STUDY ON THE PERFORMANCE CHARACTERISTICS OF GROWING NATIVE MUSCOVY DUCKS UNDER SEMI AND FULLY CONFINED SYSTEMS

BY

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ABSTRACT

A study was conducted to investigate the performance of growing native Muscovy ducks under two different rearing systems. Both field survey and on station experiment were carried out. The survey was conducted at three institution farms i.e. Ubena and Kingolwira prison farms and LITI Mpwapwa. Sixty-four ducklings aged 8 weeks were randomly allocated to the two rearing systems i.e. Semi and Fully confined systems. Cumulative feed intake and feed conversion ratio (FCR), live weight and growth rate was measured weekly. At the 20th week of age, 12 birds from each rearing system were picked at random and slaughtered for carcass yield and quality evaluation.

The result showed that on station ducks were heavier than those from surveyed farms. The mean daily feed intake for semi and fully confined birds was 148g. The mean feed conversion ratio for semi confined ducks was 10g/body-weight gain, while for fully confined ducks was 9.7g/body-weight gain. Fully confined ducks had significantly lower feed conversion ratio ($P<0.05$). The mean body weight for semi confined birds was 2281g and 2409g for fully confined birds. The daily weight gain were 19g and 17g for fully confined and semi confined birds respectively. Males and females gained 25g and 11g, respectively. The dressing percent for fully confined birds was 69% whereas it was 68% for semi confined birds. The mean percent of lean meat, bone and fat separation for semi and fully confined birds were 74 vs.72, 16 vs. 16 and 10 vs.11 respectively. The chemical composition of meat for semi confined ducks i.e. DM, CP, EE, and ash were 37, 53, 40, and 7 respectively, while in fully confined birds were 40, 48. 46 and 6 respectively. Meat quantity and quality was not affected by the two rearing systems.

From the present finding it can be concluded that native Muscovy ducks under good management can perform better than those from surveyed farms. Also can perform equally in both semi and fully confined rearing systems.

DECLARATION

I, NJAHANI MBURUMI JORDAN NGAPONGORA do hereby declare to the senate of Sokoine University of Agriculture that this dissertation has not been submitted for a degree award in any other University.

Signature Njahani

Date 29 June 2000

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DEDICATION

To my children Brown Katitu, Lucklesia Mbauku and Andrea Mburumi, my wife and my parents.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
AOAC	Association of Official Analytical Chemist
ARC	Agricultural Research Council
CF	Crude Fibre
cm	centimetre
CP	Crude Protein
CRBD	Complete Randomized Block Design
d	day
DASP	Department of Animal Science and Production
DM	Dry Matter
EE	Ether Extract
FC	Full confinement
Fig.	Figure
g	gramme
i.e.	That is
Kcal	kilocalorie
kg	kilogramme
LITI	Livestock Training Institute
LSD	Least Significant Difference

m	metre
m^2	square metre
ME	Metabolisable Energy
MJ	Megajoules
NAEP	National Agricultural Extension Project
SAS	Statistical Analysis System
SC	Semi confinement
spp	species
SUA	Sokoine University of Agriculture
viz.	Namely
vs	versus
wk	week

CHAPTER ONE

1.0 INTRODUCTION

A wide range of poultry species has made the expansion of this industry to be faster than most livestock species. Although the chicken is the most common poultry specie other species such as ducks, geese, Guinea fowls are gaining popularity in many countries. These species have some relative advantage over the chicken by being more resistant to common poultry diseases and therefore can be used as alternative sources of protein in most developing countries (Smith, 1990).

In most developing countries ducks are kept for meat and eggs. They rank second to chicken as source of eggs and meat for small-scale poultry producers (Banks, 1979; Aquino, 1992). MALD, (1984) reported that Tanzania had a total of 772,622 ducks and geese, while Morogoro region had 51,662 ducks and geese.

Apart from meat and eggs, in China ducks are used to reduce crop damage by pest infestation, remove weeds from the banks of waterways and clear aquatic weeds out of ponds and canals. However, ducks also eat crops and may cause considerable damage to cereal crops (Smith, 1990 and Lane *et al.* 1998).

Waste products from ducks have a direct access to the culture pond and excess water from this, together with nutrient rich sediments, are used for growing vegetables and fruits (Singh, 1992). Agrosilvopastoral system including ducks have economic, ecological and social advantages. The income produced from inter-cropping with agricultural crops, forestry and ducks can improve the living standards of people (Huang *et al.* 1987).

Ducks can forage for food efficiently and a large number of ducks found in rural areas are kept under scavenging conditions. The system of driving ducks through fields is commonly found in most South Eastern Asian countries (Banks, 1979 and Smith, 1990).

There are two main species of ducks found in Tropical Africa i.e. Muscovy ducks which originated from South America and Pekin ducks from China (Say, 1987). Muscovy ducks are heavier than Pekin ducks. Ducks are easily manageable without making great demand on space. Housing is mainly a question of night protection for both birds and eggs against predators (Feltwell, 1980; Bonino and Velez, 1992). Compared to other countries, in Tanzania ducks have not been fully exploited due to a number of reasons such as poor quality and inadequate supply of feeds (Mchechu, 1983).

However, limited information has been reported in East Africa and sub-Saharan countries in relation to performance characteristics of native Muscovy ducks. Inferences are often made on the basis of studies done on chickens in either temperate or sub tropical climates of Asian countries. It is imperative that studies are made on ducks with a view to provide insights on the relationship among various economic traits.

The present study was undertaken with the objective of evaluating the production potential of ducks under improved husbandry.

Specific objectives were:

(i) to evaluate the performance characteristics of ducks in the selected institution farms i.e. Ubena prison, Kingolwira prison and LITI Mpwapwa.

(ii) to evaluate and compare performance of ducks kept under semi and full confinement rearing systems in terms of feed intake, feed conversion ratio and growth.

(iii) to evaluate the carcass yield and quality of ducks kept under semi and full confinement rearing system.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Rearing management

Latif, (1990) reported that native ducks can survive and produce under poor environmental calamities especially feed shortage and poor housing conditions. Semi confinement rearing is a system of poultry production whereby birds are kept under minimum investment conditions and scavenge for the major part of their diet for herbage, seeds and insects from the surroundings (Huchzermeyer, 1973; Wilson, 1979; Latif, 1990 and Payne, 1990).

Foraging is the most common traditional method of rearing ducks at village level in developing countries (Huchzermeyer, 1973). One of the stressful environmental factors prevailing in the developing countries is foraging under semi confinement. The birds are exposed to sunny condition and high risk of parasite infestation. Although productivity under scavenging conditions is low, the system is not entirely described as being inefficient (Payne, 1990). This is because birds do get part of their energy and protein requirements and a considerable proportion of their minerals and vitamins needs from scavenging (Huchzermeyer, 1973).

The productivity of native Muscovy ducks in third world countries can be improved through manipulation of the environmental conditions like feeding, housing and rearing systems. This method of environmental manipulation to suit the production potential of native ducks is sustainable approach for rural small holder farmers in these countries (Payne, 1990).

2.2 Body weight and growth rate

Nguyen, (1996) reported that the daily weight gain of crosses and local Muscovy ducks were 31.3 g and 25.0g; marketing weights were 2.51 kg and 2.13 kg respectively. Moreover, Muscovy males continued to grow after 10 weeks of age (Swatland, 1981). All poultry species and strains within a species, including ducks have characteristic mature body weights. Males and females of the same strains also have different mature body weight (Sauvier, 1990). This phenomenon is called sex dimorphism and the differences can be large in some species such as Muscovy ducks (Stevens and Sauvier, 1985; Rose, 1997). The rate of growth and time taken to reach mature body weight changes as it moves towards its maturity weight (Rose, 1997). The coefficients describing the growth curves of different poultry species are shown in Table 1.

Salomon and Gille, (1998) reported that Muscovy ducks had greater weights than other duck species at later ages. Crosses of Muscovy ducks with other species had the fastest muscle growth. The average mature body weight of Muscovy duck is about 4.5-6.4 kg for males and 2.2-3.3 kg for females. The Indian runner breed has the lowest body weight of about 1.6-2.2 kg for males and 1.4-2.0 kg for females (Feltwell, 1980). Muscovy duck vary considerably in live weight.

Table 1: Mature body weight, growth rate and coefficients of growth curves of different poultry species

Species	Mature body weight (kg)	Growth rate (kg day^{-1})	Coefficient of growth
Male broiler	5.5	0.080	0.03953
Female broiler	3.8	0.060	0.04290
Male turkey	1.9	0.017	0.02433
Female turkey	16.8	0.013	0.02103
Male Muscovy duck	10.8	0.099	0.02492
Female Muscovy	5.0	0.080	0.04349
duck	3.0	0.052	0.04711

Source: Rose, (1997)

They reach a market live weight of 3 kg in 7 weeks at a feed conversion ratio of 3:1 (Barlett, 1986). Gao and Han, (1997) reported that ducks fed on barley based diets alone increased the live weight gain while the relative growth rate decreased with time. Table 2 shows the standard mature weight of different duck breeds approved by British Waterfowl Association.

Table 2: Body weight of domestic breeds of ducks

Breed	Body weight (kg) male	Body weight (kg) female
Aylesbury	4.5	4.0
Campbell	2.2-2.4	2.0-2.2
Cayuga	3.6	3.2
Crested	3.2	2.7
Indian Runner	1.6-2.2	1.4-2.0
Muscovy	4.5-6.4	2.2-3.1
Orpington	2.2-3.3	2.2-3.1
Pekin	4.0	3.6
Rouen	4.5	4.0

Source: Feltwell, (1980)

Growth rate of ducks can be phenomenal. Compared to chickens, ducks have higher growth rate, coupled with high nutritional requirement (McDonald *et al.* 1995). To reach 2600-2800g body weight in seven weeks ducks need feed containing 2789-2856 ME Kcal/kg and 14.13-14.82% CP (Shanshu *et al.* 1996). Ducklings show little response on growth promoters, though these are not commonly used in duck rations (Ministry of Agriculture, Fisheries and Food, 1980).

2.3 Duck feeding

Both wet and dry feeding can be employed in duck management. However, wastage can be reduced if the feed is fed in form of a wet mash (Smith, 1990). Ducks have the ability to consume and digest organic matter, crude fibre, Nitrogen free extracts and crude protein better than chickens (Schubert *et al.* 1982). Research on nutrient requirements of ducks is scarce thus many of the requirement standards for ducks were simply assumed to be similar to those of chickens (ARC, 1975). These values differ depending on the kind and age of bird and the purpose for production. However, ME value for ducks are slightly higher than those of chickens. Consequently it is justified to use ME values measured with chickens to formulate diets for ducks (Leclercq and Carville, 1985).

Feed conversion ratio is complex, highly affected by many different component traits like basal metabolism, protein accretion, level of production, liveability, growth rate, appetite, digestibility, carcass composition and behaviour (Emmerson, 1991). An improvement in feed conversion in ducks has been observed to occur at dietary levels of approximately 14 – 22 MJ/kg. Above these levels, no significant improvement in feed conversion was observed (Siregar *et al.* 1982b). Prasetyo and Susanti, (1997) reported a feed conversion ratio of 3.5-3.6. Male ducks grew faster and had high efficient feed conversion ratio compared to female ducks (Bochno *et al.* 1992). Feed conversion ratio varies with age and rearing system. At 11-16 weeks of age, feed conversion ratio was 10.1 (Petre *et al.* 1990), while it was 5.9 at 20th week of age. Feed conversion ratio for ducks kept under deep litter system ranged between 7.2-8.0 (Sharma and Nanda, 1989). Furthermore, Dean, (1978) observed no significant effect on weight gain when the energy density of diet was increased from 9.20 to 12.97 MJ/kg for Pekin ducklings.

