

The Effect of Feed Energy Levels and Particle Size on Performance of Broilers Under Farmer Management

Thomas J. Kaudia - Southern Meats P. O. Box 7160 Nairobi, Kenya

Abstract

In this study, the effect of feed particle size and energy level on the performance of broiler chicks under farmer's management was tested. Birds were reared under deep litter management system with wood shavings as the litter material. The poultry sheds measured 100 x 30 feet on an East-West orientation with ventilation ridge on the roof and sides. The stocking density was one bird per square foot. Brooding was done for twenty-one days. Heat was provided by charcoal stoves. Feed and water were provided ad libitum in tube feeders and chick founts/plastic basins respectively. Feeders: birds and drinkers: birds were provided at a ratio of 1:50 and 1:60 respectively. Birds were on light for twenty-four hours. At night, light was provided using paraffin lamps. Minimum/ maximum thermometers were used to measure brooder temperatures. Broiler chicks were placed with ten farmers around Nairobi. Each farmer received 3000 day-old broiler chicks. Chicks were transported to the farms in three-ton vehicles with sides lined with wire mesh. During the rearing, chicks were weighed using a ten-kilogram dial scale. Infectious bronchitis and New Castle vaccinations were done in days ten and twenty-one as and eye drop. Gumboro vaccine was given orally on day eighteen. Mature birds were cropped on day forty-two. Transportation to the factory was done in seven-ton lorries. At the factory, live birds were weighed using a 50-kilogram electronic scale.

Birds were slaughtered under humane conditions in a semi-automatic kitchen chicken processing factory with the following equipment: Conveyor line, water bath electric stunner, scolder plucking machine with rotating rubber fingers, washing/chilling tanks, drip line and refrigerated systems comprising chillers, freezers and blast freezers. Severing the jugular vein according to Muslim faith effected bleeding. Birds were scalded at 56° C for two minutes and eviscerated manually.

The average live weight varied between 980g and 1679 grams. The highest live weight of 1679 grams was achieved with a combination of high-energy starter crumbs and finisher pellets. A weight of 1565 grams obtained through a combination of high-energy starter crumbs and high-energy finisher mash followed this. Third best was 1450 from feed combination of high-energy starter and finisher rations. The least weight of 980 grams was the result of feeding birds on both low energy starter and finisher mash. Mortality of 15.03%, 12.65% and 11.47% were noted in birds fed on all high energy pelleted, high-energy starter crumb with low energy finisher pellet and all low energy pelleted rations respectively. High-energy mash rations fed as starter and finisher resulted in a mortality of 4.08% compared to 6.37% mortality in birds fed high-energy starter crumbs and high-energy finisher mash. Mash rations resulted in lower mortality compared to pelleted rations. Feed conversion ratio of 2.16, 2.24 and 2.34 were achieved with all mash high energy rations, high-energy starter crumbs with high-energy finisher mash and all high energy pelleted rations respectively. All low energy mash rations resulted in a feed conversions ration of 3.05. The best livability was noted in birds fed on mash. Ascites and flip-over were both prevalent in pellet fed birds. Feeding birds on mash checked and increase in mortality due to the effect of pelleted food. Birds fed on low energy mash rations had the highest percent rejection due to poor conformation. The largest breast muscle was achieved in high-energy pellet fed birds. It was concluded that mash rations should form the major component in broiler feed management under tropical conditions, factory farming.

Key Words: Farmer management, feed energy level, ascites, feed particle size, tropics, flip-over, factory farming.

Introduction

Broiler farmers have a wide range of feed rations to choose from. These include pellets, mash, crumbs, low energy, high energy and special formulations as agreed between the miller and the farmer. Feed management still poses problems to broiler farmers worldwide particularly in developing countries (Adegbola, 1988). Currently, feed takes about 65-70% of the total cost of rearing broilers to market weight (Reddy, 1996). Research emphasis within the last three decades has been on fast weight gain without considering factors like climatic conditions, eating habits, availability of raw materials for feed manufacturing, exchanges rates, level of farm inputs and knowledge in broiler rearing at farm level. Yet, these factors

influence the rearing of broilers. This research focuses on feed management at farm level.

