soyabean meals using indigenous chicken by the conventional total-collection method of Terpstra and Janssen (1976). The study was carried out to provide information on energy density of the diets, which were used to estimate AMEn intake in the Cafeteria feeding trial. The currently used true metabolisable energy of the diets could not be determined due to unavailability of appropriate facilities. A digestibility trial was carried out for a period of 10 days from to determine the AMEn content of maize and soya bean meals using indigenous chickens.

The digestibility trial was carried out at the Poultry Research Unit of the NAHRC, KARI, Naivasha. The gross energy of the diets and droppings were determined at the NAHRC's laboratories in accordance with standard procedures as outlined in AOAC (1990)

4.2. MATERIALS AND METHODS

Birds and management :

Thirty six, 21 week old indigenous chickens were housed in metallic cages measuring 96 cm long, 80 cm wide and 68 cm high, in a windowless room lit for 24 hours daily. Each cage was fitted with a feeder with a capacity of 10 kg of feed. The unit was equipped with automatic waterers. A metallic tray covered with a plastic sheet was placed under each cage to collect excreta. Prior to the start of the experiment the birds were starved for 8 hours to empty their digestive tracts.

Diets

The basic choice diets, maize and soyabean meals, were obtained from commercial feed factories. Each of them was fortified with premixes (minerals and vitamins) at the level of 1.8 % (Experiment 1).

Experimental Protocol

The unit was cleaned and disinfected one week before the birds were allocated to the cages The two diets were randomly distributed to a total of 8 digestibility cages. A total of 24 cocks were randomly allocated into these cages . Each cage had three cocks.

Apparent metabolisable energy (AME) value of the formulated diets were estimated using the conventional total collection method as described by Terpstra and Janssen (1976). This method consists of fasting the birds for 8 hours before the start of collection period, collection of droppings for 3 days, and fasting of the birds for 8 hours before the end of the collection period.

The birds were offered a mash diet (60:40 /maize: soyabean) during the adaptation period of 4 days. They were offered respective experimental diets for 2 days and thereafter starved for 8 hours. Quantities of feed offered and remaining were weighed and the balance determined at the end of the experiment. Feed and water were provided *ad libitum.* The birds were weighed individually at the beginning and end of the experiment. Clean, dry collection trays covered with clean polythene sheets, were placed under the birds and collection of the droppings started after exactly 24 hours. Two types of droppings were collected (clean and dirty) giving a total of 24 samples. Dirty droppings refers to excreta that is contaminated with feed and feathers, while clean excreta is uncontaminated. These droppings were collected into sealed plastic containers once a day and frozen immediately.

The collection was over a period of three days. The frozen droppings were thawed and thoroughly mixed. Aliquot samples were then taken dried and analysed.

The dry matter of the droppings from each cage was determined from the clean and dirty freeze dried samples so as to calculate the total amount of dry matter excreted. Gross energy of the clean droppings and feed samples was determined.

Data Collection and Calculation :

The variables measured were; feed intake and excreta weight. Feed intake was determined as the difference between feed offered and the feed balance per cage, over a period of 4 days. Excreta weight was taken at the end of the experiment per cage. Total excreta weight was obtained by adding the weights of the clean and dirty dropping . Total dry matter was estimated in the same way as excreta weight.

The AMEn values of the experimental diets were calculated according to the following formula by Terpstra and Janssen (1976):

$$AMEn = C - dW - 8.73\,(N - dT)$$

Where;

C = the gross energy value of 1 kg DM feed in kcal,

W = the gross energy value of 1 kg DM excreta in kcal,

d = the number of kg of DM excreta produced per kg DM feed,

N = gram Nitrogen in 1 kg DM feed,

T = gram Nitrogen in 1 kg DM excreta,

8.73 = kcal per gram N retention to corrected to Nitrogen equilibrium.

4.3 RESULTS AND DISCUSSION

The apparent metabolisable energy, corrected for nitrogen retention of the 2 diets were 2692 and 2786 Kcal/Kg ME for maize and soyabean, respectively. The results are summarized in Table 4.1.

Table 4.1: Apparent metabolisable energy (AMEn) values of maize, soyabean.

Diet	N	AMEn[1] Kcal./Kg.
Maize	4	2692±339
Soyabean	4	2786±331

[1]Data expressed on dry matter basis with standard deviations of the means

N = Number of observations (Replicates)

The AMEn values of the diets under consideration were lower for maize and higher for soyabean meals compared to those reported by other investigators (Sibbald, 1976; Chami et al.,1980; NRC,1984; WPSA.,1989). Sibbald (1976) obtained 3263 and 2241 Kcal./Kg ME for maize and soyabean meals, respectively. Chami et al.(1980) found AMEn values of maize and soyabean meals to be 3644 and 2444 Kcal./Kg ME, respectively, for a 24 hours collection period. The AMEn values of maize and soyabean meals were 2692 and 2786 Kcal./Kg ME, respectively, for 24 hours collection period in the present study. The differences in the AMEn values of maize and soyabean meals than those reported by other workers may be attributed to breed of chicken used, method of processing of the meals and probably method of determination. Similar AMEn values have been reported for solvent extracted soyabean products but lower for the maize flour (WPSA, 1989).

5. CONCLUSIONS AND RECOMMENDATIONS

1. The performance of Kenyan indigenous chickens is similar to those of other related chickens (Harco strains, Leghorns, Creole , Rhode Island red and, Malaysian, Sri Lankan and Ethiopian indigenous chickens) reported in the literature.
2. Indigenous chickens tend to peak in growth between the 18th and 19th weeks.
3. There are no sex differences with regard to energy and protein requirements of growing indigenous chickens.
4. Indigenous chickens are nutritionally closer to exotic commercial layers than broilers.
5. Indigenous chickens exhibit three distinct growth phases: 5-8, 8-14 and 14-21 week periods, during the initial 21 weeks of age.
6. For the purpose of ration formulation, it appears appropriate to categorise indigenous chickens into two weight categories: 'Heavy' (1.66-2.14 kg) and 'Light' (1-1.65 kg) birds.
7. The protein requirements for growing indigenous chickens are 20, 16 and 14 % CP, and 17, 14 and 12 % CP for the 'Heavy' and 'Light' birds , respectively, during the 5-8, 8-14 and 14-21 week growth periods.
8. Energy requirements during the 5-8, 8-14 and 14-21 week growth phases is approximately 3000, 2600 and 2400 Kcal/Kg ME,respectively.

Further Research:

1. There is need to determine energy and protein requirements of indigenous chickens during the brooding and laying periods.
2. There is also need to verify the energy and protein requirements of indigenous chickens, from the current study using the empirical methods.
3. On-farm research should be carried out to establish the response to energy and protein supplementation.

6. REFERENCES

Abegbola, A. A. 1989. Indigenising the poultry industry in Africa. In : Rural Poultry in Africa. Proceedings of an international workshop, Thessaloniki, Greece. 1989. pp. 19-23.

Aini, I. 1990. Indigenous chicken production in south-east Asia . World Poult. Sci. 46: 52 - 57.

Alum Yam, 1995. Poultry production in Ethiopia. World's poult. Sci. J. 51 : 197 - 201.

AOAC, 1995. Official Method of Analysis (16th ed.) Association of Official Analytical Chemists, Washington DC, USA.

Asiedu, F.H.K., and W. Weaver, 1993. Growth rate and egg production of Creole and Rhode Island Red and their crosses. Trop. Anim. Hlth. Prod., 25: 111-117.

Blum, J. C., J. Guillaum and B. Leclercq, 1975. Studies of energy and protein requirements of growing guinea fowls. Br. Poult. Sci., 16: 157 - 168.

Chami, D.B., P. Vohra and F.H. Kratzer,1980. Evaluation of a method for determination of true metabolisable energy of feed ingredients . Poultry Sci., 59:569-571.

Church.D.C., and W. G.Pond, 1982. Basic animal nutrition and feeding, 3rd edition. John Wiley & sons. New York.

Classen, H. L.,and T.A. Scott, 1982. Self selection of calcium during the rearing and early laying periods of White Leghorn pullets. Poultry Sci. 61:2065 -2074.

Covasa, M., and T.A. Forbes, 1994. The effect of social interaction on selection of feeds by broiler chickens. Br. Poult. Sci., 35 : 817.

