ADDIS ABABA UNIVERSITY
FACULTY OF VETERINARY MEDICINE

STUDY ON PERFORMANCE OF RHODE ISLAND RED (RIR) CHICKEN AT BEDELLE POULTRY BREEDING AND MULTIPLICATION CENTER AND UNDER SMALLHOLDER FARMERS CONDITIONS IN WEST SHOA ZONE, OROMIA, ETHIOPIA

NEGAWO LEMMA BULTI

JUNE 2007
DEBRE ZEIT, ETHIOPIA

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A thesis submitted to the School of Graduate Studies of Addis Ababa University, Faculty of Veterinary Medicine in partial fulfillment of the requirements for the Degree of Masters in Tropical Animal Production and Health

BY

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BY

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DEDICATION

To my family

To late Shasho Adenewu, my mother, and my father Lemma Bulti who had traverse the cultural, traditional and economic boundaries to provide me education, and I wish to my beloved wife Baleynesh Kibi and my children: Ayantu, Sab-Bontu and Rabirra Negawo and my brother Tesfaye Lemma a successful future. I love you all.

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LIST OF ABBREVIATION

AACMC	Australian Agricultural Consulting and Management Company
AOAC	Association of Official Analytical Chemists
BPBMC	Bedelle Poultry Breeding and Multiplication Center
Ca	Calcium
CF	Crude Fiber
CP	Crude Protein
CSA	Central Statistics Authority
DM	Dry Matter
EE	Ether Extracts
EC	Ethiopian Calendar
FAO	Food and Agricultural Organization
g	gram
GLM	General Linear Model
Ha	hectare
ILCA	International Livestock Center for Africa
Kcal	Kilocalorie
Kg	Kilogram
Km	Kilo meter
ME	Metabolizable Energy
MJ	Mega joule
mm	millimeter
MOA	Minster of Agriculture
MS	Micro Soft
P	Phosphorus
PAs	Peasant Associations
oC	Degree Celsius
P-value	Probability of significance
RIR	Rhode Island Red
SD	Standard Deviation

SPSS	Statistical Package for Social Science
SFRB	Scavenging Feed Resource Base

ABSTRACT

This study was carried out from September 2006 to April 2007 in West Shoa Zone of Oromia Regional State and Bedelle Poultry Breeding and Multiplication Center. The objectives of the study were to characterize the chicken production system in the study area, assess the performance of Rhode Island Red chicken on station, assess the on-farm relative performances of Rhode Island Red, hybrid and local chicken and compare the on-station and on-farm performance of Rhode Island Red chicken. A total of 120 households were selected randomly from 6 peasant associations in the study Zone. A questionnaire survey and follow-up studies were carried out to collect data on socio-economic and farming system characteristics, poultry production system characteristics and poultry performance parameters. Data was summarized with descriptive statistics and analyzed with GLM of SPSS. The results indicated that poultry were kept in the study areas mainly for egg production based on scavenging feed resources. The average poultry flock size under smallholders condition was 19.05 heads of chicken and poultry were attended mainly by women. Rainy seasons were times when poultry health problems were severe and chicks were the most susceptible group. Poultry production was constrained in the area by disease and lack of veterinary service, improved breeds and credit schemes. The on-farm performance of RIR chicken was significantly better than that of locals and hybrids in the case clutch size, clutch frequency, age at sexual maturity, egg weight and albumin weight. RIR chickens were inferior to hybrids and locals in the case of chick survival rate and length of production life, however inferior to local in hatchability. When the on-farm performance of RIR chicken was compared with their on-station performance, their on-station performance was better in the case of egg production per year and adult and chicken mortality. In the case of hatchability, their on-farm performance was better.

1. INTRODUCTION

The world poultry population has been estimated to be about 14 billions heads (FAO, 2000). Poultry production in tropical countries is based on the traditional scavenging system and chickens are the most important poultry species. The share of family poultry from the total poultry population in developing countries in general and in Africa in particular are not well documented, but has been estimated to reach 70 to 80% of the total population (Gueye, 1998; Sonaiya, 1999; Gueye, 2000). A review of available literature from eight Sub-Saharan African (SSA) countries showed that village poultry on average accounts for 78% (ranging from 30 to 99%) of the total poultry population, and the largest proportion of eggs and poultry meat produced (Tadelle, 1996). Despite this fact, little attempt has been made to characterize, understand and develop the system.

The village poultry production system is dominated mainly by indigenous birds, which have a number of adaptive traits and genes with special utility in the tropics (Horst, 1989). In developing countries, there exists a strong and close relationship between native breeds and non-intensive systems of production. However, the real value of indigenous chicken breeds is often under-estimated mostly due to their poor appearance, relatively low productivity and alleged low commercial values. To this effect, developing countries in most cases go for high performing commercial breeds from developed countries to increase animal productivity through cross breeding or, if conditions allow, by breed substitution without properly investigating the production system and potential of the indigenous birds (Hodges, 1990). Currently, there is an understanding (Sere and Steinfeld, 1996) that introducing high-yielding breeds of animals and specialized modes of production can lead to loss in genetic diversity among indigenous animals. A report estimated that 34% of all avian breeds in Africa are at risk of being lost (FAO, 2000), despite the fact that poultry are important sources of food and means of investment and determinant to the welfare of women and children in traditional and low-input systems.