Ducks have a remarkable ability to adjust their feed intake so that their ME consumption is relatively constant (Dean, 1978 and Siregar *et al.* 1982b). The feed intake for crosses ranged between 76.6-77.1g/d (Prasetyo and Susanti, 1997), but decreased with increasing the stocking rate (Osman, 1993). Feed consumption tended to be higher for outdoor ducks than for indoor ducks (Paci *et al.* 1992). Moreover, Sharma and Nanda, (1989); Hamid *et al.* (1988) reported a feed intake of 70.1-112.2g/d for Campbell ducks kept under deep litter system.

Dean, (1978) observed that 16% CP gave maximum weight gain for growing Pekin ducklings. NRC, (1989) recommended a level of 16.5% CP for both starter and grower ducklings, without distinguishing the requirements for eggs or meat types. Siregar *et al.* (1982a) reported that variation in CP content of isoenergetic diets for ducklings grown from 1-56 days did not influence feed intake or feed conversion ratio. The highest growth rate was observed on diets with a CP content of 18.7% in both starter and finisher diets, and higher content of dietary protein tended to reduce carcass fat up to 6 weeks of age (Leclercq and Carville, 1985).

The nutritional requirement of most poultry species is shown in Table 3. However, Nersessian *et al.* (1992) and Chen *et al.* (1992) reported that supplementation of methionine and tryptophan which are the major limiting essential amino acids in ducks did not improve the final weight and breast meat yield. Therefore a decrease in dietary methionine and tryptophan levels in ducks diets can be done without affecting body weight or certain immune responses. This observation is economically important since it allows for low cost formulation of the ducks diet. However, Johnson, (1971) reported that growth rate was significantly lower in ducklings fed on low protein diets. Also the survival rates of ducklings were directly related to the protein contents of the diets. Hunter *et al.* (1984) reported that reduced biomass and numbers of macro-invertebrates in ponds decreased growth rates of ducklings. Ducklings on ponds with less biomass and macro-invertebrates spent more time searching for food and less time resting.

Table 3: Typical dietary levels for poultry (fresh basis)

Nutrient	Egg birds				Meat birds
	0-6wk old	6-12wk old	12-18wk old	Over 20 wks	
ME (MJ/kg)	11.5	10.9	10.9	11.1	12.6
CP g/kg	210	145	120	160	230
Methionine/Cystine g/kg	11	7.4	6.6	7.3	12.5
Tryptophan g/kg	2	1.4	1.2	1.4	2.3
Calcium g/kg	12	10	8	35	12
Phosphorus g/kg	5	5	5	5	5

Source: McDonald *et al.* (1995)

The rate of movements around the ponds was greater than for ducklings kept on ponds with high biomass contents. Raharjo *et al.* (1987) reported that Glycidia leaf meal fed at 30% inclusion level caused blindness, reduced growth rates and sometimes death to ducks. However, Novikova, (1989) reported that conifer leaf meal when fed at 10g/head inclusion level resulted in increased growth rate of ducks when mixed with a feed mixture enriched with carotene from grass and spruce meal at 5mg/ kg and also from pine meal.

Vetesi and Mezes, (1992) reported that feed intake of cereal concentrates was not reduced when ducks were fed *ad libitum* with concentrates and forage. Feed conversion can be improved by using controlled concentrate feeding from the age of 6 weeks onwards. Ducks fed with the mixture of grains and green forage were found to be more efficient than ducks fed concentrates alone. This could be due to enhanced mechanical degradation by the gizzard due to high fibre levels resulting into efficient microbiological digestion and therefore increased digestion (Farrell, 1995). However, high levels of rice bran in duckling diets should be accompanied by an animal protein source to improve productive performance due to increased amino acid digestibility (Martin and Farrell, 1998). Indigenous ducklings have lower feed conversion efficiency than the commercial ducklings (Nguyen, 1996). Feed/gain was better in crosses than in local ducks (Smith, 1990). Feed conversion efficiency was 3.5 for male ducks and 4.5 for female ducks. Increasing the protein concentration in the diet resulted in an improvement in feed efficiency of growing ducks (Johnson, 1971; Oluyemi and Fetuga, 1978). Supplementation of potassium to growing ducks results in increased weight gain and feed efficiency (Chu *et al.* 1995). Also feeding of sucrose appears to enhance vitamin and mineral utilisation and improve performance of white Pekin ducks. Phytase can also be used in duck finisher diets at the rate of 750-1500 units per kilogram feed (Orban *et al.* 1996).

Moldy feeds containing fungi may be toxic to ducklings (Broomhead *et al.* 1996). However, Cibulka *et al.* (1987) reported that feeding 2.5% dried activated wastewater sludge might be useful if they have less toxic minerals like lead and cadmium.

2.4 Duck diseases

Ducks like other poultry species are susceptible to poultry diseases caused by bacteria, viruses and parasites although their immunity to common diseases is a bit higher than chickens (Smith, 1990). Furthermore, stocking rate greater than 2 ducks/m^2 was found to have no significant effect on mortality and growth performance (Osman, (1993). The common diseases in ducks are cholera, pasteurellosis, and liver flukes (Payne and Cook, 1992). The most important viruses in ducks are ducks virus hepatitis and ducks virus enteritis and occasionally Newcastle disease and ornithosis (Banks, 1979). Additionally fast growing ducklings are susceptible to leg weakness and in order to prevent this, high levels of B group vitamins, particularly nicotinic acid, are necessary (Banks, 1979).

2.5 Duck Meat Characteristics

2.5.1 Carcass yield

The cross of Muscovy ducks (*Cairina moschata*) with common ducks (*Anas platyrhynchos*) produces a viable but sterile hybrid. These offspring are often called

mules and used for meat production and fat liver production in some countries (Rose, 1997). About 25% of meat constitute non-edible portion as shown in Table 4. Eviscerated carcass yields generally increase with increasing body weights. However, body fatness often increases when the birds approach their mature body size. Some adipose tissue in the body cavity will be lost at evisceration time, so the percentage carcass yields decrease slightly at high carcass weights (Rose 1997). Carcass yield of Muscovy ducks finished outdoors was significantly higher than that of indoor (60.4 vs. 56.1%) as reported by Marzoni *et al.* (1992).

2.5.2 Influence of species on meat characteristics

Different breeds of ducks differ in meat traits like live and dressed carcass weight, breastbone angle, shank length and keel-bone length (Pandey *et al.* 1985). Correlation of breast skin and fat to percent whole carcass fat for various strains ranges from 0.58-0.76

(Walters and Maurer, 1992). The fast growing strains have high leg and thigh meat yield.

Table 4: The percent composition of duck carcasses

Carcass content	Common duck	Muscovy duck
Eviscerated carcass [a]	71.2	71.4
Edible meat [a]	28.8	36.3
Other edible parts [a]	29.1	21.2
Breast meat [b]	31.4	33.7
Legs and thigh meat [b]	29.8	30.2
Wing and other meat [b]	38.1	38.1

Source: Ritcher *et al.* (1989) cited by Rose, (1997)

a – percent of live weight

b – percent of total meat on carcass

Cherry valley ducks slaughtered at 7 weeks of age yielded lean meat 18,5%, bones 10.4% and dressed carcass 76-82% (Pribis *et al.* 1989). Moreover, Steklene, (1990) reported that Muscovy duck crosses can produce 68.9-71.8% edible parts, muscles 46.3-73.6%, crude protein 21.5-21.9% and fat 1.3-2.9% when slaughtered at 3-4 months of age. Fraga *et al.* (1998) reported that Pekin ducks produced more meat than local Muscovy ducks and reached mature weight 2 weeks younger than Muscovy ducks.

2.5.3 Influence of feed composition on meat Characteristics

Feeding different types of diets had no significant effect on external meat quality characteristics i.e. body size and weight, shape, carcass appearance, internal carcass, overall carcass composition and quality (Vogt, 1983). However, intensity of skin colour and grilling loss for leg meat, owing to increased fat deposition, was significantly greater with maize than with the other cereals (Seeman, 1984).

Carcass weight and breast meat yield were not influenced by energy levels, although higher protein diets resulted into reduced proportion of abdominal fat pad sizes ($P < 0.01$). Protein intake improved yields of breast muscles of Muscovy ducks (Auvergne *et al.* 1991). The effect of feeding lipids with different degree of saturation on skin tearing, carcass quality and body fat composition were studied by Sklans and Ayal, (1989) in both male and female ducks up to slaughter age. No significant differences in growth or efficiency of feed utilisation were observed when saturated fat was fed but the skin tearing was slightly improved by feeding the more saturated fat. Decreases in linolenic acid content in intra-abdominal fat was noted after feeding the more saturated fat, decreases were intensified with prolonged feeding period (Sklans and Ayal, 1989).

Moreover, Vetesi *et al.* (1998) reported that barley meal increased abdominal fat pad. Table 5 shows the carcass composition of broiler ducks.

Table 5: Carcass composition of broiler ducks

Variable	Minimum	Maximum	Mean	Sd
Live wt, g	1124.00	2575.00	1753.00	301.00
Carcass wt, g	680.30	1789.90	1205.20	236.3
Moisture content, %	51.7	76.19	63.90	6.39
Ash, %	0.58	3.81	2.49	0.62
Lipid, %	1.58	23.84	11.71	5.79
Nitrogen, %	4.90	12.65	8.00	2.02

Source: Pesti and Bakalli (1997)

2.5.4 Influence of sex on meat Characteristics

Wawro and Brzozowski, (1998) reported that male Pekin ducks at 5-11 weeks of age were significantly heavier than females (2900g vs 2640g). Breast muscle weight (324.5g and 303.9g), leg muscle weight (239.6g vs 223.1g) and total meat weight was (776.9g vs 731.7g) for male and female respectively. Similarly, Trujillo and Pampin, (1987) reported that there were significant differences between male and female in carcass yield, edible organs and fat content. Nanda and Sharma, (1990) reported that the percentage of offal was 19.6% for male and 20.8% for female ducks. Moreover, Tai *et al.* (1991) reported that fat weight and percent were significantly higher in female than in males at 20-50 weeks of age for Pekin ducks. Male ducks produce leaner carcass than females probably because of their body size (Campbell *et al.* 1983). Moreover, Wang and Ning, (1997); Fraga *et al.* (1998) reported that Male had a significantly lower percentage of internal fat than females, but there were no significant differences between the sexes in carcass yield or the yield of prime cuts.

2.5.5 Influence of age on meat Characteristics

Age of a bird plays a great role in meat characteristics. As the birds grow there is a great change in carcass yield and quality. Bochno *et al.* (1989) and Sobina *et al.* (1989) reported that at 8 weeks of age the carcass yield of duck ranged between 66.7-67.3%, muscle yield 47.1-48.1% bones 16.4%, DM 19.7%, CP 19.9%, fat 1.5% and ash 1.2%. Moreover, Wawro and Brzozowski, (1998) reported that breast muscle of Pekin ducks increased from 5.8% at 5 weeks to 13.07% at 11 weeks. Leg muscle decreased from 10.2% at 5 weeks to 7.53% at 11 weeks and total meat was increased from 22.94% at 5 weeks to 28.10% at 11 weeks of age. However, Fraga *et al.* (1998) reported that the carcass yield ranged between 57-61% for ducks slaughtered at 9-10 weeks of age.