Cowan, P. J. and W. Michie, 1978a. Environmental temperature and broiler performance: the use of diets containing increasing amounts of protein. Br. Poult. Sci. 19: 601-605

Cowan, P. J.,W. Michie and D. J., Roele, 1978. Choice feeding of the egg-type pullets. Br. Poult. Sci., 19:153 - 157.

Cowan, P. J., and W. Michie, 1978. The use of barley in choice feeding of turkey. Br. Poult. Sci., 19: 1-6.

Dessie, T., 1996. Studies on village poultry production systems in the central highlands of Ethiopia. MSc. thesis presented to the Swedish university of Agricultural sciences. Upsala

Diambra, O.H., 1990. State of small holder Rural poultry production in Cote d' Ivoire. Paper presented at CTA international seminar, Thessaloniki, Greece, Oct., pp 9-13.

Emmans, G. C., 1977. The nutrient intake of laying hens given a choice of diets in relation to protein requirement. Br. Poult. Sci., 18: 227 - 236.

Essien, A. I.,1994. The pattern of growth of exotic pullets raised in a tropical wet climate. The need for a renewed field programme. E. Afr. Agric. For. J., 54: 11-18.

FAO. 1986. FAO production year book, Volume 39. Food and Agriculture Organisation of the United Nations, Rome. Italy.

Forbes, J. M., and F. Shariatmadari, 1994. Diet selection for protein by poultry. World's Poult. Sci. J. 50: 7-24.

Forbes, J. M., and M. Covaza, 1995. Application of diet selection by Poultry with particular reference to whole cereals. World's Poult. Sci. J. 51: 149-161

Gichohi, C.M., G.K. Kiugu, B.M. Mitaru, G. Oduho, R.G. Karenge, S.J. Munyua, P.N. Mbugua, M.O. Owango and R.G. Wahome, 1988. Poultry industry in relation to oil seed cake utilization in Kenya. Vegetable oil/ Protein system project, working paper No. 7a. Egerton University. Kenya.

Gichohi, C. M. and J.G. Maina, 1992. Poultry production and marketing, Ministry of Livestock Production. Paper presented in the Nairobi - Kenya, November, 23 - 27. 1992

(GOK),Government of Kenya, 1986. Sessional paper No. 1. Economic management and renewed growth. Ministry of Planning and National Development.

GOK , 1994. Economic review. Ministry of Planning and National Development.

Gunaratne, S. P., A. D. N. Chandrasiri, W. A. P. Mengalika Hamalatha and J. A. Roberts, 1993. Feed resource base for scavenging village chickens in Sri Linka. Trop. Anim. Hlth. Prod. 25 : 249 - 257.

Holcombe, D. J., Rolland, D.A. and Harms, R. H. 1976. The ability of hens to regulate protein intake when offered a choice of diets containing different levels of protein. Poult. Sci., 55: 1731-1737.

Hughes, B. O., 1984. The principle underlying choice feeding behaviour in fowls with special reference to production experiments. World's Poult. sci.,40: 141 - 150

Hurwitz, S., and S. Bornstein, 1973. The protein and amino acid requirements of laying hens; suggested models for calculation. Poult. Sci. 52: 1124-1134.

Hurwitz, S., and S. Bornstein, 1977. The protein and amino acid requirements of laying hens: experimental evaluation of models of calculation. 1. Application of two models under variable conditions. Poult. Sci. 56: 969 - 978.

Hurwitz, S., D. Sklan and I. Bartov, 1977. New formal approaches to the determinations of energy and amino acid requirements. Poult. Sci. 57: 197-205.

Ibe, S. N., 1990. Increasing rural poultry by improving the genetic endowment of rural poultry. Proceedings of international Workshop.Greece, 1989. pp. 78 - 81.

Ivan, L. L. 1959. Procedures for determination of nutrient requirements of livestock. In: Techniques and procedures in Animal Production Research pp. 180 - 183.

Janssen, J. F.1994. Choice feeding in practice. Proceedings of the 9th European Poultry Conference, vol. 2, WPSA, pp. 223 - 226.

Kari Rao, R. , D. L. Hyman, E.J. Thornton and R. Norman. 1978. Protein requirements of Guinea keets. Poult. Sci. 57: 186-189

Karunajeewa, H. 1978. The performance of cross - bred hens given free choice feeding of whole grains and concentrate mixture and the influence of Xanthophylls on yolk colour. Br. Poult. Sci. 19: 699 - 788.

Karunajeewa, H. and Bagot, I. 1978. The effect of spectacles, a whole grain diet and dietary level citranaxanthin on yolk colour, resting behaviour and laying performance of cross -bred hens. Australian J. of Exp. Agric. Anim. Husb, 18: 223 - 230

Katule, A. M., 1990. Small holder rural poultry production in Tanzania. In: small-holder rural poultry production requirement of research and development. Proceedings of international workshop. Thessaloniki, Greece. Pp 69-70

Keshavarz,k., 1984. The effect of different dietary protein levels in the rearing and laying periods on the performance of white leghorn chickens. Poult. Sci. 63: 2229-2240.

Kimani, C.W., J. M. Ndegwa, and J. K. Tuitoek, 1997. Growth and laying performance of indigenous chicken from three districts and their crosses with Rhode island red (manuscript under preparation).

Leeson, S. and J. D. Summers, 1978. Voluntary feed restriction by laying hens mediated through dietary self - selection. Br. Poult. Sci. 19:417 - 424.

Leeson, S. and J.D. Summers, 1982. Use of single stage low protein diet for growing leghorn pullets. Poultry Sci., 61: 1684 - 1691.

Mastika, M and R. Cumming, **1987.** Effect of previous experience and environmental variations on the performance and pattern of feed intake of choice fed and complete fed broilers. In Recent Advances in Animal Nutrition in Australia (Ed. Farell, D. J.), University of New England, Airmidale, pp 260 - 282.

Mbugua, P. N., 1990. Rural small holder poultry production in Kenya. In proceedings of a seminar on small holder production, 9th - 10th October, 1990. pp 113 - 115. Thessaloniki, Greece.

Mburu, B. M., 1994. The role of research in poultry development. Paper presented at National Poultry Development Programme. Annual seminar, held in Machakos, Kenya, 4 - 7th July.

MOALD&M, 1989 . Animal Production division. Kenya. Indigenous chicken production manual pp. 49 - 54.

MOALD&M, 1993. Animal Production, poultry section, Annual report, pp. 1 - 63. Kenya.

MOALD&M, 1994. Animal Production division. Annual report, pp 22-29, Kenya.

NRC (National Research Council), 1984. Nutrient requirements of domestic animals 1. Nutrient requirements of Poultry, National Academy of Sciences. Washington D.C.

Ndegwa, J. M. 1989. Preliminary evaluation of indigenous chicken of Kenya (Unpublished).

Ndegwa, J.M., M.M.W.A. Janssen and M.O. Owango, 1991. The perfomance of indigenous chicken fed diets containing different protein during rearing. (Unpublished.)

Ndegwa, J.M., M.M.W.A. Janssen, C.W. Kimani and M.K. Maiyo, 1992. Effect of varying energy levels on the performance of layers. (Unpublished.).

Ndirangu, J . K., 1991. The performance of indigenous chicken and their crosses. (Unpublished.)

Ndirangu, J. K., C. W. Kimani, C. M. Nyachoti , P. N. Mbugua and Janssen (1991). Characterisation of Kenyan indigenous chicken on the basis of morphological characteristics and egg features (unpublished).

Norton, H. L., 1994. Speech delivered at Inaugural Luncheon of the Agri-business Association of Kenya at the Panafric Hotel in April 1994. Reported verbatim in Dairy Nation of Friday 6th May, 1994.

Nwosu,C.C., F.C. Obioha, S.S.Omeje, F.Cowan, C.T.Bellonwu and G.I. Onuora, 1984. Growth performance of local and starcross chickens under deep litter system of management. World Review of Anim. Prod. 2 : 17 - 26.

Nwosu, C. C., F.A .Gowen, F.C, Abioha, I.A. Akpan and Onuora G. I., 1985. A biometrical study of the conformation of native chicken. Nigerian Journal of Animal Production.12 : 141 - 146.