These days, village poultry production is regaining importance in smallholder agricultural systems, which are characterized by low production inputs (Sonaiya, 1999). In addition,

there is a great opportunity for commercial type of poultry production, which is created by the projected dramatic increment in the consumer demand for poultry products (Delgado *et al.*, 1999).

In Ethiopia, there is about 43 million chicken (Mitiku, 2004), which are mainly (95%) handled by smallholder rural farmers. About 90% of the egg and 92% of the poultry meat output originates from the smallholder system (Tadelle, 1996). The modern poultry production systems (intensive and semi-intensive) are limited and confined to urban and peri-urban areas, which contributes less than 10% of egg and meat production in the country. The low production performance of local birds coupled with the infancy of the commercial sector has resulted in a low supply of poultry meat and eggs to the nation. As a result, the per capita egg and chicken meat consumptions are about 1.1kg (Speedy, 2003) and 2.5 chickens (Alemu, 1987) per annum, respectively, which are very low by international standards. The low performance level of indigenous chicken in the village poultry production system is mainly due to the fact that the indigenous birds have low genetic potential and their feeding is based mainly on scavenging feed resource. In addition, the village chicken production system is also constrained by diseases caused by infectious agents and malnutrition. Moreover, lack of a clear understanding of different production systems and the different social and economical factors prevailing in the systems also affect the performance village poultry production (Gueye, 1998; FAO, 1996; Mwalusanya *et al*., 2002).

So far, there have been attempts to improve the performance of the poultry sector through introduction of exotic germplasm both for direct production or crossbreeding purposes. However, systematic studies have not been conducted to assess the rate and intensity of adoption of exotic poultry breeds, their integration into the different production systems and their contribution to improve poultry production.

The objectives of this study are thus:

- To characterize the chicken production system in the study area (on farm)
- To assess the performance of Rhode Island Red chicken on station
- To assess the relative performance of RIR, hybrid and local chicken on-farm
- To compare the on-station and on-farm performance of Rhode Island Red chicken

2. LITERATURE REVIEW

2.1. Poultry production systems

In the classification of world livestock production systems, poultry systems are described under landless monogastric systems (FAO, 1996). The most important poultry production systems identified globally are the intensive system, the semi-intensive system and the extensive system (Table 1).

Poultry production systems exclusively based on hybrid and high-performing exotic breeds and high-energy concentrate feeds are described by Sere and Steinfeld (1996) as intensive systems. Intermediary or semi-intensive systems also referred to as backyard poultry, have developed recently with higher input and output than the extensive system. Although the intensive poultry production systems can be found in rural areas of Africa, the most dominant production systems are the extensive systems that are based on the local indigenous type of birds and scavenging feeding systems. The domestic fowl (*Gallus domesticus*) is the most common species in the extensive system. The term village chicken production system differentiates the scavenging chickens from the intensive production systems. Village chicken production systems are based on the scavenging indigenous domestic fowl (*Gallus domesticus*), which remain to be predominant in African, despite the introduction of exotic and crossbred types, because farmers have not been able to afford the high input requirement of introduced breeds (Kaiser, 1990; Safalaoh, 1997). The characteristics of the different poultry production systems in the world are presented in (Table 1). The criteria use to classify the systems are breed of poultry used, flock size, housing, feed resources, health management, marketing conditions, product storage and processing and availability of technology.

Table 1. Characteristics of poultry production systems

Characteristics	Poultry production systems		
	Intensive	Semi-intensive	Extensive/Scavenging
Breed and flock size	Specialized breeds: 500-5,000	Specialized and dual-purpose breeds: 50-200	Local indigenous type: <50
Housing	Modern housing, generally with concrete walls and regulated internal environment	Varies from modern houses to simple housing made from locally available materials	Specific poultry houses are rare
Feed resource	Commercially compounded feeds	Commercially compounded, homemade mixtures and scavenging	Scavenging and occasional feeding with home grains and household refuse
Health program	Standard and regular animal health program	Disease control and health program at varying levels	No regular health program of disease control measures in place
Markets	Cold chain system for input-output distribution	Input and output distribution is based on existing trading centers	No formal marketing channels
Infrastructure	Water, electricity and communication available	Modest infrastructure depending on proximity to urban centers	Underdeveloped infrastructure
Product storage and processing	Products refrigerated; dressed birds and table eggs refrigerated	Minimum refrigeration, occasional dressing of birds	No refrigeration, sales of live birds and eggs
Technology/information	Formal training, extension services available, information disseminated through producer and consumer associations	Moderate formal training and extension services	Local knowledge, with moderate or no extension services

Source: FAO (1996)

2.2. Poultry production systems in Ethiopia

The chicken population of Ethiopia is estimated to be about 43 million heads (Mitiku, 2004), which represents about 60% of the total chicken population of East Africa (Mekonnen *et al*., 1991). Rural smallholder farmers keep more than 95% of the poultry population (Tadelle, 1996) and contributes about 90% and 92% of the national egg and poultry meat production, respectively. This is equivalent to an annual output of 72,300 metric tones of meat and 78,000 metric tones of eggs (ILCA, 1993). Poultry production is an important economic activity in Ethiopia. Beside its social and cultural benefits it plays a significant role in family nutrition. Ethiopia has both short and long term plans of food self sufficiency and poverty alleviation program launched in 1995. This plan gives more attention to local resources, among which indigenous chicken is one (Teketele, 1986; Tadelle, 1996 and Kitalyi, 1998).