A number of research activities have been conducted in an attempt to find ways of optimizing on the ever-increasing feed costs. These include the following:

Researchers at ADAS Research Unit, Gleadthorpe, Nottinghamshire, UK found that birds put on periodic fasting had a better feed conversion efficiency and reduced male mortality (ADAS, 1997). Reduced mortality due to fasting has been reported by Smith and Teeter (1998). But, fasting birds may lead to disease challenges such as coccidiosis as birds

pick up dirt from litter while looking for food.

Broiler chicks on different fasting regimes were reported to have significant difference in weight gain. Birds on ad libitum regime had the highest weight gain and attained the desired weight within the stipulated cropping times (Yu *et al.*, 1990) But ad libitum feeding has not been successful in many countries. Broilers on ad libitum feeding often die from ascites and flip over.

Heywang and Morgar (1940), in their study found out that pelleting improved efficiency of chick feed utilization. Robertson (1950), noted that crumbs

allowed greater weight gain and better feed efficiencies compared to mash.

The degree of improvement associated with pelleting or crumbing appears to depend partly on the fibre (Slinger *et al.* 1949; Barse *et al.* 1952; Dymza *et al.* 1955) and fat contents of the ration (Pepper *et al.* 1956; Combs 1959). Pelleting of broiler feed (Sell and Thopson, 1965) together with the inclusion of oils can lead to optimum growth rate.

Savory (1974), in a study on growth and behaviour of chicks fed on pellets or mash noted the following:

All chicks fed on pellets were heavier after 40 days;

The amount of feed consumed was the same;

The apparent digestibility of mash and pellets were about the same in the hybrid chicks;

All chicks fed on mash spent more time eating;

Time spent on drinking and in resting were similar in both types of feed and Chicks preferred mash to pellets.

From this study, Savory (1997) concluded that pelleted feed was converted more efficiently than mash because chicks spent less time feeding on pellets and so expended less energy. There is very little data on the effect of different feed rations on meat quality, farmers' earnings and mortality associated with ascites and flip-over. Broiler mortality because of ascites and flip-over are problems worldwide especially in developing countries where farming is yet to be established.

Objectives

The objectives of the study were:

- i) Identifying the best feed program suitable for rearing broilers in developing countries under farmer's management conditions;
- ii) Identifying disease, production and quality factors associated with feed particle size and energy levels; and
- iii) Identify feeding strategies that give maximum economic returns.

Materials Methods

Chicks

30,000 Arbo acres day old chick were used in this study. The chicks were purchased from a local poultry integrated firm in Kenya.

Feed

Eight different feed rations were used in this study. The rations were:

- i) High Energy Broiler Starter Crumb ration (HEBSC) with 3200 metabolisable energy (ME);
- ii) High Energy Broiler Starter Mash ration (HEBSM) with 3200 Kcal/g ME;
- iii) High Energy Broiler Starter Crumb (LEBSC) with 2500 ME
- iv) Low Energy Broiler Starter Mash (LEBSM) with 2500 ME
- v) High energy broiler finisher pellet (HEBFP) with 2800 ME;
- vi) High Energy Broiler Finisher Mash (HEBFM) with 2800 ME
- vii) Low Energy Broiler Finisher Pellet (LEBFP) with 2400 ME
- viii) Low Energy Broiler Finisher Mash (LEBFM) with 2400 ME.

Feeding

Broiler starter and finisher were each fed to birds for twenty-one days.

Brooding

Six charcoal brooders were used for every 3000 broiler chicks

Cropping

Birds were cropped at forty two days of age.