Okitoi, L.O.,1997. Effects of disease control, daytime housing of chicks and supplementation on the productivity of indigenous chicks in Kakamega Regional Research Centre mandate. In proceedings of first NDCPRP planning and review workshop held in Naivasha. March 3-4.

Ottaro, J.M, 1997. Rural oil/ protein production project and processing sub-project, Kenya. Animal nutrition component. paper submitted to Food and Agricultural Organisation of United Nations.(FAO), December, 1995.(Unpublished)

Ouandaogo, Z.C., 1990. Programme de development des Animax villageous. Paper prepared for CTA international seminar, Thessaloniki, Greece, Oct. 9-13.

Potter, L. M., and J. R. Shelton, 1979. Methionine and protein requirements of young turkeys. Poultry Sci. 58: 609-615.

Qureshi, A. A., 1994. Consumption of Poultry in Africa continues to drop. Misset World Poultry 10: 30 - 33. Misset International. The Netherlands.

Ramiah, A. H. , 1996. Performance of village fowl in Malasia. World's Poultry Sci. J. pp 52: 77 - 79.

Rose, S.P., A. Burnett and R.A. Elmajeed, 1986. Factors affecting diet selection of choice fed broilers. Br. Poult. Sci., 27:

Robinson, D., 1985. Performance of laying hens as affected by split time and split time composition dietary regimes using ground and unground cereals. Br. Poultry Sci., 26: 299 - 399.

SAS Institute, Inc., 1988. SAS/ STAT Users Guide, Release 6.03 Edition. Cary NC; SAS Institute Inc. 1028 pp.

Sibbald, I.R., 1976. A bioassay for true metabolisable energy in feedstuffs. Poultry Sci., 55: 303-308.

Shires, A., A.R. Robblee, R,T. Hardin and D.R. Clandinin,1979. Effect of previous diet, body weight, and duration of the assay bird on the true metabolisable energy value of corn. Poultry Sci., 58: 602-608.

Sonaiya, E.B., 1990. State of small holder rural poultry production in Africa. Paper prepared for CTA international seminar, Thessaloniki, Greece. Oct. 9-13.

Steel, R. D. G and J. H. Torrie, 1980. Principles and procedures of statistics. Mc Graw-Hill Book Company, Inc, New York.

Stotz, D., 1983. Production techniques and economics of small holders livestock production systems in Kenya. IN: Farm management handbook of Kenya, Vol. 4 pp. 95 - 106.

Summers, J. P. and S. Leeson, 1978. Dietary selection of protein and energy by pullets and broilers. Br. Poult. Sci; 19: 425 - 430.

Terpstra, K. and W.M.M.A. Janssen, 1976. Methods for determination of metabolisable energy and digestibility coefficients of poultry feeds. Report number 101.75. 'Het Spelderholt center for poultry research and information servises. The Netherlands.

Woodard, A. E., P. Vohra and R. L. Synder, 1977. Effect of protein levels in diets on growth of pheasants. Poultry Sci; 56: 1492 -1500.

World Poultry Science Association (WPSA) 1989. European table of energy values for poultry feed stuffs. Subcomittee of working group No. 2 nutrition of European Federation of the Branches of the World's Poultry Sci. Association. Beekbergen, 3rd edn., pp. 16 - 22.

Yamane T., K. Omo and T. Tanaka ,1980. Energy requirements of laying Japanese quail. Br. Poult. Sci; 21 : 451-455.

7. APPENDICES

Table 7.1: EXOTIC CHICKEN POPULATION (' 000')

Year	Layers	Broilers	Total	% Change
1983	1562	2004	3566	
1984	1605	2194	3799	6.5
1985	848	2349	3197	-15.8
1986	724	2513	3237	1.3
1987	774	2689	3463	7.0
1988	1528	2976	4504	30.1
1989	1917	3500	5417	20.3
1990	1805	5776	7581	40.0
1991	1669	5300	6969	-8.1
1992	1684	5400	7084	1.1
1993	1804	744	2608	-63.2
1994	2,609	2,526	5,135	96.8

* Source: MOALD & M, 1994

Table 7.2: INDIGENOUS CHICKENS POPULATION (' 000')

Year	Population ('000')	% Change
1987	14,471	
1988	15,194	4.9
1989	15,954	5.0
1990	17,674	10.8
1991	17,546	-0.7
1992	18,786	7.1
1993	18,415	-2.0
1994	17,488	5.0

Source: MOALD & M, 1994

Table 7.3: PRICES OF DAY OLD CHICKS (DOC)

MONTH	YEAR	LAYER (DOC)	BROILER (DOC)	COCKEREL
JANUARY	1993	38.00	25.00	5.00
DECEMBER	1993	55.00	35.00	7.00
DECEMBER	1995	59.00	39.00	8.00
JANUARY	1996	59.00	39.00	8.00
DECEMBER	1996	60	40	8.00
JULY	1997	63	57	10

Source:Kenbrid Ltd; MoALD&M 1994

Table 7.4: SOCIO-ECONOMIC IMPORTANCE OF INDIGENOUS CHICKENS IN 5 SELECTED AFRICAN COUNTRIES.

	POULTRY POPULATION		ANNUAL PRODUCTION				
COUNTRY	Total*	Indigenous Chicken	Meat ('000T)	Value US $	Egg ('000T)	Value US $	Total Value US $
Kenya	18	16	3.4	15.3	1.6	3.9	18.9
Tanzania	20	15	3.75	16.9	14.0	34.0	50.9
Ivory Cost	15	13	10	45.0	62.3	151.0	156.0
Sudan	30	24	8	36.0	28	68.1	104.1
Ethiopia[1]	56.5	55.9	72.3	325.4	78.0	188.8	514.2

Source:Sonaiya, 1990

* Total poultry population in millions

[1] Source: Dessie, 1996.

Table 7.5: ESTIMATE EGG PRODUCTION AND VALUES FOR KENYA

Breed	Total bird population (000)	No. of eggs produced (000)	Estimated value (K £000)
Layers	1864.4	372,88	74561.6
Indigenous chicken	18414.55	473,517	7127.55
TOTAL	20,278.95	846,325	145587.15

Source:MOALD & M, 1994.

Table 7.6: ESTIMATED MEAT PRODUCTION AND VALUE.

Bread	No. Slaughtered (000)	Total meat (MT)	Value (K £ 000)
Indigenous chickens	7,366	9575.8	36830
Broilers	744	892.8	4464
Culled Layers	559	838.5	2795
Total	8669	11307.10	44089

Source:MoALD & M , 1994

Table 7.7: ENERGY AND PROTEIN REQUIREMENTS OF POULTRY

	Age (wks)	CP(%)	ME (Kcal/kg)	Author / Source
Broilers	0-3 3-6 6-8	23 20 18	3,200 3,200 3,200	NRC (1984)
Layers	0 - 6 6 -14 14 -20 Layers	18 15 12 14.5	2,900 2,900 2,900 2,900	NRC (1984)
Turkeys	0 - 4 4 - 8 8 - 12 12 -16 16 - 20 20 - 24	28 26 22 19 16.5 14	2,800 2,900 3,000 3,100 3,200 3,300	NRC (1984)
Pheasants	0 - 8	24	2,600	Woodard et al (1976)
Guinea Fowls	0 - 8	24	-	Rao Kari et al (1978)

Table 7.8 : GAIN : FEED RATIOS OF HEAVY, MEDIUM AND LIGHT INDIGENOUS CHICKENS FROM 5 - 21 WEEKS OF AGE

WEEKS	N	HEAVY	MEDIUM	LIGHT
5	12	0.20	0.21	0.26
6	12	0.31	0.27	0.27
7	12	0.19	0.20	0.22
8	12	0.10	0.15	0.25
9	12	0.21	0.22	0.22
10	12	0.14	0.19	0.21
11	12	0.18	0.20	0.24
12	12	0.19	0.24	0.21
13	12	0.20	0.17	0.18
14	12	0.18	0.21	0.17
15	12	0.15	0.17	0.18
16	12	0.25	0.18	0.17
17	22	0.19	0.22	0.24
18	12	0.18	0.19	0.24
19	12	0.22	0.23	0.23
20	12	0.19	0.17	0.18
21	12	0.16	0.14	0.13