Poultry production systems in Ethiopia show a clear distinction between traditional low inputs systems and modern production systems using relatively advanced technology (Alemu, 1995). There is also a third upcoming " small scale" intensive system with small number of exotic birds (from 50 to 500) in urban and peri-urban areas with the objective of generating income. The semi-intensive system is also characterized by relatively better input than the extensive system in the form of improved feeding, housing and health care practices (Alemu and Tadelle, 1997).

2.2.1. Large-scale production systems

Modern poultry production started in the early 1950's with the establishment of higher learning agricultural institutes. The activities of these institutions mainly focused on the introduction of exotic breeds to the country and the distributions of these genotypes to farmers with recommendation of appropriate feeding, housing, health care and other husbandry practices (Alemu and Tadelle, 1997). This was expected to have a considerable positive influence for the expansion of large-scale commercial farmers in the country. However, after 40 years of effort, the contribution of exotic birds in terms of eggs and meat production is less than 10%. A number of factors can be cited as causes for

this low rate of adoption. First, one should recognize that poultry, particularly exotic birds, are food converters, not food producers. The foodstuffs used to feed chicken are often of a quality that could be fed directly to humans. Thus, in grain deficient countries like Ethiopia, adopting intensive poultry industry will be frustrated by the severe shortage of grain to feed the animals and shortage of foreign exchange to import breeding stocks and other associated inputs. Unless the grain production and foreign exchange reserve in the country is improved, such a system cannot be economically sustainable and socially acceptable (Tadelle, 2003).

2.2.2. Small scale intensive system

Small-scale intensive system is functioning with small number of exotic birds. The objective of this system is mainly as a source of household income in urban and peri-urban areas. The feeding system is improved involving the use of concentrates and slaughterhouse byproducts. Poultry in this system are confined in houses constructed using locally available cheap materials (Alemu and Tadelle, 1997).

2.2.3. The rural poultry production systems

According to Alemu (1995) and Tadelle (1996) the village poultry production system in Ethiopia is based on low input-output levels. This system has a unique position in the rural household economy in that it supplies high quality protein to the family, provides small cash income and plays a significant role in the religious and cultural life of the society. Tadelle (1996) showed that poultry rearing is one of the most appropriate activities for rural women, for landless and marginalized farmers and provides cash income for the poor.

This system of production, although appearing primitive, can be economically efficient in that the indigenous birds are performing well under very low input supply which some times is considered as virtually non-existent (Smith, 1990; Tadelle, 1996). The feed resource base for rural poultry production is obtained by the birds scavenging in and around the house, and consists of household waste, anything edible found in the immediate environment and small amounts of grain supplements. As indicated by

Cumming (1992), Tegene (1992), Tadelle (1996) and Tadelle and Ogle (2000), the scavenging feed resource base for village chickens is very variable and depends on the season and rainfall. The portion that comes as a grain supplement and from the environment varies with activities such as land preparation, sowing, harvesting, grain availability in the household, season of the year and the life cycles of insects and other invertebrates. The extremely high chick mortality caused by disease (more than 60%) (Tadelle, 1996) and unsuccessful brooding reduces the efficiency of the system.

There have been approaches to improve the genetic potential of local birds through distribution of cockerel, pullet and fertile eggs from birds of exotic origin. However, the efforts have lead to reduction of the brooding ability of hens, reduced adaptation of crossbred to the low input feeding system, and the long term adverse modification of the genetic base of indigenous chicken population (Tadelle, 1996).

2.3. Poultry feed resources and feeding

2.3.1. Scavenging feed resources base (SFRB)

As in most other sub-Saharan African countries (Sonaiya, 1998), the largest proportion of the feed of village chickens in Ethiopia is originating from scavenging feed resources (Tadelle and Ogle, 2001). The amount of feed available for scavenging in relation to the carrying capacity of the land areas and flock dynamics across the different seasons and agro-ecologies is still not quantified. However, studies on the physical quantities of nutrient supply conducted in three villages of the highlands with different altitudes and in three seasons, revealed that the materials present in the crop, as visually observed, are seeds, plant materials, worms, insects and unidentified materials (Tadelle and Ogle, 2000). According to the same report during the short rainy season (March to May), the percentage of seeds in the crop contents was higher at all the three study site, probably because of the increased availability of cereal grains which had been just harvested. In addition, the study showed that relative amounts of plant materials, worms and insects were higher during the rainy season (June to September).

The protein and energy supplied from the SFRB in villages of the central highlands of Ethiopia, as determined from chemical analyses of crop contents of scavenging local hens, were on average 8.8% of CP and 2864 Kcal/kg of ME (Table 2). The protein contents fall even lower during the short rainy and dry seasons, while energy supply is more critical in the drier months (Tegene, 1992; Tadelle and Ogle, 2000). The amount of protein supplied by the SFRB were reported to be below the protein requirement of free ranging local hens in the tropics, which is estimated at about 11g/ bird/day and the ME supply could only meet the requirement of a non-laying hen (Scott *et al*., 1982; Cumming, 1992; Gunaratne *et al.*, 1992). This indicates that the SFRB has limitations in fulfilling feed requirements of village chicken for increased productivity. Furthermore, Tegene (1992) reported that the SFRB is critically deficiency in Ca.