Reddy and Reddy, (1990); Richter, (1993) and Brun *et al.* (1998) recommended that Campbell ducks slaughtered at 3-9 months had increase in CP and fat in their muscles. The dressing percentage at 80-90 weeks of age were slightly higher than at 72 weeks, but weight of heart, gizzard and liver were not significantly affected by age at 72-100 weeks (Wang and Wan, (1995). Study by Baeza *et al.* (1998) showed a decrease with age in meat tenderness, juiciness and mellowness whereas there was an increase in flavour and stringiness. At any given age, breast meat from females were less tender, less juicy and less mellow but had a more intense flavour and was more stringer than males. Roger et al. (1993) also reported similar observation with a linear decrease in leg and thigh meat with age. Like other animals, if Muscovy drakes are left too long the flesh becomes too tough (Batty, 1979).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Field survey

The survey was conducted at three farms namely Kingolwira, Ubena Bwawani Prison farms and Livestock Training Institute Mpwapwa. The aim of the survey was to get knowledge on how ducks are reared on these farms and correlate information gathered with that obtained from the on station experiment. During the survey, structured questionnaires were administered to the three farms. Main information collected from these farms includes feeding regime, housing, meat and egg production, reproduction performance, diseases and mortality rates during the different stages of growth. In addition on site observations and measurements were taken for body weights at different ages, egg size and number.

3.2. On station experimental layout

A study aimed at evaluating the performance of Muscovy ducks kept under two rearing systems i.e. semi and full confinement was conducted at the Department of Animal Science and Production, Sokoine University of Agriculture (SUA). The University lies about 600m above sea level and has a hot climatic condition almost throughout the year. The average humidity is about 78% and temperature ranges between 20^0 C and 35° C.

The initial set up of the experiment was to use 1-7 day s old ducklings. However, the plan didn't work since the supliers ran out of business due to high feed costs. Therefore I compelled to use older ducklings that were randomly selected from Mpwapwa and morogoro rural. This was however accounted by including a covariate (initial body weight) in the model that was significantly shown in appendix Ic (IWT). Weaned ducklings aged 8 weeks were purchased from Mpwapwa and Morogoro rural areas. Numbered plastic tags were fixed to one wing of each duckling at end of the first week of the experiment. This was not done at arrival because the ducklings were exhausted and the operation was therefore delayed to reduce stress.

Sixty-four ducklings were randomly allocated to the two rearing systems under complete randomised design. Each rearing system had 32 ducklings with two replicates having 16 birds. Space allowance per bird on range was kept at 7.5 m^2/bird and for full confinement, the floor area of about $1.2m^2$/bird was provided. Birds stayed on the range from 0800-1600 hours in the evening. The pop holes leading to the range were closed during the daytime. Water baths were availed outside of the living quarters. These yards were used to provide water for swimming and also forage for ducks kept under semi-confinement. The distribution of forage plants showed dominance of *Cynodon spp.* including natural grasses and forbs, mainly *Amaranthus spp. and Sida spp.*

Full confinement had two replicate pens adjacent to each other with dimension of 3m x 6m. For semi confinement system, two running yards each with dimensions of 6m x 20m were provided (Fig. 1).

3.2.1. Management of experimental birds

All birds were fed commercial growers mash. Proximate analysis of feed was done as described by AOAC, (1992).

<table>
<tr><td colspan="2">Semi confinement
Running yard 1</td><td colspan="2">Semi confinement
Running yard 2</td></tr>
<tr><td>Semi confined
Pen 1</td><td>Fully confined
Pen 2</td><td>Fully confined
Pen 3</td><td>Semi confined
Pen 4</td></tr>
</table>

Figure 1: Experimental Layout

Chemical composition of the experimental diet is presented in Table 6. To reduce risk of diseases, all ducklings were given antihelminths and bacteriostat during the first week. Litter replacement was done after 4 weeks in order to control coccidiosis. However, one bird was infected by typhoid disease during the 13^{th} week of age. The bird was isolated and treated using oxytetracycline drug. The bird recovered after one week. The remaining birds in all pens were also given the same drugs to prevent further spread of the disease. No further outbreak of diseases was observed after prophylactic treatment.

Table 6: Chemical composition of experimental diet.

Nutrient component	Amount in percentage
Dry matter	92.99
Nitrogen free extracts	45.30
Ash	17.11
Crude protein	14.90
Crude fibre	10.38
Ether extract	5.30

3.3. Parameters measured

3.3.1. Feed Intake and weight gain

Ducklings were weighed at the end of the first week in order to get the initial body weight. During the 12 weeks of the experiment, individual live weight of the ducklings was taken every week. Feed was given in metal troughs fixed about 15cm above the floor. Wire mesh was placed on the top of feeding troughs in order to minimise spillage. Every morning feed left in the troughs was weighed. This was subtracted from the weight of the feed given the previous day to obtain daily feed intake. Cumulative weekly feed intake in each pen was obtained by adding daily feed intake. Growth rate (g/day) was calculated from live weight using the following formula:

$$GR = (WT2 - WT1) / T$$

Where:

GR = Growth rate

WT1 = Live weight at the beginning of the week

WT2 = Live weight at the end of the week

T = Time period (days)

3.3.2 Meat characteristics

At the end of the 20th week of age, 24 ducks were randomly picked from the two treatments (viz semi & full confinement) and slaughtered for carcass analysis. Plucking was done after scalding in hot water. The legs were severed at the tibio-metatarsal joint. Evisceration was done through a transverse incision of the abdominal wall 1cm caudal to the distal end of the keel. Liver and heart were separated from the carcass. The gizzard was separated from the rest of the gut, longitudinally split so that the ingesta and horny layer of gizzard could be separated and discarded. The gizzard was also weighed and recorded. Weight for other none-edible parts such as the heads, intestines, shanks, blood and feathers were also recorded. The intestinal length was recorded. Dressing percentage of the ducks slaughtered were obtained by expressing the carcass weights as percentage of live weight using the following formula:

$DP=(CWT/LWT) \times 100$

Where:

DP= dressing percent

CWT= carcass weight

LWT= live weight

3.3.2.1 Meat separation

Deep frozen carcasses were longitudinally split into two halves using a hacksaw and dissecting knife. One half was weighed and dissected into lean meat, bone and fat using sharp dissecting knives. Each separated component (lean meat, bones and fat) were weighed and then multiplied by two in order to get the weight of the two halves. Percentage of lean meat, bones and fat were calculated by using the following formula:

Percent X = (Weight of X/ Weight of dressed carcass)X 100

Where:

X = Lean meat or bones or fat.

3.3.2.2: Chemical analysis of carcasses

The same birds used for meat yield and separation were used for chemical analysis. The number of birds and sampling procedure are as described in 3.3.2. The separated lean meat, bones and fat were mixed with the other half and then minced together to meat paste. The meat paste was minced twice in order to get homogenous paste. The meat pastes was then deep-frozen and freeze dried for five days. Proximate analysis of meat was done as described by AOAC, (1992). Dried samples were ground and analysed for dry matter (DM) on dried basis, crude protein (CP) ether extracts (EE), ash and crude fibre (CF) using the proximate analysis procedures.

3.4 Statistical Model and Analysis of Data

Two way analysis of variance described by Snedecor and Cochran, (1996) was done for the individual live weights, and average daily gain of ducks. Points to be considered in experimental design are few birds per subclass (16 birds per replicate) and unbalanced design in terms of sex distribution (6 males and 10 females per replicate). Physical carcass characteristics of 12 ducks from each replicate (3 males and 3 females) picked up for slaughter were analysed in a complete randomised block design (CRBD) fitting initial body weight as a covariate for weight gain and slaughter weight for carcass evaluation.

Treatment means of parameters analysed were subjected to the Least significant difference (LSD) test as described by Snedecor and Cochran, (1996) and SAS, (1992). The statistical model for feed intake analysis was as follows:

$$Y_{ijkl} = \mu + R_i + P_j + W_k + B_l + \eta_{ik} + E_{ijkl}$$

Where

Y_{ijkl} = Response of duck in the i^{th} rearing system in the j^{th} replication in the k^{th} week on the l^{th} bird.

μ = General mean

R_i = Effect due to i^{th} Rearing System

P_j= Effect due to j th Replication

W_k = Effect due to k th week

B_l = Effect due to the lth bird

η_{ik} = Interaction between rearing system and week

E_{ijkl} = Random error specific to each ducks.

The statistical model for body weight gain, sex, growth rate and carcass yield and quality was as follows:

$Y_{ijkl} = \mu + R_i + P_j + S_k + B_l + \eta_{ik} + b(X - \bar{X}) + E_{ijkl}$

Where

Y_{ijkl} = Response of duck in the i th rearing system in the Jth replication in the k th week

μ = General means

R_I = Effect due to ith Rearing System

P_j= Effect due to j th replication

S_k= Effect due to k th week

B_l = Effect due to the lth bird

η_{ik} = Interaction between rearing system and sex.

X = Effect due to the covariate (initial body weight on growth or slaughter weight for carcass composition)

$\bar{X}$ = Overall mean of the covariate (initial or slaughter body weight)

b = regression of X on $\bar{X}$

E_{ijkl} – Random error specific to each duck.

CHAPTER FOUR

4.0 RESULTS

4.1 Field survey

4.1.1 General overview of surveyed farms

Ubena and Kingolwira prison farms were mainly involved in agricultural activities. Both farms kept different farm animals as indicated in Table 8. LITI Mpwapwa was mainly involved in training livestock technicians and farmers on modern livestock husbandry. In all three surveyed farms, ducks were kept, as secondary animals while dairy cattle were primary.

Ubena prison farm kept Pekin ducks, while Kingolwira and LITI Mpwapwa farms kept native Muscovy ducks obtained from their neighbouring farmers around the institutions. Detailed summary of general management at the farms is as shown in Table 7.

Table 7: General management practices of the surveyed farms

Parameter	Ubena prison	Kingolwira prison	LITI Mpwapwa
Farm activities	Livestock production	Dairying	Training livestock technicians and farmers
Livestock species kept	Cattle 381, goat 12, sheep 8, ducks 108	Dairy cattle 245, beef cattle 160, pigs 40, ducks 74	Cattle 27, pigs 20, ducks 40
Source of ducks	Hungary	Neighbouring farmers	Neighbouring farmers
Egg production			
- laying ducks	2	0	0
- average egg/d	Not recorded	Not recorded	Not recorded
- average egg wt (g)	70	Not recorded	Not recorded
- laying season	Throughout the year	Throughout the year	Throughout the year
- Season (high egg yield)	Dry season	Dry season	Dry season
Egg demand	High	Low	Low
Marketing place	At the farm, Mikumi tourist hotel	Shop centres, at the farm	Shop centres, at the farm
Duck product price (Tshs)	Not sold	1200	Not sold
- egg/tray	4000	1500	2000
- male duck	5000	1500	2000

- female duck Type of housing	Mud sheds with water pond	Burnt clay houses	Burnt clay houses with fenced yard and water bath
House condition	Fairy good	Fairy good	Good
Death causes	Diseases and predators	Diseases and predators	Diseases and predators
Major diseases	Not known	Not known	Salmonella borne diseases
Mortality rate %	6	Not recorded	Not recorded

4.1.2 Feeding and management practice

Semi confinement was practised at Ubena prison and Livestock Training Institute (LITI) Mpwapwa whereas free-range system of feeding was used at Kingolwira. At LITI Mpwapwa there was a concrete water trough with dimension of 3m X 1.5m X 0.6m. The yard was fenced with wire mesh while at Ubena prison farm there was a water dam stocked with fish. Ducks were fed both the commercial nd locally compounded feeds. Other feedstuffs used in feeding were maize bran, maize meal, wheat bran and sunflower seed cake.