Table 7.9 : GAIN: FEED RATIOS OF MALE AND FEMALE INDIGENOUS CHICKENS FROM 5 - 21 WEEKS OF AGE

WEEKS	N	MALES	FEMALES
5	12	0.23	0.24
6	12	0.28	0.28
7	12	0.19	0.21
8	12	0.22	0.23
9	12	0.22	0.22
10	12	0.18	0.20
11	12	0.20	0.24
12	12	0.21	0.21
13	12	0.18	0.18
14	12	0.18	0.19
15	12	0.16	0.17
16	12	0.18	0.19
17	22	0.19	0.24
18	12	0.9	0.20
19	12	0.21	0.25
20	12	0.16	0.21
21	12	0.13	0.16

Table 7.10 : CRUDE PROTEIN INTAKE (g) OF HEAVY, MEDIUM AND LIGHT INDIGENOUS CHICKENS FROM 5 - 21 WEEKS OF AGE

WEEKS	N	HEAVY	MEDIUM	LIGHT
5	12	6.1	4.7	3.8
6	12	5.7	4.3	4.6
7	12	5.5	5.1	4.4
8	12	5.3	5.0	4.0
9	12	6.9	6.3	6.1
10	12	7.7	5.8	6.5
11	12	7.4	6.5	5.7
12	12	8.9	6.4	7.5
13	12	9.4	6.7	8.5
14	12	9.3	7.4	6.9
15	12	9.4	8.6	7.1
16	12	10.0	7.3	8.5
17	12	11.4	9.1	8.3
18	12	12.2	10.2	8.6
19	12	14.2	10.7	8.6
20	12	9.7	11.6	10.6
21	12	12.2	12.0	11.8

Table 7.11 : CRUDE PROTEIN INTAKE OF MALES AND FEMALES INDIGENOUS CHICKENS FROM 5 - 21 WEEKS OF AGE

WEEKS	N	MALES (gm/b/day)	FEMALES (gm/b/day)
5	12	5.5	4.1
6	12	5.2	4.3
7	12	5.7	4.5
8	12	5.8	5.8
9	12	6.9	6.2
10	12	7.3	6.2
11	12	7.3	5.9
12	12	8.3	6.8
13	12	9.1	7.1
14	12	9.2	6.9
15	12	8.2	7.2
16	12	9.9	7.2
17	12	11.1	8.4
18	12	11.6	8.9
19	12	12.5	9.7
20	12	13.0	8.3
21	12	14.5	10.0

Fig. 7.1 Body weights of heavy, medium and light indigenous chickens from 5 - 21 weeks of age

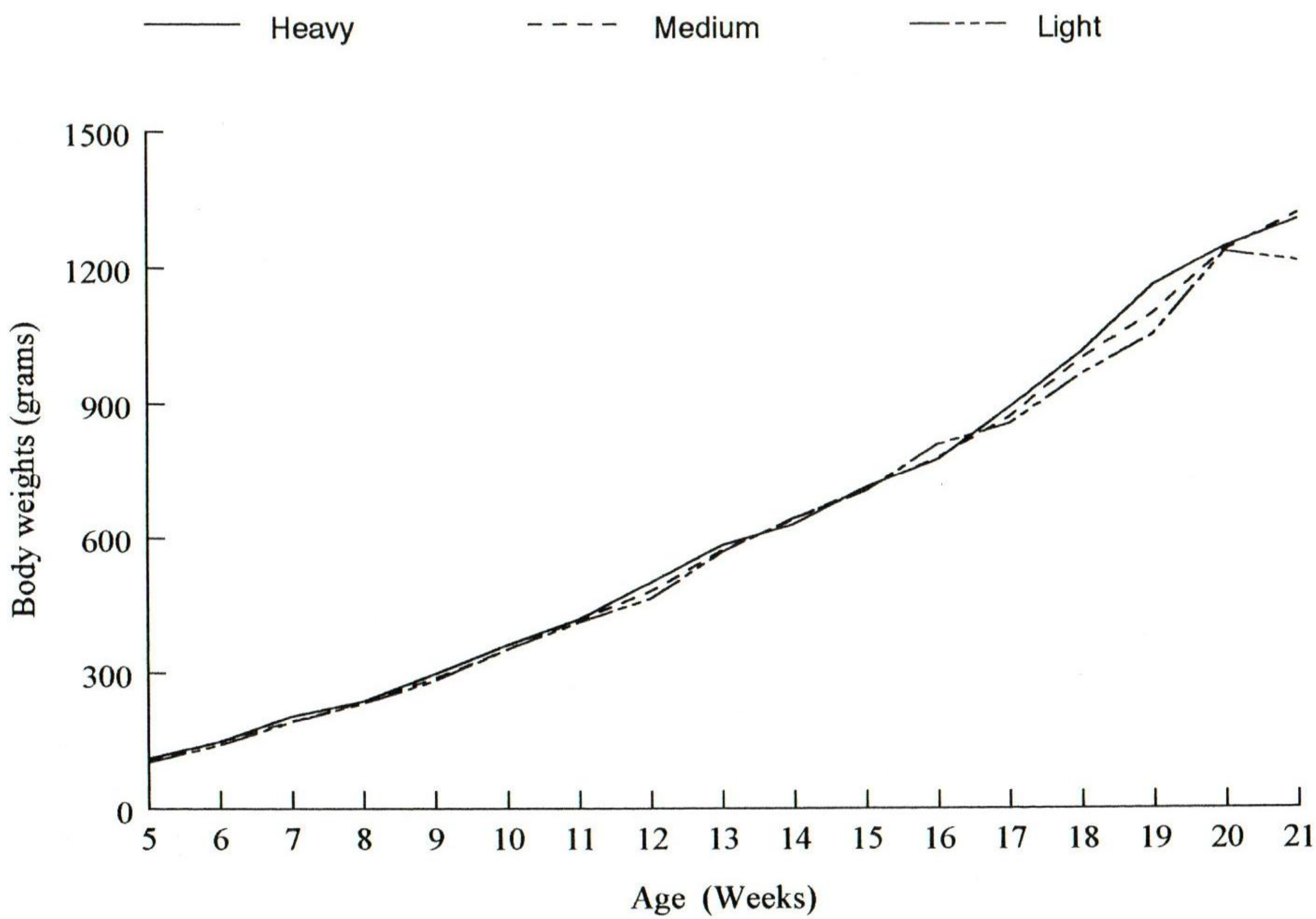


Fig. 7.2 Body weights of male and female indigenous chickens from 5 - 21 weeks of age