2.3.2. Supplementary poultry feed resources

Supplementary poultry feed resources available in Ethiopia include energy, protein and mineral sources and premixes. The most important energy sources are wheat bran, maize and brewer's grains. Meat, bone and blood meal constitute the animal protein sources while oilseed cakes are sources of plant proteins. The mineral supplements are derived mainly from bone meal, limestone and salt (Alemu, 1981; Alemu and Guenther, 1992). The details of the nutritional value of the supplementary poultry feeds are presented in Table 3.

Table 2. Nutrient compositions of the crop contents of scavenging hens (N= 270).

Components of crop content	Values
	Mean ± SD
Dry matter (%)	50.7 ± 12.5
Crude protein (%)	8.8 ± 2.3
Crude fiber (%)	10.2 ± 1.6
Ether extract (%)	1.9 ± 0.9
Ash (%)	7.8 ± 2.7
Calcium (%)	0.9 ± 0.4
Phosphorus (%)	0.6 ± 0.3
Energy (ME)(Kca1/kg)	2864.3 ± 247

N= Numbers of birds slaughtered for crop analysis

Source: Tadelle and Ogle (2000)

Table 3. Nutritional values of supplementary poultry feeds in Ethiopia

Supplementary feeds	DM (%)	CP (%)	EE (%)	CF (%)	Ash (%)	ME (MJ/kg)
Energy						
Wheat bran,	89.77	18.17	2.58	11.2	5.65	8.68
Maize feed meal	90.84	9.16	12.62	9.23	3.34	11.42
Maize grain	89.39	10.54	5.42	3.07	2.19	15.45
Brewers grains	90	21.54	4.43	15.68	11.88	7.58
Animal protein supplements						
Meat & bone meal, dehydrated	95.69	44.68	19.89	1.81	30.58	13.6
Plant protein supplements						
Gossypium spp.	93.34	38.34	5.96	16.67	6.21	9.18
Guizotia abyssinical	92.67	33.11	7.43	21.67	10.12	8.77
Mineral supplements						
Bone meal, steamed, dehydrated	93.82	29.65	2	0.52	65.8	5.27
Limestone	99.22	-	-	-	98.07	-
Salt	99.49	-	-	-	97.5	-
Dry forages and roughage						
Alfalfa meal, seeds crushed	89.15	29.31	3.3	15.23	16.43	7.02

Source: Alemu and Guenther (1992)

Assuming that chemical analysis of crop contents accurately reflects the feeds consumed, the nutritional status of laying village hens in the highlands of Ethiopia would satisfy maintenance needs only and production of about 40 eggs/hen per year (Tadelle and Ogle, 2000). According to Tadelle (1996), it was possible to attain a hen-day production of about 30% from local chickens by supplementing a combination of 15g maize and 15g noug cake (*Guizotia abyssinica*)/bird/day in the short rainy and dry seasons compared to a 14% production under scavenging conditions. In addition, the improvement in feeding results in increment of annual egg production of local hens by about 100%.

In villages around the southwestern part of the country, scavenging White Leghorn layers, which were provided with 90g commercial layer ration per day, vaccinated against Newcastle disease and provided regularly with water and small night enclosure produced 200 eggs/hen/year after each hen was supplemented with energy and protein (Solomon, 1997). This indicates that there is a great potential for improvement in the village systems.

2.4. Socio-economic aspect of poultry production

Rural poultry represent a significant part of the rural economy. This segment of production in Africa as a whole represents an asset value of US$ 5.75 billion (Sonaiya, 1990). In addition to their contribution to high quality animal protein and as a source of easily disposable income for farm households, rural poultry integrate very well and in a sustainable way into other farming activities, because they require little in the way of labor and initial investment compared to other farm activities (Tadelle and Ogle, 1996). A number of authors, including Veluw (1987), Sonaiya (1990) and Gunaratne *et al*. (1992), have also reported that rural poultry play a significant role through their contribution to the cultural and social life of rural people. Poultry keeping in most of the developing countries is the responsibility of women. Tadelle and Ogle (1996), in a study of three villages, found that it is the women that look after the birds, and the earnings from the sale of eggs and chickens are often their only source of cash income. Teketel

(1986), Tadelle (1996), Leulseged (1998) and Tadelle and Ogle (2001) reported households in rural Ethiopia keep birds also for socio-religious functions such as sacrifice for healing purposes and in some cases gifts to visitors (Tadelle and Ogle, 1996). Poultry also serve as starting capital for youths and newly married women. Moreover, birds perform a valuable sanitary function in the villages through eating discarded food and cockroaches.

2.5. Poultry production performance

2.5.1. Egg production performance

Native chickens are still very common in the areas of most rural people in most developing countries and are important sources of high quality protein (Sonaiya, 1997; Smith, 1990). According to Gueye (1998), in village chickens, annual egg production per hen ranges from 20-100 eggs with an average weight ranging from about 30-50g. Other reports on egg weight were ranging from 50.6 to 53.6g (Kumer *et al*., 2002). Köster and Webb (2001) reported an average egg production/hen/week of 2.1-4 for different breeds of chicken reared under an intensive system. Improvement of the performance of village chicken in better management conditions was reported (FAO, 1996) (Table 4). There are varying reports as to the performance of crossbred chicken in different production systems. Rahman (1995) reported that crosses of Rhode Island Red male with Fayoumi female had the best performance with the highest hen day egg production (63%) in semi-scavenging system of production. Tareq (1992) found an egg production of 129.9 and 93.4 for Fayoumi and Rhode Island Red chickens under rural conditions, respectively. Amber (1994) observed that productivity of pure native chickens was very low and the crossbreds of Rhode Island Red male and Fayoumi female were the best for rearing under semi-scavenging system.