Birds were fed once a day and used both wet and dry feeding methods were used. The major problems encountered in all farms included feed availability and high feed prices. The summary of feeding practices at the farms is shown on Table 8.

Table 8: Summary of feeding practices on the surveyed farms

Parameter	Ubena Prison	Kingolwira Prison	LITI Mpwapwa
Method of rearing	Semi confinement	Free range	Semi confinement
-Reason	Water availability	Lack of feeds	For training purposes
Grain feeding	Yes	Yes	Yes
Type of feeds	Commercial feeds, maize bran, wheat bran	Commercial feeds, maize bran, wheat bran	Maize meal, maize bran, sunflower seed cake
Reason for Choice	Depend on fund availability	Depend on fund availability	Feedstuffs are grown by students
Frequency of feedings per day	2	1	1
Access to swimming water	Yes	No	Yes
Major feeding problems	Lack of funds, high costs of feeds	Lack of funds, high costs of feeds	Drought, poor availability of commercial feeds

4.1.3 Body weight and Growth rate

Table 9 gives a summary of body weight of different groups of ducks in the three farms. However, sexing was not done at day old stage. Male ducks of the same age were heavier than females (Table 9) thus indicating that male ducks had faster growth rates than females. It was also observed that male ducks had slower feathering than female ducks. In Ubena prison farm, Pekin ducks were heavier than Muscovy ducks from Kingolwira prison and LITI Mpwapwa farms.

4.1.4 Breeding practice

Table 10 shows the number of ducks in different age groups in the three surveyed farms. The average male/ female ratio was 1:6. Ubena prison farm the ratio being higher than at LITI Mpwapwa. Due to poor record keeping ratios at Kingolwira prison farm were not available. There was no controlled breeding thus birds were allowed to breed throughout the year. It was noted that high egg production and hatchability was achieved during the dry season. Kingolwira prison and LITI Mpwapwa used natural incubation and brooding while Ubena prison used artificial incubation. The average eggs set for natural incubation ranged between 10-15 eggs per duck while for artificial incubation ranged between 50-100 eggs per batch. The hatchability for natural incubation ranged between 60-90% while for artificial incubation was 50-60%.

Table 9: Weight of different groups of ducks in the three surveyed farms (g).

Sex	Ubena prison[1]	Kingolwira[2] prison	LITI Mpwapwa[2]
Male			
- 0-12weeks	700	Not recorded	Not recorded
- 13-24 weeks	2000	1200	1200
- 25-52 weeks	2500	1800	1900
- over 52 wks	3000	2000	2000
Females			
- 0-12weeks	700	not recorded	not recorded
- 13-24 weeks	1500	800	700
- 25-52 weeks	2300	1300	1400
over 52 wks	2600	1500	1700

[1]-White Pekin ducks

[2]-Muscovy ducks

However, LITI Mpwapwa and Kingolwira prison farms used natural brooding when ducklings were hatched during the rainy season. Detailed summary of breeding parameters is shown in Table 11.

4.1.5 Health status of birds

The average mortality rate for ducks on the surveyed farms was 6%. The most vulnerable group was the ducklings between 0-12 weeks of age. The major disease conditions were Salmonella borne diseases as reported by LITI Mpwapwa. However, Ubena and Kingolwira prison farms didn't know the causal factors. Other causes of death included vermin attack and nutritional deficiencies.

4.2 On station experiment results

4.2.1. Feed intake

Least square means for feed intake (g/day) for the two rearing systems are presented in Table 12. Analysis of variance for the two systems is shown in Appendix II. The mean daily feed intake for semi and fully confined ducks (148.8g vs. 148.3g) was similar at $P>0.05$. However, there was significant increase ($P<0.001$) in feed intake with age.

Interaction between the two rearing systems and rearing period was highly not significant at P>0.05.

Table 10: Number of birds of different age groups in the three Surveyed farms.

Sex	Ubena prison	Kingolwira prison	LITI Mpwapwa
Male			
- 0-12weeks	0	10	0
- 13-24 weeks	11	16	3
- 25-52 weeks	25	9	5
- over 52 wks	0	4	5
Females			
- 0-12weeks	0	5	0
- 13-24 weeks	18	20	7
- 25-52 weeks	54	10	15
- over 52 wks	0	0	5
Total	**108**	**74**	**40**

Table 11: Summary of breeding information of the surveyed farms

Parameter	Ubena prison	Kingolwira Prison	LITI Mpwapwa
Breeds and their physical	White Pekin	Muscovy ducks	Muscovy ducks
features	(White)	(Black and white)	(Black and white)
Mating ratio			
(male/female)	1:7	Not recorded	Not recorded
Breeding season	throughout the year	throughout the year	throughout the year
Incubation method	Artificial	Natural	Natural
Number of eggs per	More than 50	15	10-15
incubation	Dry season	Dry season	Dry season
High hatchability season	Not recorded	Not recorded	
Hatchability (%)			
- Per duck	50	Not recorded	80-90
- Per flock	Not recorded	Not recorded	60-70
Brooding method	Artificial	Natural	Natural
Feathering rate			
- Male	Slow	Slow	Slow
- Female	Fast	Fast	Fast

Figure 2 shows the feed intake pattern for the whole rearing period. During the first two weeks of the experiment feed intake was similar for the two rearing systems, while during the last 4 weeks fully confined birds had higher feed intake than semi confined birds.

Table 12: Least square means for feed intake (g feed/d/b) in the two rearing systems (±SEM)

Parameter	Rearing system	
Age (week)	Semi confinement	Full confinement
9	61.7 ± 2.6	60.2 ± 2.6
10	99.3 ± 2.6	99.3 ± 2.6
11	121.3 ± 2.6	117.2 ± 2.6
12	143.3 ± 2.6	140.3 ± 2.6
13	148.6 ± 2.6	147.2 ± 2.6
14	158.6 ± 2.6	160.7 ± 2.6
15	162.9 ± 2.6	161.3 ± 2.6
16	170.2 ± 2.6	161.6 ± 2.6
17	177.4 ± 2.6	178.5 ± 2.6
18	175.5 ± 2.6	178.3 ± 2.6
19	178.4 ± 2.6	181.5 ± 2.6
20	187.9 ± 2.6	193.4 ± 2.6
overall mean	148.8 ± 0.7	148.3 ± 0.7

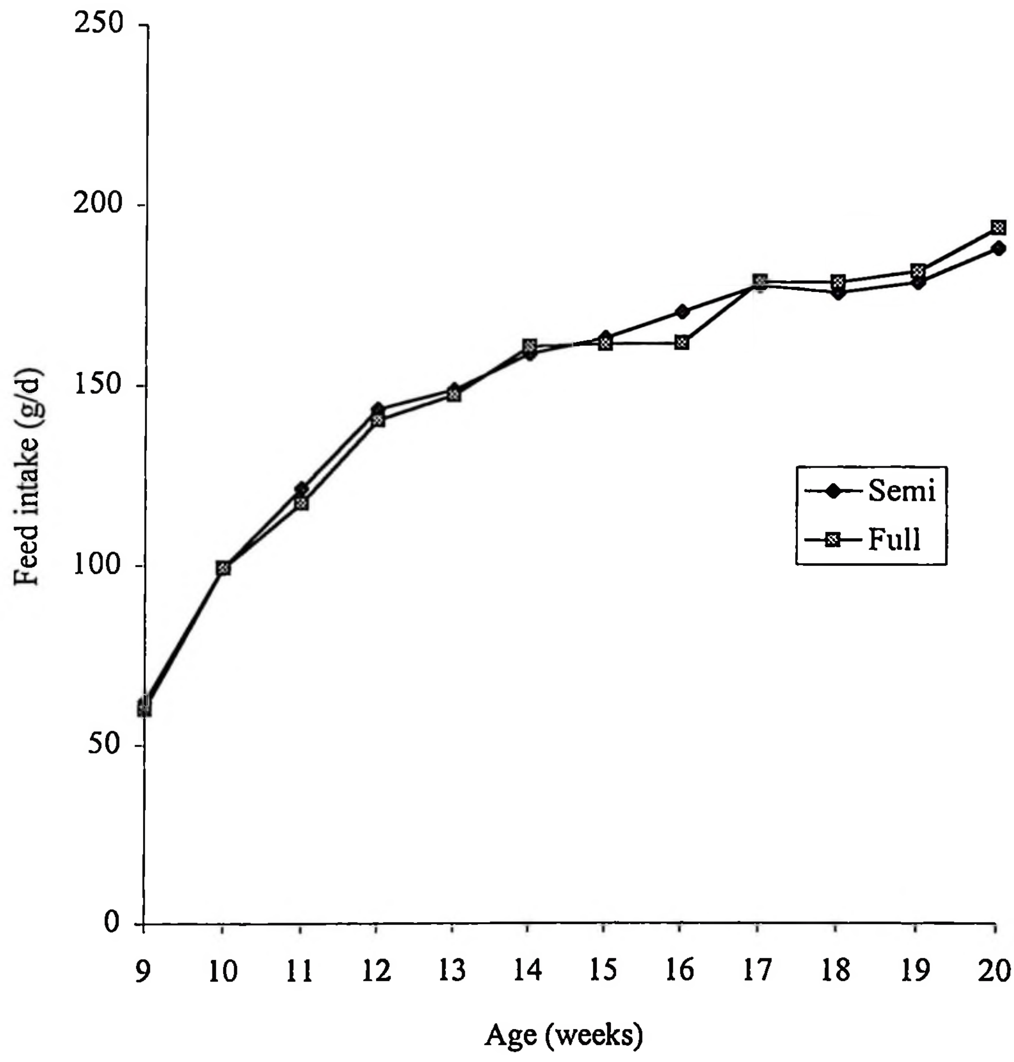

Figure 2: Weekly feed intake

4.2.2 Feed conversion ratio

Least square means for feed conversion ratio (feed/gain) for the two rearing systems are shown in Table 13. The analysis of variance summary is shown in appendix II. The results showed that semi and fully confined birds had no significant difference (P>0.05) on feed conversion ratio. Moreover, Feed conversion ratio significantly increasing with age.

4.2.3 Body weight

Least square means for weekly body weight for the whole rearing periods are shown in Table 15. The results showed that the body weight of semi and fully confined birds had no significant difference (P>0.05. Male ducks had higher body weight than females (2868g vs. 1821g respectively). The interaction between sex and rearing period was very significant at P<0.001. Figure 3 and 4 shows a linear trend of weekly body weight for the two rearing systems.

Table 13: Least square means for feed conversion ratio (g feed/body weight gain) in two rearing systems (±SEM)

Parameter	Rearing system	
Age (week)	Semi confinement	Full confinement
9	6.2 ± 2.5	4.4 ± 2.5
10	4.9 ± 2.5	4.1 ± 2.5
11	5.1 ± 2.5	4.5 ± 2.5
12	6.3 ± 2.5	6.7 ± 2.5
13	6.7 ± 2.5	7.4 ± 2.5
14	6.8 ± 2.5	9.5 ± 2.5
15	8.7 ± 2.5	7.5 ± 2.5
16	11.1 ± 2.5	7.8 ± 2.5
17	13.9 ± 2.5	20.6 ± 2.5
18	27.9 ± 2.5	14.5 ± 2.5
19[a]	11.4 ± 2.5	9.1 ± 2.5
overall mean	10.0 ± 1.0	9.7 ± 1.0

[a] The drop in FCR was due decrease in rain which was affecting the performance ducks.