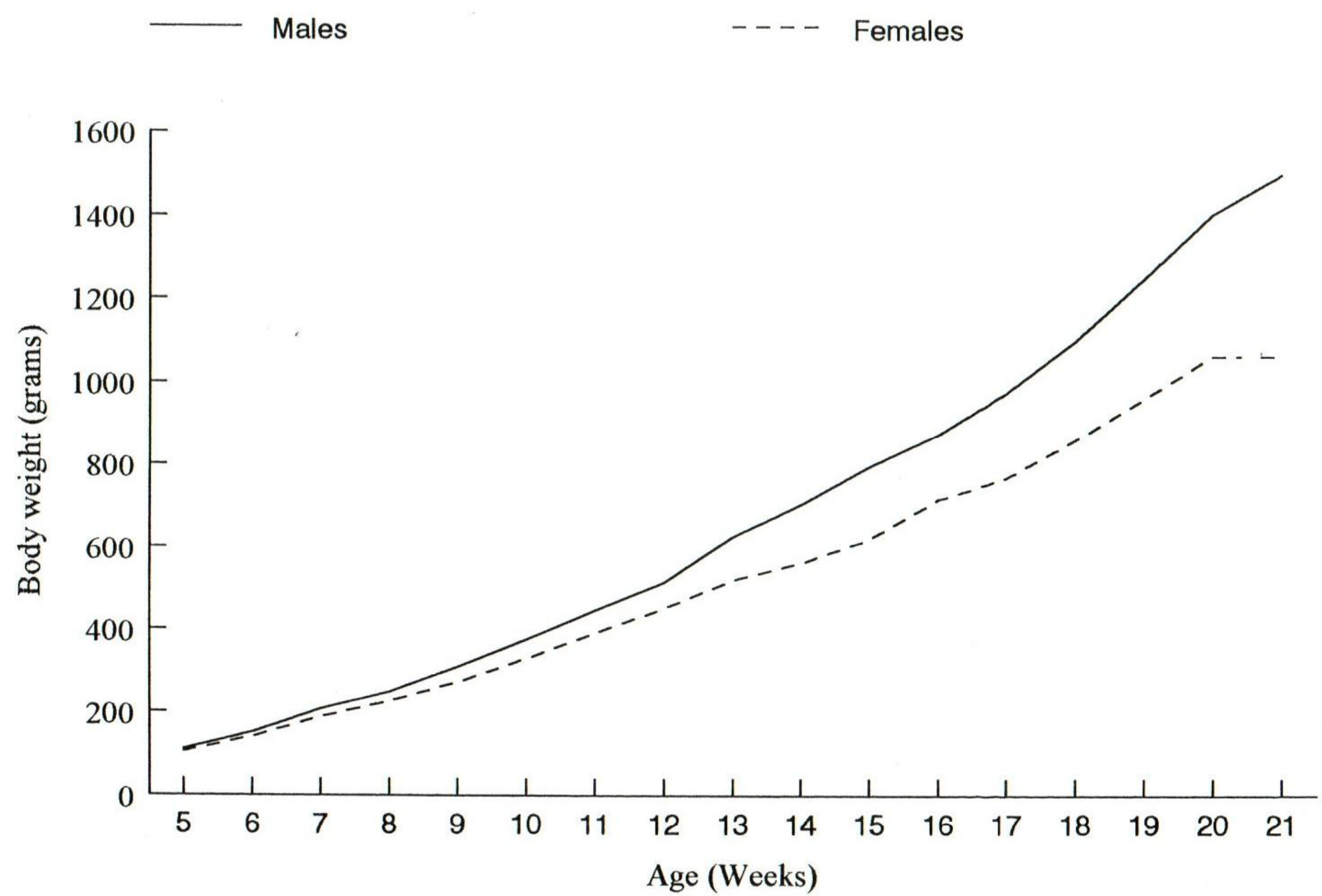


Fig. 7.3 Growth rates of heavy, medium and light indigenous chickens from 5 - 21 weeks of age

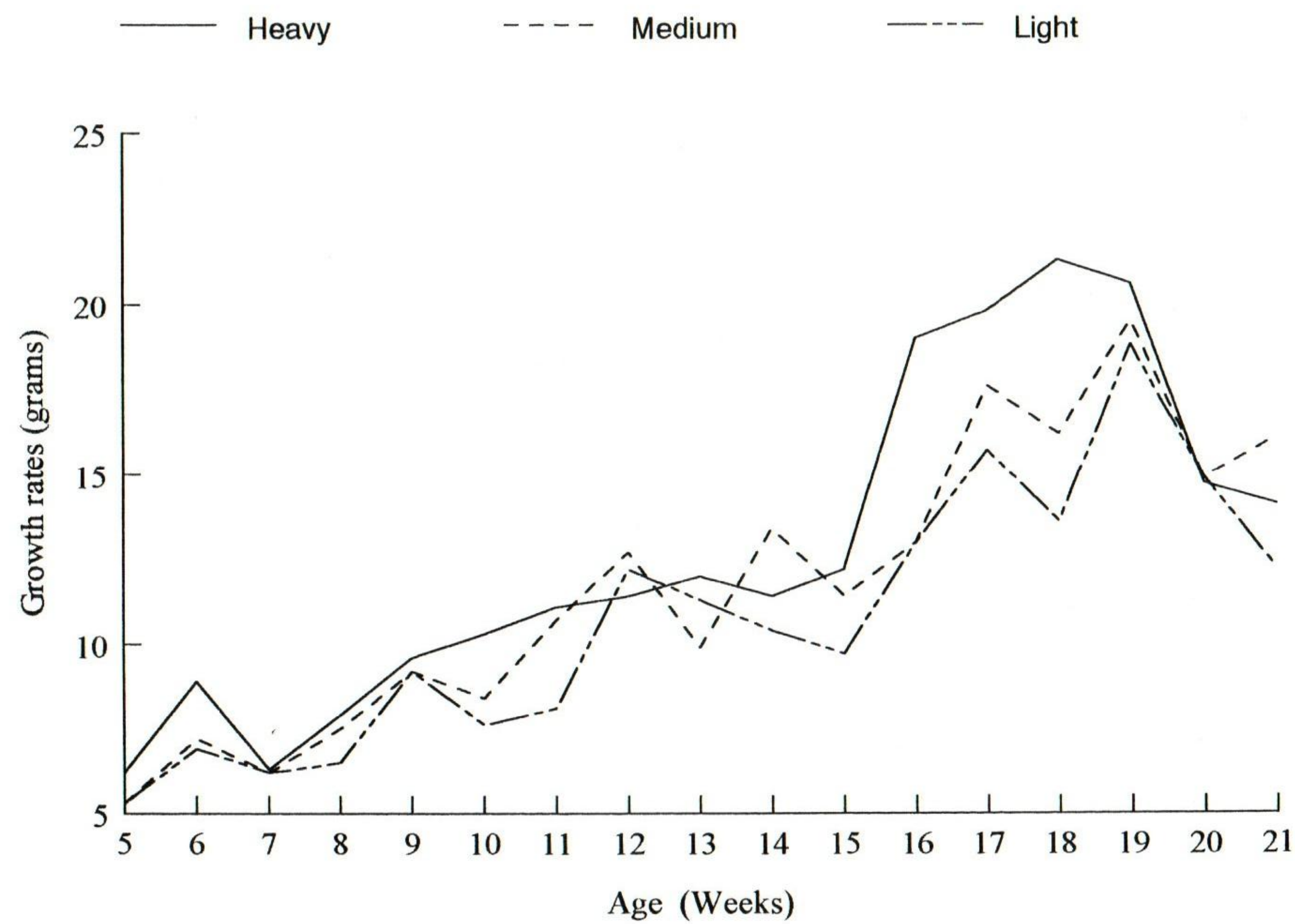


Fig. 7.4 Growth rates of male and female indigenous chickens from 5 - 21 weeks of age