Table 4. Performances of village chicken flock at two management levels

Production characteristic	Traditional management	Improved management
Eggs laid per hen	9-15	15-18
Total number of eggs laid	15-25	75-90
Chicks hatched	9-15	45-54
Chicks raised to six weeks	4-6	31-38
Mature chickens	1.8-2.7	24-30
Estimated harvested eggs	3-5	15-18

Source: FAO (1996)

2.5.2. Age at sexual maturity

Age at sexual maturity is the time between the date of hatch and the date of first egg. Age and weight at sexual maturity is influenced by genetic make up of the individual, feed intake, lighting, duration of day length and other environmental factors (Morries and Fox, 1960 and Wessels, 1962). Amer (1965) observed earlier sexual maturity in Fayoumi than Rhode Island Red chicken. Rahman *et al.* (1997) found that the age at sexual maturity of crosses of Rhode Island Red male and Fayoumi female was 33 weeks. Sazzad (1992) found that the age at sexual maturity of Fayoumi, Rhode Island Red and hybrids of Fayoumi male and Rhode Island Red female was 155.5 days, 164 days and 150 days, respectively, under farm conditions

2.5.3. Survivability and mortality

The survivability of chicken is influenced by breed of chicken and weaning age. Upgrading improves the viability of exotic birds under rural conditions, which is due to the effect of hybrid vigor. Amin *et al*. (1992) reported the mortality rate of crosses of Rhode Island Red male and Fayoumi female and Deshi to be 50% and 29%, respectively, in semi-scavenging condition. Rahman *et al*. (1997) found mortality rate of 18.07% for crosses of Rhode Island Red male and Fayoumi female under semi-scavenging condition. Amber (1994) studied the production performance of 22 different genetic combinations

of both native and exotic birds under intensive condition and found survivability ranging from 80-86.9%. Huque *et al*. (1990) found higher mortality in chicks separated from broody mothers 7 days after hatch than those separated after 21 days under traditional scavenging system. Upgrading improves the viability of exotic birds under rural conditions and this is due to effect of hybrid vigor in viability. As a result crossbred progeny from them shows.

According to Tadelle (1996), chick mortality, which may be over 60 % between hatching and end of brooding, represents a major loss in scavenging village chicken production systems in Ethiopia. This may be due to a combination of poor housing, competition for feed with stronger and more vigorous members of the flock, low protein and energy content of available feed, the low hatching weight of chicks, predation and diseases.

2.5.4. Fertility and hatchability

Trail (1961) observed higher fertility rate in crossbred progeny than in exotic parents. This was also supported by Kicka *et al*. (1978), who obtained the higher (92.3%) fertility in crosses of Fayoumi and Rhode Island Red chicken than purebred Fayoumi (89%) and Rhode Island Red chicken (77.9%).

Hatchability of eggs plays a major role in determining the number of chicks to be kept for breeding purposes or the number of birds to be replaced. Thus, higher hatchability ensures more intensive selection. Hatchability is a variable phenomenon affected by several factors among which are egg size, weight, shell thickness and egg holding period. The higher the proportion of quality eggs (in terms of size and weight of egg and shell thickness), the better will be hatchability. Under backyard conditions, eggs are usually hatched through a broody hen; thus, management faults could adversely affect hatchability. Similarly, seasonal fluctuations could cause wide variability in hatchability. North (1984) reported better hatchability in eggs set in spring as compared to those set in summer. Since backyard chickens are usually produced under scavenging feed resource base, where they have a limited access to balanced diets, wide variation is expected in

their hatching performance compared with those produced under commercial farm conditions. In the study conducted by Farooq *et al*. (2000), hatchability varied from 63.1 to 84.1% under backyard conditions in Pakistan. There are reports indicating that crossbreeding improves hatchability (Byerly *et al*., 1934; Bice and Tower, 1939; Trail, 1961; Laxi, 1964).

2.5.5. Chick quality

Quality of chicks are graded by visual examination and evaluation based on the quality standards described by North (1984). Accordingly, chicks that are not malformed, dehydrated, physically active, able to stand up well, without unhealed navels and look lively are considered as good quality chicks. The mean percentage of quality chicks obtained was calculated by expressing the number of quality chicks as percentage of the total number of chicks hatched.

2.5.6. Egg quality

Egg quality is expressed in terms of egg weight, shell weight, shell thickness, weight of egg yolk and albumin. The importance of egg quality in determining hatchability and chicks weight was indicated by Farooq *et al*. (2001). They reported better hatchability and chick weight values for good quality eggs. Among the aforementioned traits, egg weight is the only parameters, which could be determined before setting eggs for hatching, while information on rest parameters are not possible as these are usually determined after breaking egg. Broken eggs can't be used for hatching; thus, it is imperative to develop some prediction equations that could provide information on shell weight, shell thickness and weight of egg yolk and albumin without breaking eggs.

Egg weight

Egg weight can be easily predicted from egg length and width as positive association exists among these traits (Farooq *et al*., 2001a). It is affected by breed of chicken, housing type and level of supplementation. Rahman *et al*. (1998) found that egg weight

of Sonali hens increases with the level of supplementation. They also found significant differences in egg weight between Rhode Island Red, Fayoumi and their crosses. Moorthy *et al*. (2000) reported that eggs laid by caged birds were significantly heavier than birds kept on deep litter. Wilson (1993) and Murad *et al*. (2001) found that hatching chick weight is 62-76% of the initial egg weight.