Procedure

Thirty thousand (30,000) Arbo Acres broiler chicks were randomly divided into ten batches of 3,000 chicks and each fed the following rations under farmers' management practices:

- i) Batch 1 - High energy broiler starter crumbs and high-energy broiler finisher pellets;
- ii) Batch 2 - High-energy broiler starter crumb and high-energy broiler finisher mash;
- iii) Batch 3 - High-energy broiler starter crumb and low-energy broiler finisher pellet;
- iv) Batch 4 - High-energy broiler starter crumb and low-energy broiler finisher mash;
- v) Batch 5 - Low-energy broiler starter crumbs and high-energy broiler finisher pellets;
- vi) Batch 6 - Low broiler starter crumb and high-energy broiler finisher mash;
- vii) Batch 7 - Low-energy broiler starter crumb and low-energy broiler finisher pellet;
- viii) Batch 8 - Low energy broiler starter crumb and low-energy broiler finisher mash

ix) Batch 9 - Low energy broiler starter mash and low-energy broiler finisher mash and

x) Batch 10 - High-energy broiler starter mash and high-energy broiler finisher mash.

Feed Prices

All the different feed rations were purchased at prevailing market values. The market values were:

- (i) High-energy starter rations (Crumb and mash) was valued at USD 25 per 70 kg bag
- (ii) High-energy broiler finisher mash and pellet was valued at USD 20 per 70 kg bag
- (iii) Low energy broiler starter rations (crumb and mash) was valued at USD 17 per 70 kg.
- (iv) Low energy broiler finisher pellet and mash had a value of USD 15 per 70 kg bag.

Producer Prices

Mature broilers were bought at live weight prices. First quality birds were bought at USD 1.5 per kilogram. Second grade birds were bought at USD 1.1 per kilogram.

Post Mortem Examination And Disposal of Dead birds

Post mortem examination was carried out on all dead birds to determine the cause of death. Birds with distended belly full of water were classified under water belly (ascites). Dead birds lying on their back were classified under flip over. Any other cause of death was classified as others. Dead birds were either burned and/or buried in disposal pits.

Vaccination

All birds were vaccinated against Infectious Bronchitis (IB), New Castle Disease (NCD) and Infectious Bursal Disease (IBD) or Gumboro strain D78. Infectious Bronchitis and New Castle were administered to birds on days ten and twenty as a combined vaccine (Bipestos). The vaccine was administered as an eye drop. Gumboro vaccine was given orally in water on eighteen. One thousand doses of Gumboro were dissolved in 20 liters of water plus one liter of fresh skimmed milk. Drinking water was withdrawn from birds for two hours before Gumboro vaccine was given. All the vaccines were carried under ice in cool boxes.

Weighting At the Farm

Weight gain during rearing circle was determined by weighing chicks using a

10 kg manual dial scale. Birds were weighed weekly.

Lighting

Birds were on light for twenty-four hours during the rearing period. Birds were on natural light during the day. Six paraffin lanterns were used to provide light in the night.

Collection of Slaughter

Eight people were employed to catch and load the birds in plastic crates before loading the crates into seven-ton lorries. Collection was done at night between 8.00 and 10.00 pm. Fifteen birds were loaded in each crate. Night collection was preferred because broilers are usually calm at night. This was to avoid unnecessary bruising.

Weighing and Processing

Live birds were weighed using a 20 kg electronic weighing scale and shackled on a conveyor system. Humane killing was effected using an electric stunner with an electric current between 15 -150 mv. Bleeding was effected by severing the jugular vein using a sharp knife. This was based on the Muslim faith (Hala processing method) The bleeding-out time was two minutes and fifty-five second as determined by the conveyor speed.

Scalding and Feather Plucking

Scalding was done at 56° C for 2 minutes in a scalding machine. Scalding water was agitated using a motor driven stirrer. Birds were plucked mechanically in a machine with rotating rubber-plucking fingers.

Evisceration and Washing

Evisceration was done manually. Carcasses were washed in a spin wash tank with mechanically rotating paddles. Each tank held 3000 litres water and was fitted with an overflow pipe.