4.2.4 Growth rate

The average daily gains of birds were 17.5g. Table 15 shows the summary of daily gain during the experiment. The results showed considerable variation between weeks with respect to growth rate throughout the experiment. Generally, the growth rate between the two rearing systems gave similar results at $P>0.05$. Males had significantly higher ($P<0.001$) growth rate than females. Also the growth rate was decreasing with age ($P<0.001$). However, interaction between rearing systems and age was not significant at $P>0.05$. The cumulative growth rate was as shown in fig. 5.

Table 14: Least square means for weekly live weight (g/ bird) in the two sexes and rearing systems (±SEM)

Parameter	Sex		Rearing system	
Age (week)	Female	Male	Semi confinement	Full confinement
9	978.5 ± 45.1	946.4 ± 48.7	960.5 ± 47.4	964.5 ± 47.0
10	1054.0 ± 45.1	1034.7 ± 48.7	1027.8 ± 47.4	1060.9 ± 47.0
11	1161.6 ± 45.1	1236.2 ± 48.7	1167.9 ± 47.4	1229.9 ± 47.0
12	1300.8 ± 45.1	1445.1 ± 48.7	1333.8 ± 47.4	1412.1 ± 47.0
13	1405.9 ± 45.1	1645.9 ± 48.7	1492.7 ± 47.4	1559.1 ± 47.0
14	1502.3 ± 45.1	1843.4 ± 48.7	1646.0 ± 47.4	1699.7 ± 47.0
15	1567.5 ± 45.1	2059.4 ± 48.7	1807.0 ± 47.4	1820.0 ± 47.0
16	1630.5 ± 45.1	2278.0 ± 48.7	1937.2 ± 47.4	1971.3 ± 47.0
17	1688.7 ± 45.1	2472.1 ± 48.7	2043.7 ± 47.4	2117.0 ± 47.0
18	1710.7 ± 45.1	2600.4 ± 48.7	2131.8 ± 47.4	2179.4 ± 47.0
18	1731.0 ± 45.1	2710.8 ± 48.7	2174.6 ± 47.4	2267.2 ± 47.0
20	1821.3 ± 45.1	2868.4 ± 48.7	2280.9 ± 47.4	2408.9 ± 47.0

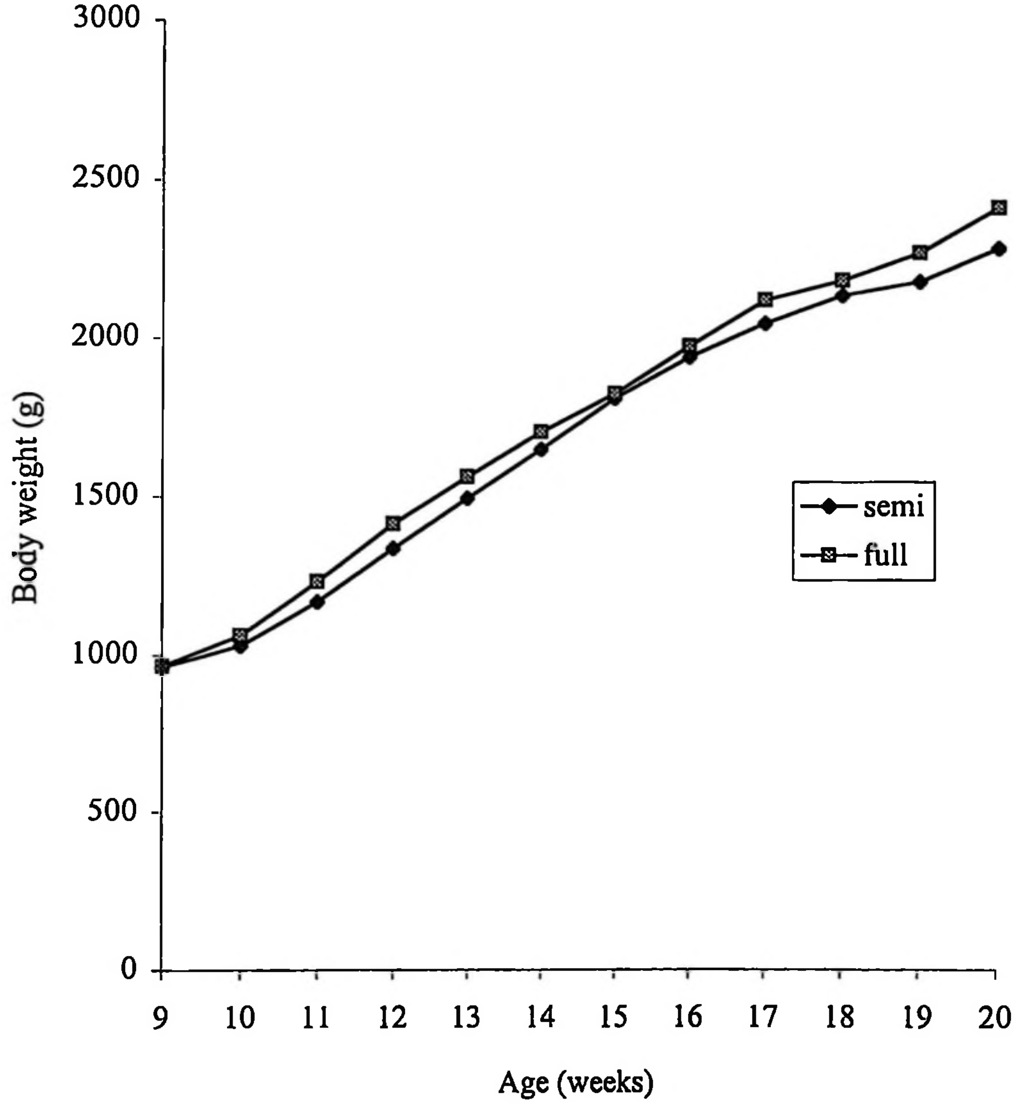

Figure 3: Weekly body weight

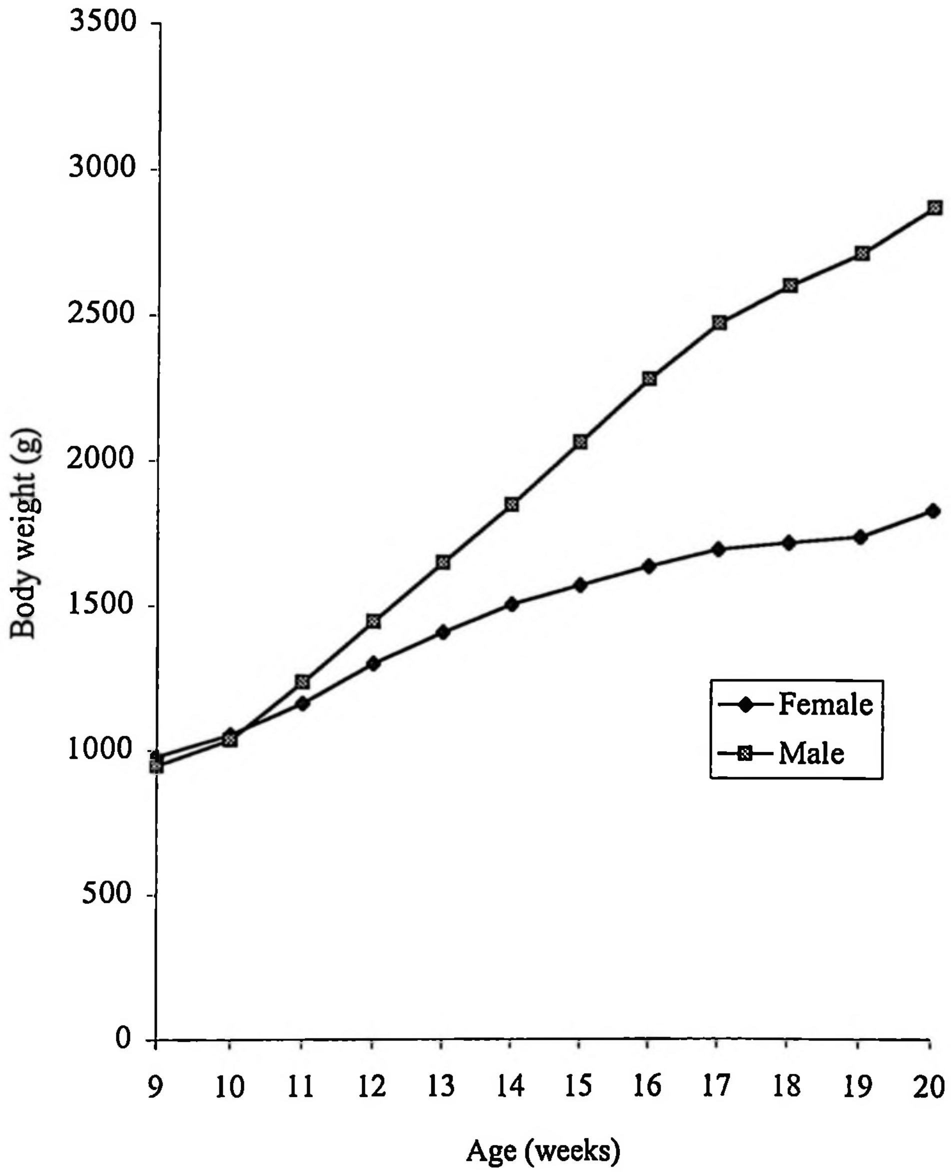

Figure 4: Weekly body weight of male and female birds

Table 15: Least square means for growth rate (g/day) in the two sexes and rearing systems (±SEM)

Parameter	Sex		Rearing system	
Age (weeks)	Female	Male	Semi confinement	Full confinement
9	17.4 ± 2.1	12.5 ± 2.4	9.7 ± 2.3	13.6 ± 2.3
10	15.2 ± 2.1	28.8 ± 2.4	20.2 ± 2.3	23.9 ± 2.3
11	19.7 ± 2.1	29.9 ± 2.4	23.9 ± 2.3	25.8 ± 2.3
12	14.9 ± 2.1	28.7 ± 2.4	22.9 ± 2.3	20.8 ± 2.3
13	13.3 ± 2.1	28.3 ± 2.4	22.1 ± 2.3	19.9 ± 2.3
14	9.2 ± 2.1	30.9 ± 2.4	23.2 ± 2.3	17.0 ± 2.3
15	8.9 ± 2.1	31.3 ± 2.4	18.8 ± 2.3	21.4 ± 2.3
16	8.2 ± 2.1	27.8 ± 2.4	15.4 ± 2.3	20.6 ± 2.3
17	3.1 ± 2.1	18.4 ± 2.4	12.8 ± 2.3	8.7 ± 2.3
18	2.8 ± 2.1	15.8 ± 2.4	6.3 ± 2.3	12.3 ± 2.3
19	12.8 ± 2.1	22.8 ± 2.4	15.4 ± 2.3	20.0 ± 2.3
Overall mean	10.9 ± 0.6	25.2 ± 0.7	17.3 ± 0.7	18.6 ± 0.7