Yolk color

The color of the yolk is determined by the presence and absence of xanthophylls some of which are precursor of Vitamin A (Smith, 1996). Therefore, the color of the yolk is influenced to a large degree by nutrition. Dark yellow yolks can be produced by feeding laying birds on grass meal (Smith, 1996 and Taplin *et al.*, 1983). Akbas *et al.* (1996) found that yolk index varied due to differences in age and egg size.

Shell thickness

There are reports indicating that shell thickness varies with the type and level of feeding and type of housing. Sale and El-Naggar (1983) stated that shell thickness was significantly higher for hens fed 2.5 or 3.5% calcium than for those fed 1.5%. Thicker shell has been also reported for eggs laid by birds given farm-mixed feed than those given commercial feed (Moorthy *et al.*, 2000). Mohan *et al.* (1991) observed that shell thickness was higher in birds housed in cages than in birds on deep litter. Shell weight and thickness have been reported to affect hatchability of eggs (Murad *et al*., 2001).

2.6. Major constraints of poultry production in Ethiopia

Poultry development in Ethiopia is constrained by many factors. According to Alemu and Tadelle (1997) the major constraints are availability, quality and cost of feed; diseases; cultural taboos; poor infrastructure; inadequate emphasis to poultry research and extension; shortage of trained personnel; lack of coordination and strategy for research and development programs and lack of basic facilities.

The major causes of mortality as reported by Tadelle (1996) in the order of their importance are disease, predation, lack of feed, poor housing, parasites etc. Insufficient water is also one of the causes of mortality in chicks and older birds and also a contributing factor to low productivity (Tadelle, 1996). Teketel (1986) and Abebe (1992) found higher mortalities and morbidities in local stock than in White Leghorns raised under conditions of intensive management in Awassa and Alemaya, respectively. Similarly, Brannang and Pearson (1990) observed high incidences of mortality among local birds when kept in confinement at Assela. The researchers suggested that the reason for mortality of local chickens could be ascribed to lack of adaptation to confinement.

3. MATERIALS AND METHODS

3.1. Study areas

3.1.1. Bedelle Poultry Breeding and Multiplication Center

The on-station follow-up study was carried out in Bedelle Poultry Breeding and Multiplication Center. The Center is located at 480 km west of Addis Ababa in Ilu-Ababora Zone of Oromia Regional State. The center has a total area of 5 hectare, altitude of 2020 meters above sea level, average temperature of 20 to 25^0C. The rain pattern consists of a short rain season (March to May) and long rainy season (June to September). There are five poultry houses in the Center among which three are used for rearing and two for layers. The type of housing is deep litter and the housing density is 10-12 birds/m^2 for starters and 4-5 birds/m^2 for layers. The numbers of breeder stock is range from 1500 to 1600 per cycle. Out of these, 90% are female and 10% male. At its full capacity, the Center can handle about 138,240 eggs and 64,652 chickens per year. The feeding of chickens in the center is manual while watering is automatic. The Center used to purchase mixed feed from processing plants but currently it has its own feed mixer. The raw materials used for mixing are maize, soybeans, wheat bran, wheat middling, nouge cake, lysine, methionine, premixes, salt and limestone. The average feed provided for chicks and layers per day is 45gm and 128gm, respectively (farm manager personal communication). The major diseases occurring in the farm in the order of their importance are coccidiosis, salamonellosis and ascriasis. The control measures applied against diseases are anticoccidials, antibiotics and antihelmenthics. In addition, the chickens are vaccinated against Newcastle disease

At present the center is engaged in production and rearing of the Rhode Island Red chicken from a foundation stock introduced from abroad. Chicks reared by the Center and day old chicks are dispatched to Ambo, Fiche and Nekemte rearing centers for rearing and distribution to farmers.

3.2.2. West Shoa Zone

The on-farm questionnaire survey and follow-up study was carried out in West Shoa Zone of Oromia National Regional State. The Zone is located between $8^{o}17'$-$9^{o}56'$N latitude and $37^{o}17'$-$38^{o}45'$E longitude with altitude ranging from 800 to 3,270 meters above sea level. The Zone receives a unimodal rainfall pattern during the months of June, July and August (MOA, 2005). The Zone covers a total land area of 14,921.2 km^2, which is 4.1% of the total land area of the Oromia region. According to the population census of (CSA, 1994), the zone has a human population of 1,966,621 of which 90.07% and 9.93% are living in rural and urban areas, respectively. There are 549-peasant association and 45 towns in the 18 Woredas of the zone.

Mixed farming is the commonest practice in the zone where crop production and rearing of animals are carried out side by side. The people are living a totally sedentary life. The livelihood of the majority of the population depends directly or indirectly on agriculture. Agriculture is the main source of income and employment to the society though the degree of importance varies along the ecological zones and across the rural and urban areas. The major staple food crops grown in the zone include teff, wheat, barely, maize, sorghum, beans, field pea, chickpea and Niger seed (MOA, 2005). Livestock play a significant role in the farming system. There are about 1,741,969 cattle, 421,020 sheep, 189,724 goats, 253,600 equine and 1, 162,678 poultry (MOA, 2005).