Water-chilling and Dripping

Carcasses were further chilled in a spin wash by adding ice blocks to the tank. Chilling at this stage was done for 30 minutes. The average deep muscle temperature at the exit point was 8° C. Excess water in the abdominal cavity was removed by hanging the carcasses by the wings on a drip line.

Grading

Carcasses were graded after dripping. The grading parameter was the dressed weight. The following graduating scale was used:

- (i) Springs: 400-800 grams;
- (ii) Grillers: 800-1000 grams; and
- (iii) Capons: Above 1000g.

Removing Breast Meat

Breast meat was removed manually using sharp de-horning knives, packed in plastic bags and weighed using an electronic scale.

Quality Evaluation

The following parameters were used to determine the best feeding regime:

- (i) Live-ability/ mortality;
- (ii) Live weight in grams;
- (iii) Daily weight gain;
- (iv) Feed conversion ratio (F.C.R);
- (v) Breast muscle output;
- (vi) Production number; and
- (vii) Profitability.

Analysis of Results

Descriptive statistics were used to compare the results from the different feed rations. The experiment was however, based on a completely randomized design.

Results and Discussion

Livability

Figure 1 shows that use of pelleted feed resulted in lower livability than mash. This was not affected by the energy level of the feed. The highest mortality was noted in flocks fed on a combination of high-energy broiler starter crumbs and high-energy broiler finisher pellet (Batch One). This is contrary to the findings of Shreek *et al* (1963) who reported a low mortality with pellet fed broilers. Livability improved in batches where pellet and mash feed rations were used together. This observation suggests that mash can be used to control mortality in broiler feeding regimes where pelleted feed is the main ration.

It can be concluded that fine ground broiler feeds are more appropriate under tropical conditions.

Ascites

Higher mortality due to ascites was noted in birds fed on pellet compared to those fed on mash (Fig 1). This agrees with the findings of Dale, (1994) and Maxwell, (1990). They reported that feeding mash might result in minimizing ascites. Slow growing birds fed on low energy pellets also had ascites contrary to reports that only fast growing birds develop ascites (Morris, 1997). Although other research (Maxwell, 1990; Lee, 1997: Personal communication) indicate that ascites has

many causes such as poor ventilation (chronic hypoxia), use of some drugs such as furazolidone, vitamin E and selenium deficiencies, increased sodium (salt) in the drinking water or diet, disease altitude genetics and stress. The cause of ascites seems to be type of feed in terms of feed particle size. The incidence of ascites in birds fed on low energy pellet and not on birds fed on low energy mash can be due to excessive water intake due to high feed intake since pellets are compact. This makes birds drink a lot of water. The excess body water, which cannot be lost through the normal excretory and evaporative routes, finds its way into the abdominal cavity. Mortality due to ascites ranges between 8.3 and 0.6% (Figure 1). Control of ascites through skip a day feed program (Maxwell and Robertson, 1996), may lead to severe coccidiosis challenge because birds tend to scavenge on the litter. This method may only be successful in well-managed farms typical in developed countries.

Flip Over

Mortality due to flip-over ranged between 0.8-3.8% (Figure 1). Higher incidence of flip over was noted in birds fed on Pellet than those fed on mash (Figure 1). This agrees with the results of Proudfoot *et al.*, (1982) and further confirms that mash is the feed for tropical conditions where stress due to heat is a major poultry production problem (Adegbola, 1988).