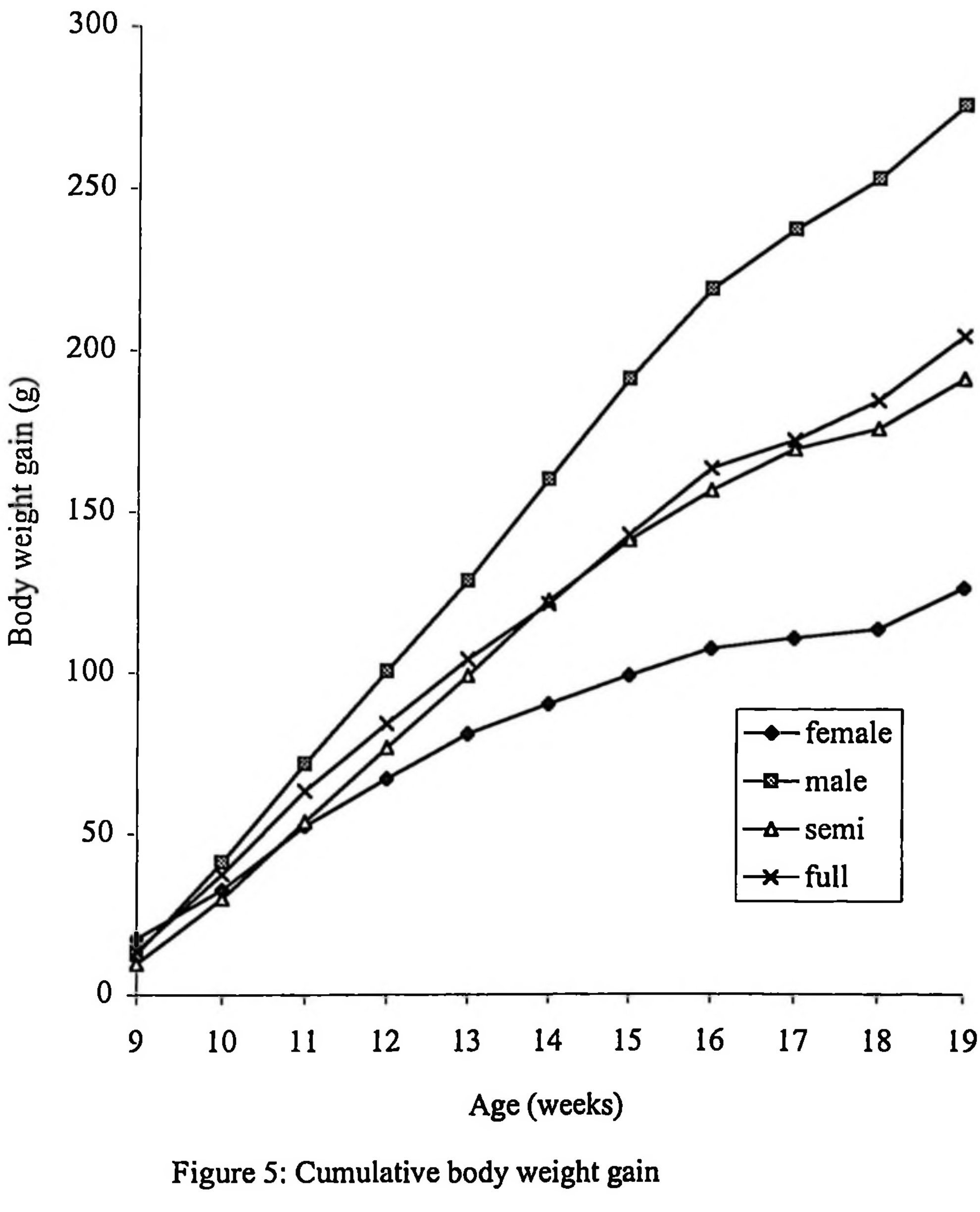

Figure 5: Cumulative body weight gain

4.2.5 Carcass yield

Table 16 shows the summary of least square means for carcass composition. The overall mean for carcass dressing was 68 percent. The dressing percentage of carcass between the two rearing systems was similar at $P>0.05$. The mean percentage for muscle, bones, body fat, edible and non- edible parts were as shown in appendix II. In general, the carcass yield in the two rearing systems was non-significant results at $P=0.05$. The interaction between the two rearing systems and sex was not significant. However, male ducks produced more meat than females.

Muscle yield for the two rearing systems was similar values at $P>0.05$. Bone yield did not differ between full and semi confinement system. Body fat i.e. abdominal pad fat and fats around the organs of ducks in the two rearing systems were not significant different ($P>0.05$).

The percent of the internal edible organs i.e. liver, heart and gizzard in the two rearing systems didn't differ significantly ($P<0.05$). Sex had significant effect on ash, gizzard, heart, fat and lean meat. Similarly the non-edible organs i.e. intestines, shanks, head, blood and feathers yield of ducks in the two rearing systems didn't differ. The intestinal length means were significantly different ($P<0.01$) between sexes. Semi confined birds had longer intestines (191.3cm) than fully confined birds (168.5cm).

4.2.6 Chemical composition of meat

Table 17 shows the summary of proximate analysis of the duck meat. The ANOVA tables are shown in appendix II. The DM content in the two rearing systems was similar at ($P>0.05$). Females had higher ($P<0.001$) DM content than males.

The CP content between the two rearing systems didn't differ at $P>0.05$ but males had higher CP content ($P<0.05$) than females. The EE content was similar ($P>0.05$) between semi and fully confined birds and also between males and females. The ash content in the two rearing systems was similar at $P>0.05$. Males had higher CP content than females at $P<0.05$.

Table 16: Least square means for carcass traits in the two sexes and rearing systems (±SEM)

Parameter	Sex		Rearing system	
	Female	Male	Semi confinement	Full confinement
Live weight (g)	1821.3 ± 45.1	2868.4 ± 48.7	2280.9 ± 47.4	2408.9 ± 47.0
Dressed carcass(%)	64.6 ± 2.9	72.2 ± 2.9	68.9 ± 0.8	67.9 ± 0.8
Edible organs (%)	5.5 ± 0.7	6.9 ± 2.9	6.4 ± 0.2	5.9 ± 0.2
- Liver (%)	1.3 ± 0.3	2.6 ± 03	1.9 ± 0.1	1.7 ± 0.1
- Heart (%)	0.9 ± 0.1	0.9 ± 0.1	0.9 ± 0.0	1 ± 0.0
- Gizzard (%)	3.2 ± 0.4	3.4 ± 0.4	3.6 ± 0.1	3.3 ± 0.1
Non edible organs(%)	29.9 ± 2.9	21.0 ± 2.9	24.7 ± 0.1	26.2 ± 0.8
- Head (%)	3.6 ± 0.3	5.0 ± 0.3	4.4 ± 0.1	4.2 ± 0.1
- Intestines (%)	6.2 ± 0.6	4.5 ± 0.6	5.4 ± 0.2	5.3 ± 0.2
- Shanks (%)	2.2 ± 0.2	3.6 ± 0.2	3.0 ± 0.1	2.8 ± 0.1
Blood + Feather(%)	17.9 ± 3.1	7.9 ± 3.0	11.9 ± 0.9	13.9 ± 0.9
intestinal length (cm)	181.7 ± 3.2	178.0 ± 13.2	191.3 ± 3.7	168.5 ± 3.7
Dissected carcass				
- Meat (%)	65.9 ± 4.7	80.5 ± 4.7	74.1 ± 1.3	72.3 ± 1.3
- Bones (%)	15.9 ± 1.2	16.5 ± 1.2	16.4 ± 0.3	16.0 ± 0.3
- Fats (%)	18. ± 4.0	3.0 ± 3.7	9.6 ± 1.2	11.6 ± 1.2

Table 17: Percent chemical composition of meat (±SEM)

Parameter	Sex		Rearing system	
	Female	Male	Semi confinement	Full confinement
DM (wet basis)	40.8 ± 0.9	34.7 ± 0.9	36.6 ± 0.9	38.9 ± 0.9
DM (dry basis)	99.6 ± 0.1	98.6 ± 0.1	99.0 ± 0.1	99.3 ± 0.9
Crude protein	47.3 ± 2.1	53.8 ± 2.1	52.8 ± 2.1	48.3 ± 2.1
Ether extracts	46.0 ± 2.6	39.3 ± 2.6	39.6 ± 2.6	45.7 ± 2.6
Ash	5.7 ± 0.4	7.0 ± 0.4	6.6 ± 0.4	6.0 ± 0.4

CHAPTER FIVE

5.0 DISCUSSION

5.1 General overview of surveyed farms

The present results showed that dairy farming was major activity on the farms. Ducks were the least in ranking. Thus, most of the resources were directed to cattle and very little to ducks production. This might have contributed in lowering the performance of ducks in these farms. Also the population sizes in all the three farms was very small probably due to high cost of feeding and low demands for eggs and live ducks.

Record keeping is very important in any enterprise in order to monitor production and performance of birds. However, it was noted that records were poor in terms of egg production, body weight, mortality rate and disease control. Poor record keeping might also contribute to problems in improvement especially when one wants to carry out selection for economic traits.

Low demand and marketing system of duck eggs might hinder expansion of duck industry. Also the price of live ducks was similar to that of broiler chicken. The price could discourage expansion of duck industry bearing in mind that they consume more feed compared to chickens (McDonald *et al.* 1995).

5.1.2 Health status of birds

The only health problem observed during the experiment was typhoid in fully confined birds. However, the disease did not cause any mortality. The health status of birds on station experiment was better than at Ubena prison, Kingolwira prison and LITI Mpwapwa farms probably due to good hygienic conditions. As described earlier, most of deaths were reported to occur when birds were younger i.e. during the first 12 weeks of age at Ubena, Kingolwira prison and LITI Mpwapwa farms. The present study, used birds aged 8 weeks. This could be one of the factors, which made mortality rate lower and better than that of the surveyed farms. Lack of proper disease control in the farms could be one of the reasons for high incidence of diseases. Duong *et al.* (1995) reported the survival rate of 98% for commercial ducks kept under intensive system and 90% for ducks kept in the field. The birds in semi confined system were not affected by the disease.

Ducks like watering and tends to wallow or swim when containers are large, therefore creating damp conditions in pens. This is likely to promote salmonella infection for fully confined birds due to minimum sanitation of feed and watering troughs. In semi confined birds the incidence might be minimal due to exposure to sun, which prevent the dampness. However, the housing conditions for Ubena and Kingolwira prison farms were fairly good. Moreover, the litter material was not thick enough to control dampness thus a contributing factor for disease outbreaks and poor health conditions.

Johnson, (1971) reported that the survival rates of ducks was directly related to the amount of protein contents of diets, thus by imposing the ducks direct to semi confinement i.e. range might have contributed supply of certain amount of protein from the forage thus reducing the mortality rate.

5.1.2 Breeding practice

Natural breeding was practiced in all farms. Male and female birds were mixed together. Therefore mating was done without influence of human and no labour was required. The system is commonly used in most developing countries especially to all poultry species kept extensively because it is easy to manage and practice. Besides, the system can be used for large population size. Another reason for popularity is because of its cheapness when compared to artificial breeding that involves importation and storage of semen. Ubena prison farm made use of artificial incubation probably due to hatching many ducklings at a time. The farm reported that Pekin ducks were poor brooders. However, the Muscovy ducks were reported to be good brooders Which caused Kingolwira prison and LITI Mpwapwa farms use natural incubation and brooding. The average mating ratio (male/female) of 1:6 concurs with the recommendation made by Say, (1987). The ratio gives maximum conception and thus increasing percent hatchability of birds (Hafez, 1974). Likewise, natural incubation practiced in the two farms can also increase percent hatchability. Small population size of ducks in the two surveyed farms might contribute in the use of natural incubation. Other factors that may affect hatchability include farm management (improper handling, holding, transport and storage of eggs prior to incubation and improper management of hatchery), diseases transmitted within the eggs, genetics, nutritional and age of birds (Opel, 1979).