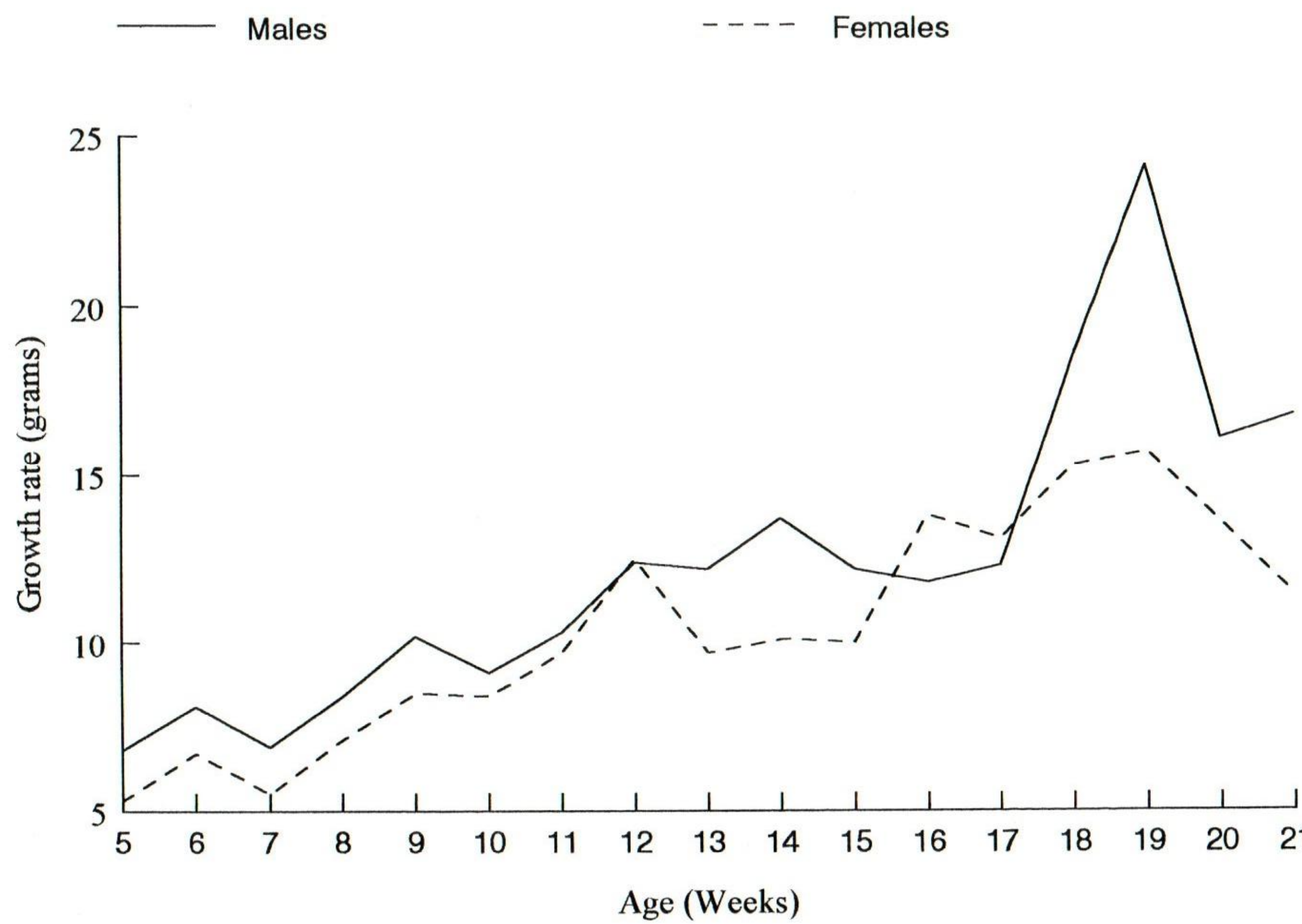


Fig. 7.5 Feed intake of heavy, medium and light indigenous chickens from 5 - 21 weeks of age

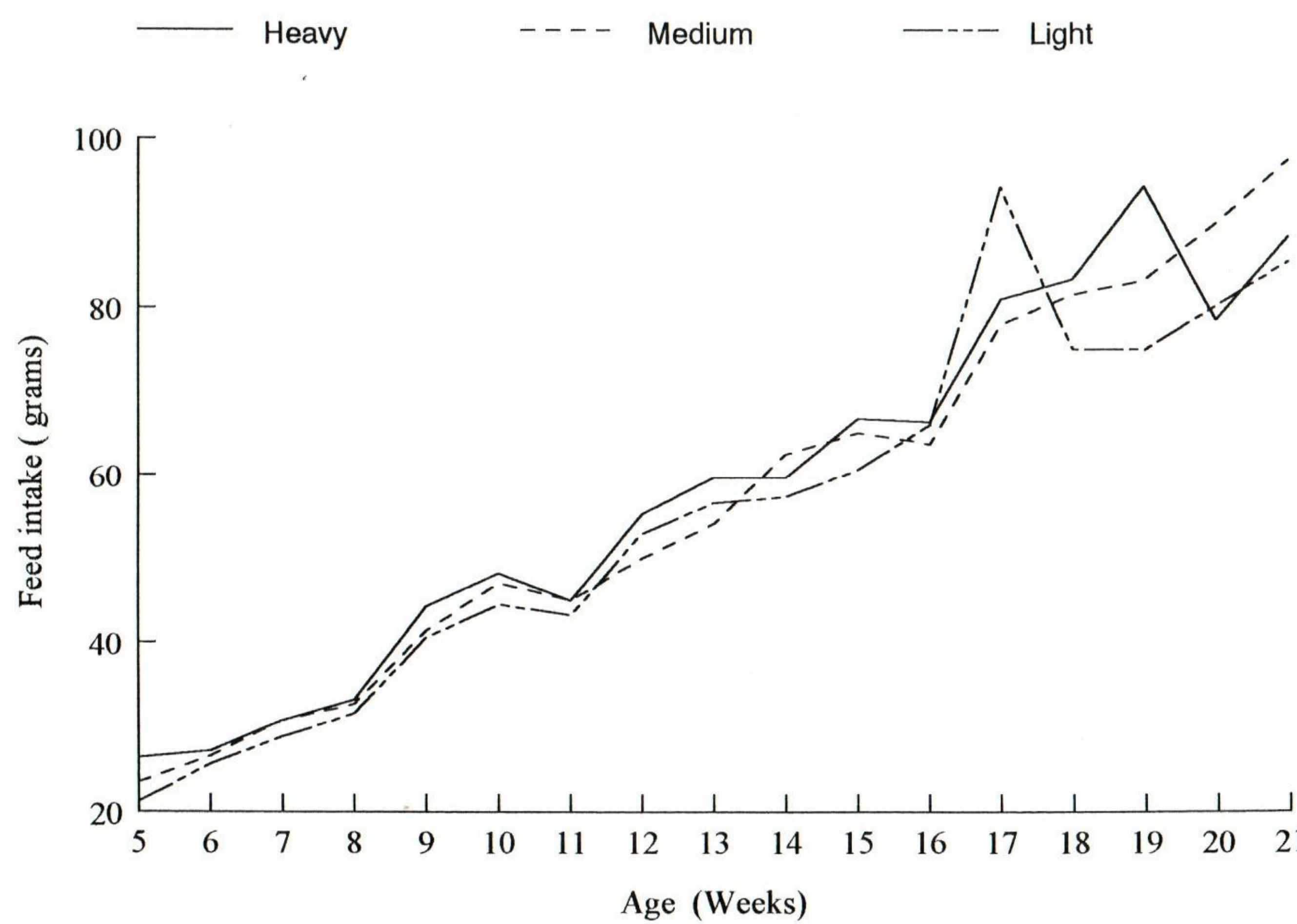


Fig. 7.6 Feed intake of male and female indigenous chickens from 5 - 21 weeks of age