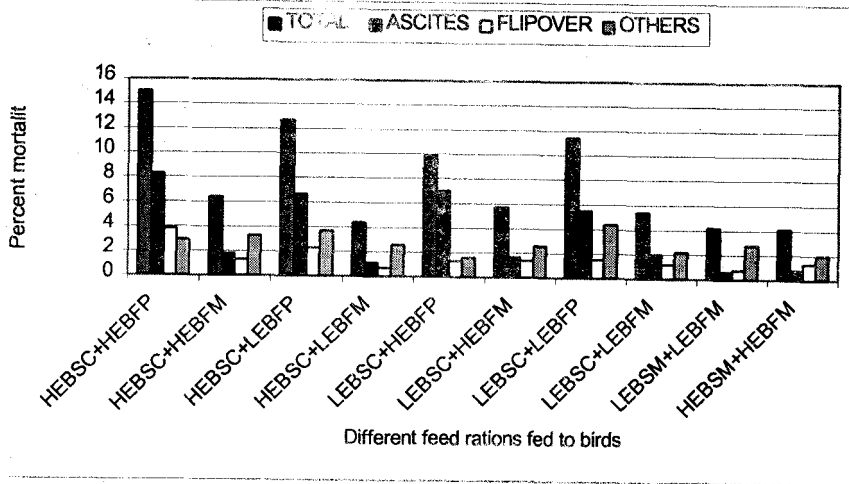
Other Disease Conditions

It is evident from this study that losses from other disease conditions cannot be ignored (Figure 1). Mortality due to other diseases ranged between 4.4% and 1.6%. There was no clear trend in the mortality due to other diseases. Disease conditions classified under other diseases were coccidiosis, respiratory infections, diarrhea, pasted vents and stunted birds.

Mortality Pattern

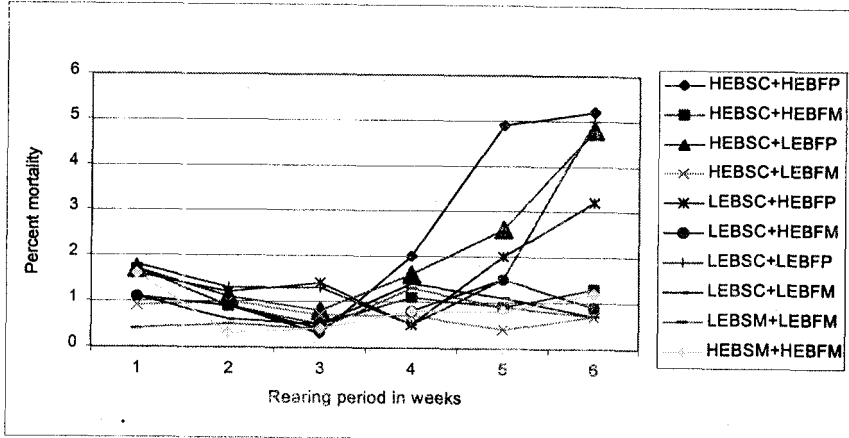
A general mortality trend has emerged from this study (Figure 2). The mortality decreased between week one and three and then increased again from week four through to week six. The high mortality in the first week may be explained by; poor placement conditions, poor chick quality, stress on the chicks during transport from the hatchery to the farm and poor brooding conditions. The mortality in the second phase of rearing after brooding has major effects on farmers' financial returns. Birds at this stage have high value having eaten a lot of feed. The increase in

Fig. 1. Total mortality and mortality due to ascites, flip-over and other causes



mortality in week four could be due to a number of reasons. These include: Onset of disease challenges such as coccidiosis, stress due to ascites which may be aggravated by change from broiler starter to broiler finisher rations, the IBD and IB+NCD vaccinations which follow closely on days eighteen and twenty-one respectively and adverse cold temperatures in the night since brooding was stopped on day twenty assuming that birds have developed enough feather cover.

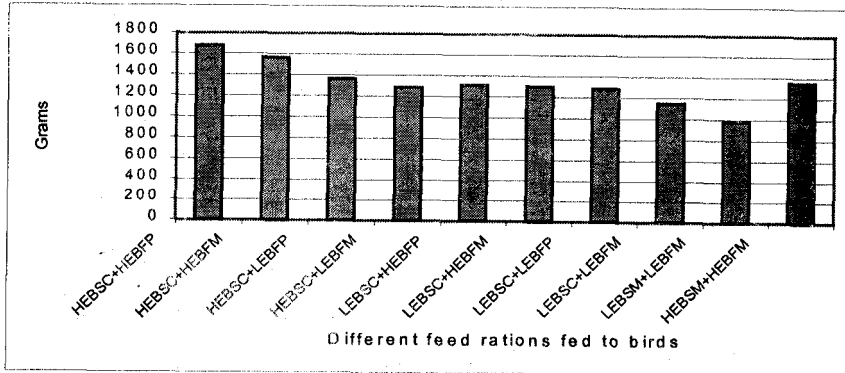
Fig. 2. Mortality pattern during the whole rearing period.