3.2. Study animals

The breeding stock of Rhode Island Red chicken in the Bedelle Poultry Breeding and Multiplication Center and the indigenous, hybrid and Rhode Island Red chicken (reared by the Multiplication Center and distributed to smallholder farmers) in the West Shoa Zone of Oromia Regional Sate are the study population.

3.3. Study methodology

3.3.1. Study design

Cross-sectional and longitudinal types of study were carried out in smallholder farms of West Shoa Zone to collect information about socio-economic and production system characteristics and production performances of indigenous, hybrid and Rhode Island Red chickens. A longitudinal type of study was carried out to collect data on on-station performances of Rhode Island Red chicken in Bedele Poultry Breeding and Multiplication Center.

3.3.2. Sampling procedure

A stratified random sampling method was applied for selection of study areas and households. The list of districts and peasant associations in the West Shoa Zone were used as sampling frames to select districts and peasant associations. Only districts and peasant association, where there has been distribution of Rhode Island Red chicken, were considered in the sampling frame. Accordingly, two districts and three peasant associations from each district were selected randomly. Finally, the lists of all households owning Rhode Island Red chicken in peasant associations were used as sampling frames to select randomly 20 households from each peasant association. This made a total of 120 households included in the cross-sectional study. For the on farm follow up study, 30 households (5 from each PA) were selected randomly to collect on farm data on performance parameters.

The breeding stock available during the duration of this study (September 2006 to March 2007) 787 chicken were included in the on-station follow-up study.

3.3.3. Data collection methods

Questionnaire survey

A structured questionnaire format was prepared and a one-visit interview was carried out collect information about the production system conditions in the selected households. The information collected includes socio-economic and farming system characteristics, poultry flock size and structure, poultry performance, functions of poultry products (importance of poultry in a household), and poultry management practices including housing, feeding, breeding; and constraints associated with poultry production (Annex 1).

Follow-up study

A weekly follow-up study was carried out for six months to collect data poultry feeding practices and performances of Rhode Island Red chicken at station and farm levels. The data collected include weekly egg production per bird, egg fertility, average number of eggs incubated/brooded, hatchability, chicken mortality, quantity and quality of feedstuff supplied, and health care management. At station level, eggs were considered to be fertile, if eggs candled on the 18^{th} day of incubation had embryo. At farm level, fertility and hatchability were determined at the same time; i.e. un hatched eggs from each of the broody hen were broken to verify the presence or absence of embryos. If the broken out eggs were found to have blood rings, they were considered as fertile (North, 1984).

Laboratory examination

Egg quality

Egg samples were collected both from chicken in the Center and under smallholder farmers management (indigenous, hybrids and Rhode Island Red). The eggs were stored at room temperature for a maximum of one week until laboratory analysis is done. The egg quality parameters considered in the analysis were egg weight, albumin weight, shell

thickness, shell weight, yolk weight and yolk color. The egg quality analysis was carried out at the Debir Zeit Agricultural Research Center.

Egg weight was determined by a sensitive digital balance. Egg shell thickness was measured at the equatorial part of the shell using a micrometer gauge. The eggs were then broken out on a flat mirror for internal quality assessment. Shell weight was taken immediately following breaking using a sensitive balance. Yolk color was determined after the yolk was carefully separated from the albumen by Roche Fan Color Scale. Yolk was then weighed. Albumen weight was derived by subtracting the summed weights of shell and yolk from the final weight of the egg.

Feedstuff

Feedstuff samples of wheat, maize, sorghum and teff were taken from commercial ration, feed mixed at the Center, and feed available at smallholder farm level were collected and submitted to Holetta Agricultural Research Center supplied for determination of levels of DM, ME, CP, Ca, and P. The analyses followed the methodology recommended by (A.O.A.C, 1980; Goering and Van Soest, 1970; Wiseman, 1987). The detail of the procedure is indicated in Annex 2.

Chick quality

Quality of chicks was graded by visual examination. Chicks were examined for physical malformations, abnormality in posture and alertness. Those without any of these problems were considered as quality.

3.3.4. Data management and analyses

MS excel spread sheet (Microsoft Office Excel, 2003) program was used to store data. Descriptive statistics was employed to summarize the qualitative data obtained from questionnaire survey, follow-up and laboratory studies. One-way ANOVA was used to

compare means of on-farm performance parameters. SPSS (Release 11.5, 2002) was used to compute descriptive statistics and ANOVA.

The following considerations were made while the data was analyzed:

- Total egg production: refers to the number of eggs that are produced from each production cycle.
- Total eggs incubated: refers to the number eggs, which are incubated from the total eggs produced per cycle.
- Fertility percentage: was calculated by dividing the number of fertile eggs by the total number of eggs set.
- Hatchability from total eggs set: was calculated by dividing the number of chicks hatched by the total number of eggs set.
- Hatchability from fertile eggs: was computed by dividing the number of chicks hatched by the number of fertile eggs.
- Chicks' mortality: refers to the numbers of chicks, which died from day old to dispatch day as pullet and cockerels.
- Adult male and female mortality: refers to the number of parent stock died from the initial period to the end day of the production cycle.
- Hen day egg production (percentage): is calculated by dividing the total number of eggs produced by the flock divided by the product of the number of days and the number of birds alive in a cycle.
- Fit/quality chicks: refers to the proportion of chicks, which were evaluated as quality from the total chick population in a cycle.
- Dead in shell: refers the proportion of fertile eggs, which were not hatched, from the total number of fertile eggs.
- Reproductive life of layers: the time in which layers stay in production.