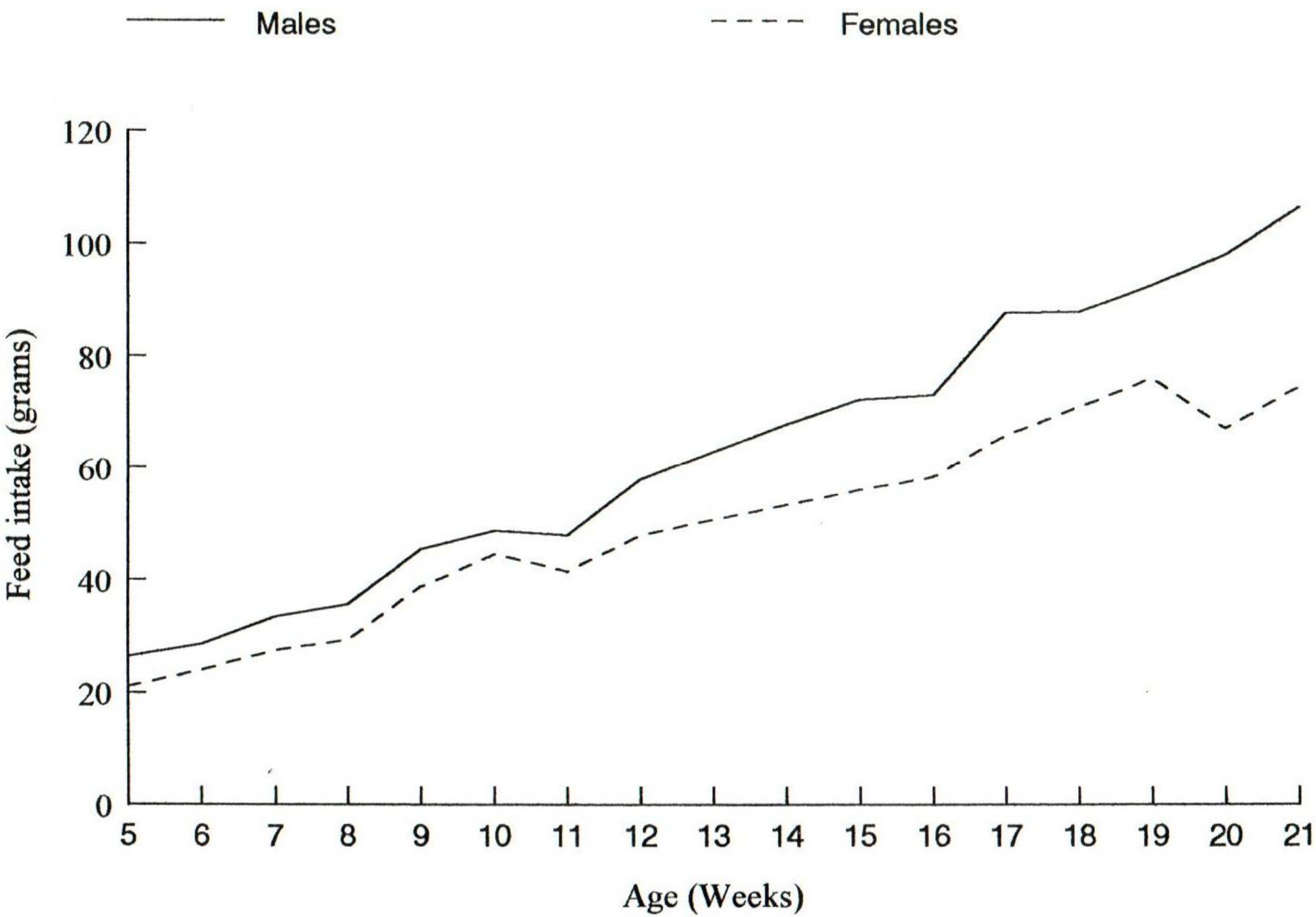


Fig. 7.7 Feed conversion ratios of heavy, medium and light indigenous chickens from 5 - 21 weeks of age

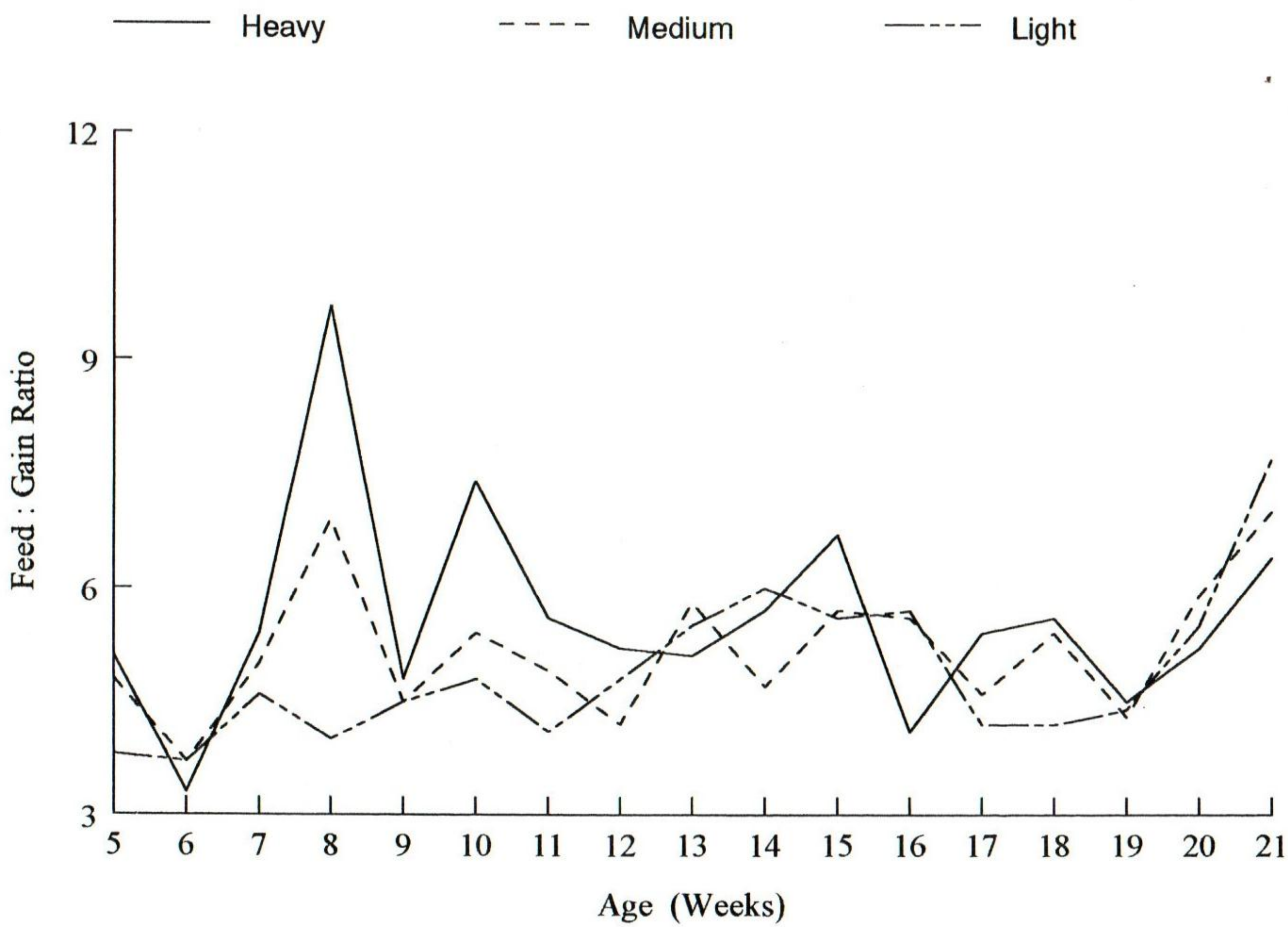


Fig. 7.8 Feed conversion ratios of male and female indigenous chickens from 5 - 21 weeks of age