Weight Gain

Weight gain was dependent on energy level and nature of feed (Figure 3). High energy rations produced higher daily weight gain than low energy rations. Pellets on the other hand produced higher daily weight gain compared to fine ground mash of the same energy level. This result concurs with the results of Farrell *et al* (1973) who found that the time required to reach a given weight was dependent on the energy level of the diet. The higher weight gain on pellet could be due to the fact that birds fed on pellet ate more feed than those fed on mash.

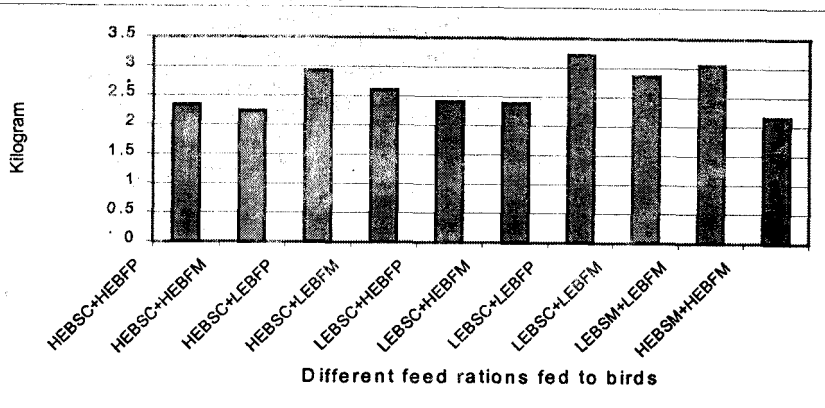
Fig. 3. Average liveweight at slaughter age (42 days).



Feed Conversion Ratio (FCR)

The best-feed conversion ratio was obtained from the combination of high-energy starter crumbs and high-energy finisher mash (Figure 4). A combination of low energy starter and higher-energy finisher gave a better result than high-energy starter and low energy finisher in terms of feed conversion ratio (Figure 4). Use of low energy finisher resulted in the worst feed conversion ratio as indicated by batches 7 & 3 (Figure 4). High energy mash rations in both starter and finisher gave better feed conversion ratio than high energy starter crumb and high energy finisher pellet. These results disagree with those of Allred *et al* (1957) who found that pelleting improves feed conversion. Better feed conversion on mash ration could be attributed to the low mortality and better digestibility although Bolton (1960) found no difference between the digestibility of pellet and mash. It can be concluded that efficiency of feed conversion also depends on farmers' management practices.

Fig. 4. Feed Conversion Ratio (FCR)