5.2 On station experiment

5.2.1 Proximate analysis of diet

The crude protein, ether extract and ash levels of the commercial grower's mash used in this study concur with recommended levels (McDonald *et al.* 1995 and Shanshu *et al.* 1996). Similar findings were reported by Leclercq and Carville, (1989) suggesting that CP content of 15% gave maximum weight gain and did not alter abdominal fat content. However, the crude fibre level of 10.8% observed in the present study was higher than recommended level of 3-5% of the total diet for poultry species. The commercial growers mash had significantly higher crude fibre probably due to use of high fibre feed ingredients like maize bran, wheat bran, and cotton and sunflower seed cake.

5.2.2 Feed intake

The overall intake for birds in semi and fully confined systems were similar. This result differ with that of Paci *et al.* (1992) which noted higher daily feed consumption for outdoor ducks than for ducks kept indoors. However, the results are similar with the findings reported by Sharma and Nanda, (1989) who did the study with Campbell ducks kept under deep litter system. Lack of significant differences for feed intake, could be due to limited greens because of small space for semi confined birds. Bintang and Tangendjaja, (1996) and El-Deek *et al.* (1997) obtained similar findings when assigned protein diets at different levels were fed to ducks.

A slight increase in feed intake observed towards the end of the study for semi and fully confined birds might be due to increase in feed requirement because of increase in physiological activities, body size accompanying sexual maturity. Feed intake was increasing with respect to age in both rearing systems. The same trend was reported by Edar *et al.* (1996) when birds were kept on paddocks because of increased feed requirement so as to maintain body weight, physiological and metabolic body activities.

5.2.3 Feed Conversion ratio

Findings from the present study showed that fully confined birds had similar feed conversion ratio to the semi confined birds. Similar results were obtained by Petre *et al.* (1990) for Mullard ducks kept for 16 weeks and Sharma and Nanda, (1989) for Campbell ducks kept under deep litter system. This result differs with observation made by Farrell, (1995) which suggest that concentrate when mixed with green forage can enhance mechanical degradation by the gizzard due to the high fibre levels.

In both rearing systems the feed conversion ratio value in this study was very high compared to that reported by (Duong *et al.* 1995). The reason for high feed conversion ratio for ducks in the present study was probably age factor. The present study was conducted at the age range of 8-20 weeks. During this period growth rate was lower than the first 8 weeks thus affecting the feed conversion ratio. High growth rate at the early stage of life is associated with high feed efficiency, hence low feed conversion ratio and vice versa. The difference in feed conversion ratio might be due to breed effects. Most of the authors used improved breeds of ducks especially crosses and hybrids which have low feed conversion ratio for meat and egg production. Nguyen, (1996) reported that feed conversion ratio might be affected by breed. He emphasized that indigenous ducks in most cases have lower feed conversion efficiency when compared to commercial ducks. The performance of birds in these two rearing systems probably was influenced by this factor bearing in mind that ducks were collected from rural areas. The reason which might have contributed to semi confined birds having similar feed conversion ratio to confined birds might be poor quality of green forage. High feed conversion ratio might affect the ducks body weight gain and hence low body weight at slaughter. However, the cumulative feed conversion ratio could be improved through increasing the stocking rate of ducks because birds will have less space for exercise thus more weight gain per feed eaten (Osman, (1993). Also as a biological factor, selection for feed conversion efficiency can help to improve the performance of ducks (Emmerson, 1991).

5.2.4 Body weight and growth rate

The average body weight for ducks at the surveyed farms and on station experiment at the age of 20 weeks males were 1333g vs. 2868g and for females were 1000g vs. 1821g respectively. The reason for the difference between on station and surveyed farms could be difference in management in terms of feeding and hygienic conditions. Also difference in body weight between ducks at Ubena prison farm and those from Kingolwira prison and LITI Mpwapwa was probably due to difference in breeds. Pekin ducks at Ubena prison imported from Hungary have been developed for either meat or egg production while the Muscovy ducks from Kingolwira prison farm and LITI Mpwapwa were indigenous and have been not developed for any trait. Ubena prison farm had a large pond, which might have more biomass, invertebrates, and vertebrates like fish. Nevertheless, Muscovy ducks at LITI Mpwapwa had better body weight than from Kingolwira prison farm probably due to good management bearing in mind that LITI Mpwapwa is a livestock-training centre. Rearing system might also be a contributing factor between Kingolwira prison farm and LITI Mpwapwa as they use free range and semi confinement respectively.

There was a significant increase in body weight for fully confined birds as compared to the semi-confined birds. Duong *et al.* (1995) reported similar findings on the performance of CV Super-M duck breed in the Southern province of Vietnam. Fully confined birds had high stocking rate, which might reduce space for exercise and other activities thus reducing energy wastage. On station experiment showed that body weight of birds at the 20th week of age were slightly heavier than that from the surveyed farms probably because of good diet and management during the experiment.

Nguyen, (1996) reported the daily weight gain of local Muscovy ducks of 25g and for crosses was 31g when raised up to 12 weeks of age. However, in the present study the average daily gain at 11th week was 25g and at 12th week was 22g. Therefore the daily weight gain was almost similar. Nevertheless, at the end of the 20th week, the average daily gain was 18g. This means that the growth rate was decreasing with age from 11th week. Another reason, which might have contributed to the differences in daily weight gain could be the management of ducklings during the early stages. The ducklings were collected from different farmers with different management condition therefore poor management before the beginning of the experiment might have led to poor growth rate.

Rose, (1997) reported that male mature Muscovy duck had growth coefficient of 80g/day and female had 52g/day. In the present study, at 20th week of age males gained 25g/day while female gained 11g/day. The difference in growth coefficient might be as stated earlier that experimental birds had stunted growth before start of experiment. Differences in management and geographical location of experimental sites could have an effect on growth rate. However, Male ducks were significantly heavier than females as observed from both on station experiment and surveyed farms. This concurs with findings reported by Feltwell, (1980), Campbell *et al.*, (1983) and Smith (1990). The reason for the difference might be due to male having high feed conversion efficiency than females and hormonal influence (Johnson, 1971).

Lack of significant difference in growth rate between fully and semi confined system in the present study might be due to the fact that the environment were the same but the systems were different. The growth rate had similar trend as observed by Astiningsih *et al.* (1994). Male birds in both rearing systems had higher growth rate than females probably due to genetic make up. Sex and age had significant effect on growth during the first 8 weeks of experiment and the effect decreased during the last 4 weeks of experiment. This was in agreement with observation made by Rose, (1997) that the growth rate and time taken to reach mature body weight changes as it moves towards its maturity weight.

Feltwell, (1980) reported the average body weight of 6000g for male ducks and 3000g for females. The present study, the average body weight was 2868g for males and 1821g for females. This indicates that birds were still growing (Fig.5); thus, with good management and time the experimental birds might reach recommended mature body weights.

5.2.5 Carcass yield and quality

As expected birds that were heavier at slaughter had also heavier carcasses as observed in the present study. High growth rate was linked to higher dressing percentage (Hayse and Marion, 1973; Pesti and Fletcher, 1984). The birds kept on fully confinement had similar carcass weight like birds on semi confined system. Osman, (1993) revealed that the stocking rate had no significant effect on carcass traits and meat quality of male Pekin ducks. This might be due to similarity in the growth rate and efficiency of feed utilization (Bintang and Tangendjaja, 1996).

The carcass dressing percent was similar in both rearing systems. The major reasons for such similarity might be due to having similar genetic make up, feed intake, feed conversion ratio and growth rate (Garachka and Kas, 1994; Luong, *et al.*, 1995; Bogenfürst et *al.* 1995 and Vicenti *et al.* 1996). However, results differ with the suggestion of Marzoni *et al.* (1992) that Muscovy ducks finished outdoors had higher carcass yield than those of indoor, but there was no significant effect on fat and muscles was observed. The dressing percentage was affected by age but the internal organs like heart, gizzard, liver were not affected by age (Wang and Wan, 1995). Richter, (1993) reported that diets and finishing periods had an effect on proportion of fat. He noted that with increasing finishing time, body weights, and proportions of non-edible parts and offal usually decrease and the proportion of valuable parts increase. The percent of fat and muscle increased with age, (Brun *et al.* 1998). The reason for such trend might be due to stage of growth of birds. At that time most of ducks were approaching maturity age thus tended to deposit more fats and muscles.

The intestinal length for semi confined birds was significantly longer compared to fully confined birds. Bintang *et al.* (1997) observed similar findings when low, medium and high-energy diets were compared. The reason for the increase in length might be due to longer time required for digestion of high fibre foodstuff especially green forages. The DM, EE, CP and ash contents of the carcass were similar in both rearing systems. The results of the present study differ from those observed by Sobina *et al.* (1989), and Steklene, (1990). The reason might be the age of birds at slaughter since Sobina *et al.* (1989) slaughtered at 7 weeks of age, which was at younger stage, while in the present study birds were at the 20^{th} week of age. Thus at early stage of growth, the above nutrients are low. However, Reddy and Reddy, (1990) concluded that Campbell ducks slaughtered at 3-9 months of age showed an increase of protein and fat in their muscles.

The amount of fat in the present study was higher than the values reported by Garachka and Kas, (1994). The major reason might be due to stage of growth. Meat evaluation was done when birds were approaching point of maturity causing birds start depositing more fat rather than growing. The amount of fat in female ducks was slightly higher than that of males in both systems. Tai *et al.* (1991) reported similar findings on Pekin ducks. The major reason for such difference might be due to high-energy requirement for egg production as female birds were approaching egg production period.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS:

6.1 Conclusion

The findings of the present study showed that native Muscovy ducks found in the study area were resistant to most poultry diseases. The use of antibacterial drugs and good hygienic condition could prevent the outbreak of diseases. However, variability in ducks live weight between the farms was due to difference in management practices among the farms. Moreover, on station ducks were heavier than those from the surveyed farms indicate that native ducks can do well under good management practices. Natural breeding was commonly practiced in all the three farms. Also the natural incubation increased percent hatchability, but this is only suitable for small-scale production system as observed from the surveyed farms.

Performance characteristics of native Muscovy ducks in terms of feed intake, feed conversion ratio; body weight gain, carcass yield and quality were not affected by rearing system. This indicates that native Muscovy ducks can perform well in both semi and fully confined systems. Therefore the farmer can use any system depending on the preference.

6.2 Recommendations:

(a) There is a need to carryout further studies on performance of native ducks on various locally formulated rations.

(b) Sensory and organoleptic evaluation of duck meat in order to determine the acceptability of meat to the community.

(c) In order to improve performance of Muscovy strains, good management practices in terms of feeding, housing and disease control should be taken in consideration.

(d) Surveyed farms i.e. Ubena prison, Kingolwira and LITI Mpwapwa should improve the nutritional status and hygienic conditions of duck houses and feeding utensils in order to get better performance of ducks in their farms.