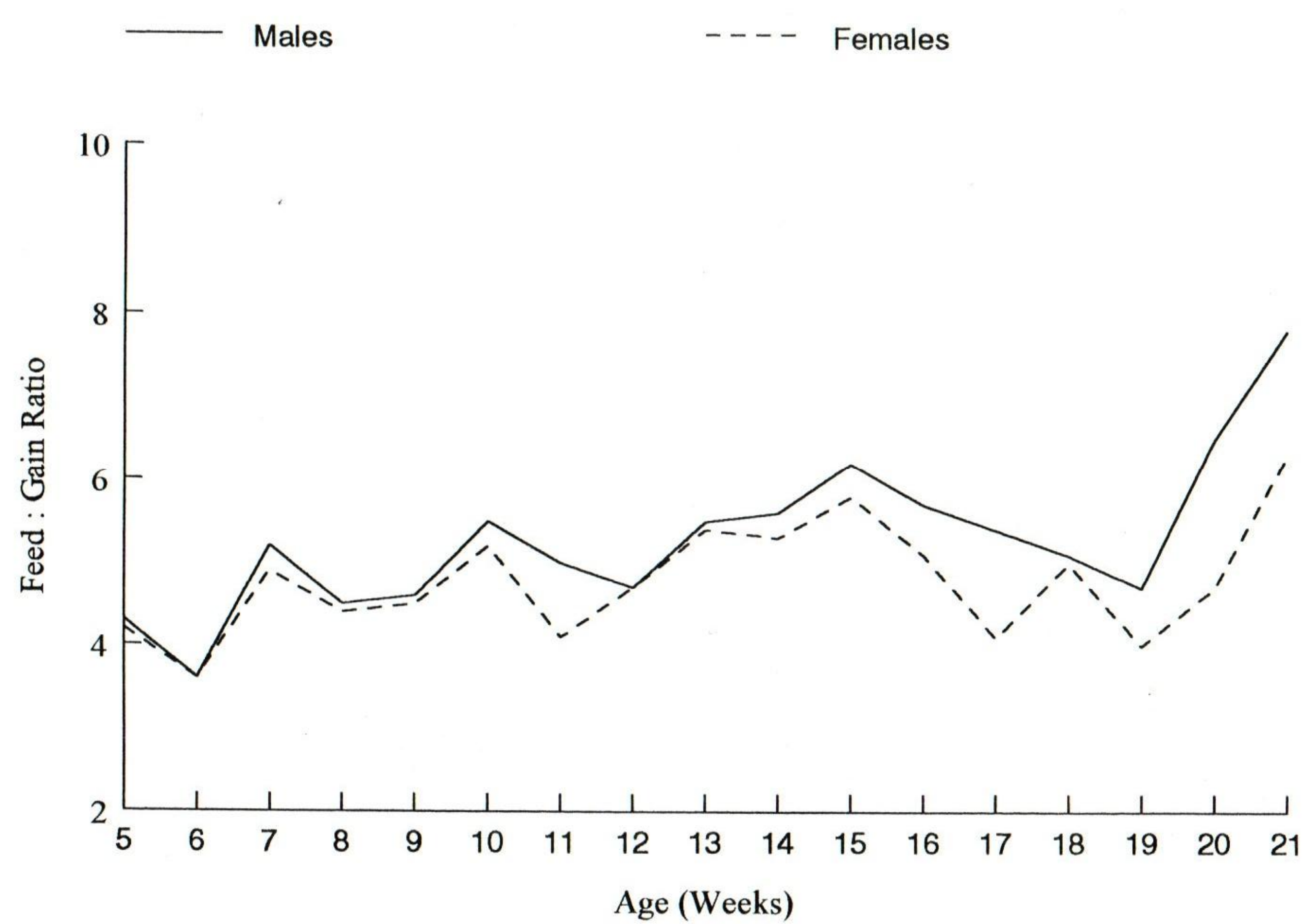


Table 7.20 : CRUDE PROTEIN INTAKE % OF HEAVY, MEDIUM AND LIGHT INDIGENOUS CHICKENS FROM 5 - 21 WEEKS OF AGE

WEEKS	N	HEAVY	MEDIUM	LIGHT	SEM
5	8	22.9^{a}	20.0^{ab}	18.0^{b}	0.72
6	8	20.6^{a}	16.3^{b}	18.0^{c}	0.79
7	8	18.0^{a}	16.7^{ab}	15.3^{b}	0.71
8	8	15.9^{a}	12.3^{c}	14.7^{b}	0.41
9	8	15.5^{a}	15.3^{a}	14.7^{a}	0.46
10	8	15.9^{a}	12.3^{b}	14.7^{c}	0.80
11	8	16.5^{a}	14.6^{ab}	13.1^{b}	0.60
12	8	16.1^{a}	12.8^{ab}	14.1^{b}	0.55
13	8	15.6^{a}	12.3^{b}	15.0^{a}	0.61
14	8	15.7^{a}	11.8^{b}	12.0^{b}	1.28
15	8	14.1^{a}	13.1^{ab}	11.7^{b}	0.48
16	8	15.0^{a}	11.5^{ab}	12.8^{b}	0.52
17	8	14.0^{a}	11.7^{b}	11.2^{b}	0.38
18	8	14.6^{a}	12.5^{ab}	11.4^{b}	0.52
19	8	15.0^{a}	12.8^{b}	11.5^{c}	0.32
20	8	12.4^{b}	12.9^{ab}	13.2^{a}	0.33
21	8	12.8^{b}	12.3^{b}	13.8^{a}	0.46

^{abc} means in the same row with different superscript are significantly different ($P<0.05$)

Table 7.21 : CRUDE PROTEIN INTAKE OF INDIGENOUS CHICKENS OF BOTH SEXES FROM 5 - 21 WEEKS OF AGE

WEEKS	N	MALES	FEMALES	SEM
5	12	20.7	19.6	0.59
6	12	18.4	17.9	0.64
7	12	17.0	16.3	0.59
8	12	16.4	16.0	0.34
9	12	15.3	15.0	0.38
10	12	14.9	13.9	0.65
11	12	15.2	14.2	0.49
12	12	14.4	14.2	0.45
13	12	14.5	14.0	0.49
14	12	13.6	13.1	0.05
15	12	13.1	12.9	0.39
16	12	13.5	12.4	0.43
17	12	12.4	12.2	0.32
18	12	13.2	12.5	0.43
19	12	13.5	12.7	0.26
20	12	13.2	12.4	0.27
21	12	13.6	13.4	0.38

Table 7.22: APPARENT METABOLISABLE ENERGY (AMEn) INTAKE OF HEAVY, MEDIUM AND LIGHT INDIGENOUS CHICKENS FROM 5-21 WEEKS OF AGE.

WEEK	N	HEAVY *(kcal ME/d)	MEDIUM *(kcal ME/d)	LIGHT *(kcal ME/d)	SEM
5	8	113.0[a]	62.9[b]	74.5[b]	1.83
6	8	111.3[a]	65.6[b]	69.3[b]	2.45
7	8	112.9[a]	89.5[b]	87.0[b]	6.64
8	8	105.0[a]	78.5[b]	89.1[b]	7.10
9	8	120.7[a]	100.0[b]	107.8[b]	6.31
10	8	119.4[a]	102.1[b]	120.1[b]	12.73
11	8	142.2[a]	115.7[b]	103.4[b]	13.43
12	8	156.1[a]	111.5[c]	131.7[b]	13.11
13	8	161.0[a]	123.4[b]	143.6[b]	17.34
14	8	159.1[a]	150.9[a]	153.6[a]	22.89
15	8	185.5[a]	161.8[a]	161.6[a]	15.07
16	8	192.1[a]	177.0[b]	157.8[b]	24.23
17	8	217.3[a]	183.7[a]	176.1[a]	25.27
18	8	221.1[a]	169.0[b]	161.6[b]	27.62
19	8	227.9[a]	174.9[b]	186.5[b]	35.46
20	8	219.1[a]	209.0[a]	217.7[b]	36.83
21	8	246.2[a]	254.6[b]	224.6[b]	46.94

[abc] means within the same row, with a common superscript are not significantly different at $p<0.05$

*Metabolisable energy intake per bird per day in kilo calories

Table 7.23: APPARENT METABOLISABLE ENERGY (AMEn) INTAKE OF MALE AND FEMALE INDIGENOUS CHICKENS FROM 5 -21 WEEKS OF AGE.

WEEK	N	MALES *(kcal ME/d)	FEMALES *(kcal ME/d)	SEM
5	12	81.7^{a}	73.6^{a}	0.93
6	12	92.6^{a}	84.9^{a}	1.22
7	12	103.6^{a}	89.3^{a}	0.78
8	12	94.9^{a}	78.0^{b}	0.64
9	12	116.5^{a}	100.5^{b}	0.56
10	12	122.1^{a}	115.6^{b}	0.42
11	12	134.0^{a}	107.1^{b}	0.58
12	12	145.1^{a}	121.1^{b}	0.72
13	12	158.3^{a}	128.4^{b}	0.83
14	12	168.5^{a}	133.6^{b}	0.79
15	12	193.6^{a}	145.7^{b}	0.71
16	12	189.1^{a}	146.4^{b}	0.45
17	12	226.7^{a}	166.5^{b}	0.63
18	12	211.5^{a}	156.8^{b}	0.57
19	12	237.8^{a}	174.9^{b}	0.52
20	12	272.8^{a}	181.9^{b}	0.48
21	12	275.4^{a}	208.2^{b}	0.84

^{ab} means in the same row with a common superscript are not significantly different at P<o.05

*Metabolisable energy intake per bird per day in kilo calories

Table 7.24: FEED INTAKE OF INDIGENOUS CHICKEN AND OT RELATED POULTRY STOCK.

Source	Breed	Age (weeks)	Feed intake (g/b/day)	
			Females	Males
Asiedu and Weever (1993)	Creole	0 - 7 8 -22 23 - 70	39.1 82.2 71.4	
Ramlah (1996)	Malaysian indigenous fowl	0- 16	58.4*	
Current study	Kenyan indigenous chickens	5 - 7 8 - 14 15 - 21	24.2 43.7 67.0	29.4 52.3 88.5
Asiedu and Weever (1993)	Rhode Island Red	0 - 7 8 - 22 23 - 70		51.8 103.7 85.4
Essien (1994)	Harco Strain Pullets	0 - 7 8 - 22	38.2 93.6	
NRC (1984)	Leghorn-type pullets	0 - 8 9 - 22	25.7 64.9	
NRC (1984)	Broilers	0 - 8	80.9	95.4

* This value was for unsexed birds