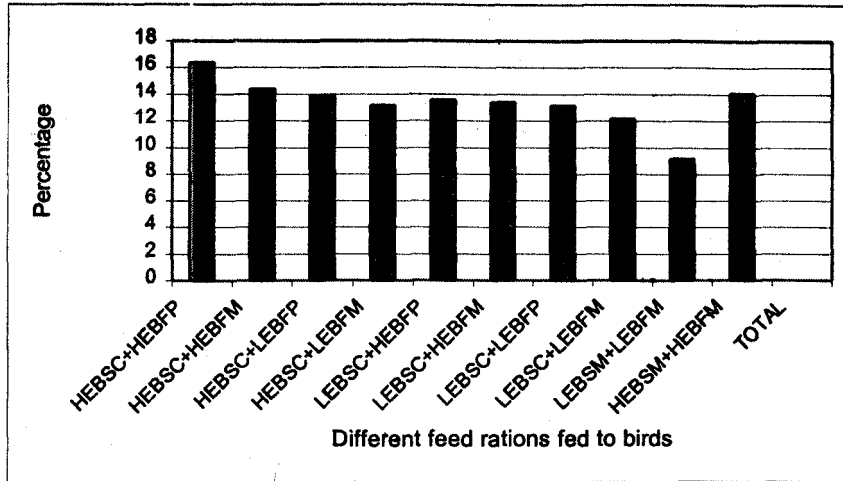


Quality of Meat

Breast Muscle Output

Breast yield depended on the average live weight. The higher the average live weight the higher was the breast yield. Pelleted

Fig. 5. Percent breast muscle yield.

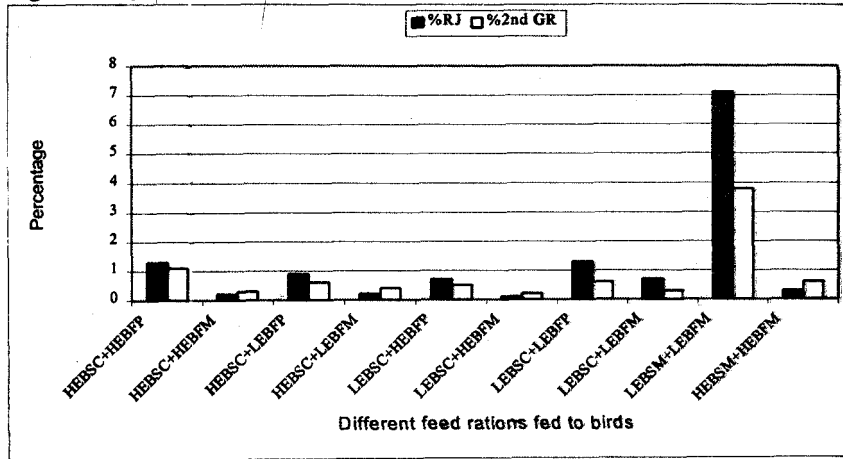


feed gave better breast muscle yield (Figure 5).

Second Grades

The percentage of second carcasses varied between 3.8% and 0.2% (Figure 6). Batch 9 (LEBSM +LEBFM) had the highest second grade (3.8%). Batch one (HEBSC+HEBFP) produced 1.1% second grades. Most of the birds in batch one were downgraded due to broken limbs. This must have occurred during catching and transportation due to broken limbs. This must have occurred during catching and transportation because the birds were heavy at 1.679 kilograms live weight. Batch two (HEBSC+HEBFM) produced the least second grades among the high energy fed birds. This further shows that mash rations of the right energy levels is desirable for rearing broilers under tropical conditions.

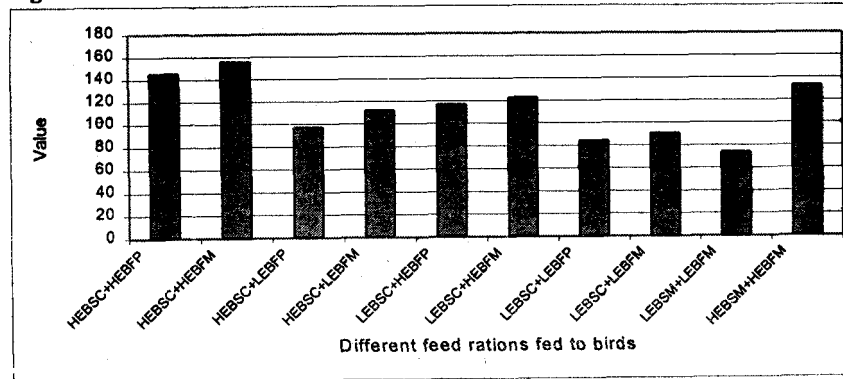
Fig. 6. % Reject and 2nd grades



Factory Rejects

Percent rejection varied between 0.2% and 7.1% (Figure 6). The highest rejection (7.1%) was noted in batch nine (LEBSM +LEBFM), followed by batches one (HEBSC + HEBFP) and seven (LEBSC+LEBFP) which both had 1.3% rejects. Most birds in batch nine were rejected due to poor body conformation. Birds fed on low energy rations particularly mash ration should be marketed by small scale farmers who have no contract to supply live broilers and/or broiler meat with specific product requirements.