APPENDIX II ANALYSIS OF VARIANCE (ANOVA)

Appendix II a: ANOVA FOR FEED INTAKE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	17.78360119	17.78360119	0.19	0.6627
REP	1	352.80502976	352.80502976	3.78	0.0527
WEEK	11	449263.63794643	40842.14890422	437.86	0.0001
RSY*WEEK	11	1104.71532738	100.42866613	1.08	0.3796
Error	311	29009.39282739	93.27779044		
Corrected Total	335	479748.33473216			

Square	C.V.	Root MSE	INTAKE Mean
0.939532	6.502677	9.65804279	148.52410714

Appendix II b: ANOVA for feed conversion ratio

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	0.22918343	0.22918343	0.00	0.9834
REP	1	44.24473248	44.24473248	0.09	0.7723
WEEK	11	5741.51771073	521.95615552	1.03	0.4745
RSY*WEEK	11	6027.51931940	547.95630176	1.09	0.4425
REP*WEEK	11	7798.18252108	708.92568373	1.40	0.2838
Error	12	6058.14519872	504.84543323		
Corrected Total	47	25669.83866584			

R-Square	C.V.	Root MSE	FCR Mean
0.763998	227.1151	22.46876573	9.89311852

Appendix II c: ANOVA for weekly body weight (g)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	89700.52083331	89700.52083331	1.28	0.2590
REP	1	2287691.61774296	2287691.61774296	32.54	0.0001
SEX	1	52249480.51169530	52249480.51169530	743.21	0.0001
WEEK	11	149898223.42665400	13627111.22060490	193.83	0.0001
RSY*SEX	1	7779736.65678880	7779736.65678880	110.66	0.0001
RSY*WEEK	11	1066071.53454477	96915.59404952	1.38	0.1779
SEX*WEEK	11	26459173.88231860	2405379.44384715	34.21	0.0001
IWT	1	95136386.57064810	95136386.57064810	1353.24	0.0001
Error	729	51250709.75794050	70302.75686960		
Corrected Total	767	386217174.47916600			

R-Square	C.V.	Root MSE	WTG Mean
0.867301	15.78425	265.14667049	1679.81770833

Appendix II d: ANOVA for percent lean meat

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	14.41500000	14.41500000	0.72	0.4078
REP	1	12.61500000	12.61500000	0.63	0.4382
SEX	1	123.30666667	123.30666667	6.14	0.0233
RSY*SEX	1	12.90666667	12.90666667	0.64	0.4330
SWT	1	25.13031856	25.13031856	1.25	0.2778
Error	18	361.24468144	20.06914897		
Corrected Total	23	549.61833333			

R-Square	C.V.	Root MSE	MUWT Mean
0.342735	6.119331	4.47986037	73.20833333

Appendix II e: ANOVA for percent bones

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	0.60166667	0.60166667	0.44	0.5148
REP	1	0.32666667	0.32666667	0.24	0.6303
SEX	1	0.13500000	0.13500000	0.10	0.7566
RSY*SEX	1	6.20166667	6.20166667	4.55	0.0469
SWT	1	0.02070791	0.02070791	0.02	0.9033
Error	18	24.53262542	1.36292363		
Corrected Total	23	31.81833333			

R-Square	C.V.	Root MSE	BOWT Mean
0.228978	7.210148	1.16744320	16.19166667

Appendix II f: ANOVA for percent fat

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	20.53500000	20.53500000	1.40	0.2519
REP	1	9.12666667	9.12666667	0.62	0.4402
SEX	1	130.66666667	130.66666667	8.92	0.0079
RSY*SEX	1	1.60166667	1.60166667	0.11	0.7447
SWT	1	27.40597107	27.40597107	1.87	0.1883
Error	18	263.73736227	14.65207568		
Corrected Total	23	453.07333333			

R-Square	C.V.	Root MSE	BFWT Mean
0.417893	36.16822	3.82780298	10.58333333

Appendix II g: ANOVA for dressing percent

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	5.32041667	5.32041667	0.70	0.4125
REP	1	0.40041667	0.40041667	0.05	0.8206
SEX	1	4.08375000	4.08375000	0.54	0.4718
RSY*SEX	1	4.08375000	4.08375000	0.54	0.4718
SWT	1	17.51385388	17.51385388	2.32	0.1453
Error	18	136.04739612	7.55818867		
Corrected Total	23	167.44958333			

R-Square	C.V.	Root MSE	DRWT Mean
0.187532	4.019077	2.74921601	68.40416667

Appendix II h: ANOVA for percent liver

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	0.18375000	0.18375000	2.47	0.1338
REP	1	0.01041667	0.01041667	0.14	0.7129
SEX	1	0.00041667	0.00041667	0.01	0.9412
RSY*SEX	1	0.02041667	0.02041667	0.27	0.6071
SWT	1	0.25304748	0.25304748	3.40	0.0819
Error	18	1.34153586	0.07452977		
Corrected Total	23	1.80958333			

R-Square	C.V.	Root MSE	LIWT Mean
0.258649	15.20193	0.27300141	1.79583333

Appendix II i: ANOVA for percent heart

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	0.01041667	0.01041667	0.52	0.4817
REP	1	0.00041667	0.00041667	0.02	0.8873
SEX	1	0.22041667	0.22041667	10.92	0.0039
RSY*SEX	1	0.01041667	0.01041667	0.52	0.4817
SWT	1	0.00474030	0.00474030	0.23	0.6337
Error	18	0.36317636	0.02017646		
Corrected Total	23	0.60958333			

R-Square	C.V.	Root MSE	HEWT Mean
0.404222	15.28723	0.14204388	0.92916667

Appendix II j: ANOVA for percent gizzard

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	0.40041667	0.40041667	2.15	0.1597
REP	1	0.07041667	0.07041667	0.38	0.5462
SEX	1	2.22041667	2.22041667	11.93	0.0028
RSY*SEX	1	0.03375000	0.03375000	0.18	0.6753
SWT	1	0.18370306	0.18370306	0.99	0.3337
Error	18	3.35088027	0.18616002		
Corrected Total	23	6.25958333			

R-Square	C.V.	Root MSE	GIWT Mean
0.464680	12.61279	0.43146265	3.42083333

Appendix II k: ANOVA FOR percent edible organs

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	0.84375000	0.84375000	1.94	0.1807
REP	1	0.12041667	0.12041667	0.28	0.6053
SEX	1	3.76041667	3.76041667	8.64	0.0088
RSY*SEX	1	0.18375000	0.18375000	0.42	0.5240
SWT	1	1.27859688	1.27859688	2.94	0.1037
Error	18	7.83265312	0.43514740		
Corrected Total	23	14.01958333			

R-Square	C.V.	Root MSE	EOWT Mean
0.441306	10.71887	0.65965703	6.15416667

Appendix II I: ANOVA for percent head

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	0.20166667	0.20166667	2.61	0.1238
REP	1	0.32666667	0.32666667	4.22	0.0547
SEX	1	0.88166667	0.88166667	11.39	0.0034
RSY*SEX	1	0.13500000	0.13500000	1.74	0.2031
SWT	1	0.84728224	0.84728224	10.95	0.0039
Error	18	1.39271776	0.07737321		
Corrected Total	23	3.78500000			

R-Square	C.V.	Root MSE	HDWT Mean
0.632043	6.506676	0.27816040	4.27500000

Appendix II m: ANOVA for percent intestines

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	0.04166667	0.04166667	0.12	0.7300
REP	1	0.06000000	0.06000000	0.18	0.6790
SEX	1	2.04166667	2.04166667	6.02	0.0245
RSY*SEX	1	0.08166667	0.08166667	0.24	0.6295
SWT	1	0.33132656	0.33132656	0.98	0.3360
Error	18	6.10200677	0.33900038		
Corrected Total	23	8.65833333			

R-Square	C.V.	Root MSE	INTWT Mean
0.295245	10.86602	0.58223739	5.35833333

Appendix II n: ANOVA for percent shanks

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	0.08166667	0.08166667	2.95	0.1028
REP	1	0.06000000	0.06000000	2.17	0.1580
SEX	1	0.08166667	0.08166667	2.95	0.1028
RSY*SEX	1	0.10666667	0.10666667	3.86	0.0652
SWT	1	0.43228686	0.43228686	15.63	0.0009
Error	18	0.49771314	0.02765073		
Corrected Total	23	1.26000000			

R-Square	C.V.	Root MSE	SHAWT Mean
0.604990	5.733969	0.16628509	2.90000000

Appendix IIo: ANOVA for percent blood and feather

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	17.85375000	17.85375000	2.00	0.1745
REP	1	1.55041667	1.55041667	0.17	0.6819
SEX	1	35.28375000	35.28375000	3.95	0.0623
RSY*SEX	1	6.10041667	6.10041667	0.68	0.4194
SWT	1	38.72771968	38.72771968	4.34	0.0519
Error	18	160.79019698	8.93278872		
Corrected Total	23	260.30625000			

R-Square	C.V.	Root MSE	BLFWT Mean
0.382304	23.14639	2.98877713	12.91250000

Appendix II p: ANOVA for percent non edible offal

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	10.80041667	10.80041667	1.43	0.2471
REP	1	0.03375000	0.03375000	0.00	0.9474
SEX	1	15.52041667	15.52041667	2.06	0.1687
RSY*SEX	1	2.34375000	2.34375000	0.31	0.5842
SWT	1	27.64678709	27.64678709	3.66	0.0716
Error	18	135.81446291	7.54524794		
Corrected Total	23	192.15958333			

R-Square	C.V.	Root MSE	NEOWT Mean
0.293220	10.79140	2.74686147	25.45416667

Appendix II q: ANOVA for percent dry matter (fresh basis)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	31.51041667	31.51041667	3.21	0.0900
REP	1	0.00375000	0.00375000	0.00	0.9846
SEX	1	221.43375000	221.43375000	22.56	0.0002
RSY*REP	1	0.18375000	0.18375000	0.02	0.8927
RSY*SEX	1	8.28375000	8.28375000	0.84	0.3704
Error	18	176.68083333	9.81560185		
Corrected Total	23	438.09625000			

R-Square	C.V.	Root MSE	DMFR Mean
0.596708	8.296554	3.13298609	37.76250000

Appendix IIr : ANOVA for percent ash

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	2.53500000	2.53500000	1.16	0.2957
REP	1	0.32666667	0.32666667	0.15	0.7033
SEX	1	9.88166667	9.88166667	4.54	0.0481
RSY*REP	1	0.13500000	0.13500000	0.06	0.8064
RSY*SEX	1	0.06000000	0.06000000	0.03	0.8701
SWT	1	2.11511488	2.11511488	0.97	0.3382
Error	17	37.01988512	2.17764030		
Corrected Total	23	52.07333333			

R-Square	C.V.	Root MSE	ASH Mean
0.289082	23.36174	1.47568299	6.31666667

Appendix II s : ANOVA for percent ether extracts

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	219.01041667	219.01041667	2.58	0.1264
REP	1	13.95375000	13.95375000	0.16	0.6900
SEX	1	266.00041667	266.00041667	3.14	0.0944
RSY*REP	1	1.65375000	1.65375000	0.02	0.8906
RSY*SEX	1	28.38375000	28.38375000	0.33	0.5704
SWT	1	39.24201495	39.24201495	0.46	0.5054
Error	17	1441.09215171	84.77012657		
Corrected Total	23	2009.33625000			

R-Square	C.V.	Root MSE	EE Mean
0.282802	21.58118	9.20706938	42.66250000

Appendix II t: ANOVA for percent crude protein

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
RSY	1	123.30666667	123.30666667	2.21	0.1552
REP	1	1.92666667	1.92666667	0.03	0.8547
SEX	1	252.20166667	252.20166667	4.53	0.0483
RSY*REP	1	0.48166667	0.48166667	0.01	0.9270
RSY*SEX	1	0.66666667	0.66666667	0.01	0.9142
SWT	1	42.24100839	42.24100839	0.76	0.3961
Error	17	947.42065828	55.73062696		
Corrected Total	23	1368.24500000			

R-Square	C.V.	Root MSE	CP Mean
0.307565	14.77545	7.46529483	50.52500000