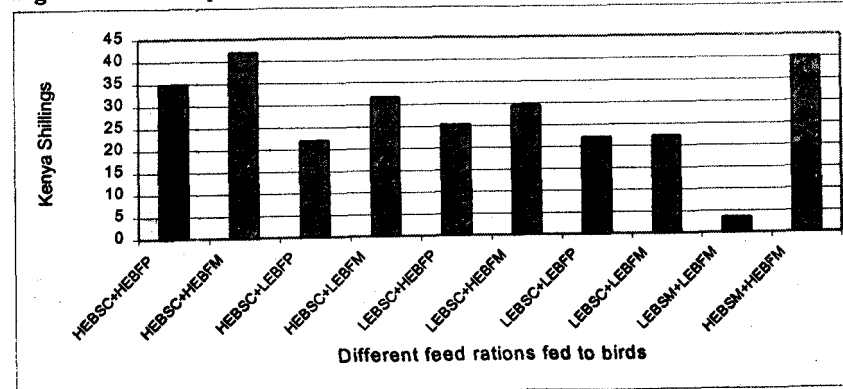
Fig. 7. Production Index Number (PIN).



Production Index Number (PIN)

The production number like weight gain depended on the energy level and the nature of feed ration (Figure 7). High energy feed rations produced the highest production numbers. A combinations of high-energy broiler starter crumbs and high-energy broiler finisher mash gave the best production number. The pattern of change in production number did not follow that of feed conversion ratio and gross profit. It can be concluded that production number is not an efficient measure of broiler production. Production number is defined as: Percent Survivors multiplied by average live weight divide by the product of multiplying feed conversion ration with age. The resulting figure is multiplied by 100 (Vest, 1995).

Fig. 8. Gross Profit per bird Placed.



Gross profit

Figure 8 Shows that the highest gross-profit margin levels were achieved in batches 2 (HEBSC+HEBFM), 10

(HEBSM+HEBFM), 1 (HEBSC+HEBFP), and 4 (HEBSC+LEBFM). Good performance of mash rations may be due to the associated low mortality. This further emphasizes that live-ability is a key factor in profitability of rearing broilers. This has often been overshadowed by the need for high live weight particularly where farmers are paid by live weight.

A combination of LEBSM+LEBFM (Batch 9) gave the lowest profit margin compared to batch six where chicks were started on crumbs of the same energy level. Starting chicks on crumbs should therefore be encouraged.

Conclusion

The following conclusion can be drawn from this study:

For successful rearing of broilers in the tropics, mash rations ought to be included in the feed management program;

More mash should be used during the second rearing phase after brooding to control ascites and flip-over;

An all mash feed ration is more suitable where feed management may be a limiting factor such as in farms and/or where extension services have limitations; and

All stakeholders (Breeders, hatchery managers, farmer, processors, consumers and policy makers) in the poultry industry should work together at all levels.

Recommendations

- Pellet and mash rations should be used together during a broiler rearing cycle;
- A standard minimum energy level in

broiler feed rations should be set;

- Feed manufacturers should be compelled to indicate the energy level on the bag; and

- More research should be done to.

- determine causes in upsurge in mortality after introduction of finisher rations in a broiler rearing cycle;
- Identify optimal energy levels in pelleted and feed rations to achieve minimum mortality of broilers under tropical and farmers' management conditions; and
- Develop broiler-rearing systems based on Hazard Analysis and Critical Control Points under farmers' management conditions.

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