4. RESULTS

4. 1. Socio- economic and farming system characteristics

4. 1.1. Socio-economic characteristics

The socioeconomic characteristics of sampled households are summarized in Table 5. The majority of the households (61.7%) were in the age group between 31-50 years. Most of the households were led by males (91.7%) with very little involvement of females. About 80% of the household leaders were literate.

Table 5. Age, sex and level of education of sampled households

Variables	N	Group	Frequency	Percentage
Age	120	<=30	22	18.30
		31-50	74	61.70
		Above 51	24	20.00
Sex	120	Female	10	8.30
		Male	110	91.70
Level of Education	120	Illiterate	24	20.00
		Elementary School	61	50.83
		High school and above	35	29.17

N=number of respondents

4.1.2. Farming system characteristics

The farming system of the study areas is mainly mixed crop-livestock system. The average land holding, and livestock herd composition is displayed in Table 6. The total land holding per household in the study area ranged from 0 to 7 ha. Farmers use a relatively larger proportion of their land for crop cultivation (79.8%). The cattle herd size ranged from 0 to 24 heads while the chicken flock size ranged from 1 to 65 heads. In general, there were very few sheep, goat, horses and mules in the study areas. The major staple food crops grown in the study areas were teff, wheat, barely, maize, sorghum, beans, field pea, chickpea and Niger seed. Some of the farmers use irrigation during the dry season to grow tomato, onion and potato.

Table 6. Land holding (ha) and livestock herd size and composition (number)

Variables	N	Mean	SE
Total Farm size	120	2.03	0.13
Cultivated land	120	1.64	0.10
Cattle	120	6.80	0.37
Sheep	120	1.42	0.29
Goat	120	0.67	0.23
Donkey	120	1.05	0.13
Horses	120	0.12	0.05
Mules	120	0.05	0.02
Chicken	120	7.97	0.51

N = number of respondents, SE= standard error

4.2. Poultry production system

4.2.1. Poultry management characteristics

The status of poultry management practices in the study areas are presented in Table 7. The most important objective of poultry keeping was production of egg and poultry meat both for household consumption and selling (78.33%). Only insignificant proportion (0.83%) was using poultry products totally for household consumption. Slightly more than half of the householders (52.5%) were involved in poultry production for 5 years or less. Farmers acquired foundation stocks either from extension services/market (70%), own farm/market (24.2%) or own farm (5.8%). Foundation and replacement stock (94.17%), veterinary services (78.3%) and feed (63.3%) were inputs incurred on the poultry production. The majority of the households had separate poultry houses (85%). In most of the households, poultry were attended by wives (71.7%).

Table 7. The frequency of in poultry management activities and responsibilities

Variable	N	Group	Frequency	Percentage
Objective of poultry keeping	120	Home consumption	1	0.83
		Sale / Cash income/	25	20.83
		Both	94	78.33
Age of poultry farm	120	1- 2	22	18.30
		2.1 – 5	41	34.20
		5.1 – 10	37	30.80
		10.1 – 15	13	10.80
		Above 15 years	7	5.80
Source of foundation stock	120	MOA/Purchased	84	70.00
		Hatched	7	5.80
		Hatched/purchased	29	24.20
Inputs for poultry	120	Feed	76	63.30
		Veterinary service	94	78.30
		Foundation and replacement stock	113	94.17
Availability of separate housing	120	Yes	102	85.00
		No	18	15.00
Poultry attendant	120	Husband	8	6.70
		Wife	86	71.70
		Daughters	8	6.70
		Sons	16	13.30
		Elders	2	1.70

N= number of respondents

4.2.2. Poultry feed resources and feeding practice

Poultry feeding was based mainly on scavenging feed resource. In addition, poultry were also supplemented with wheat, teff, maize sorghum, injera, and other household leftovers. The supplementations were usually done during the harvesting season (from October to March) twice daily (morning and afternoon). The aggregated average amount of supplemental feeds provided per bird per day is 44.50g (SE=1.63), which ranged from 0 to 67 g per bird per day. There is variation in the type of supplementation feeds provided for the different groups of poultry. Wheat, teff and injera were supplied to chicks by 40-

47% of the households. Pullets were supplemented with wheat (62.5%) maize (65.8%), household leftovers (47.5%) and sorghum (19.2%). Mature males and females were supplemented with the same feed stuffs but with different extents. Wheat and maize were supplemented to mature poultry by 87.5-88.3% of the households while household leftovers and sorghum were supplemented by 66.7-72.5% and 18.3-19.2% of the households. Most of the households supply river water for their poultry (73.3%) and the rest use pipe water (17.5%) and boreholes (9.2%).

The results analyses of the nutrient content of the different feedstuffs used as poultry feeds by smallholder farmers at the study areas are shown in Table 8. All the feedstuffs studied had comparable dry matter (90.6-91.30%) content. The highest crude protein content was found in wheat grain (10.11%) while the lowest was that of sorghum (7.68%). The metabolizable energy content of the feedstuffs was almost similar (14.60-14.62 MJ/kg of DM). With regard to minerals, there was variation in calcium content among the different feedstuffs (from 0.004% in maize to 0.057% in sorghum), but the phosphorous content of the feedstuffs was comparable (0.58-0.65%).

Table 8. Nutrient compositions of different poultry feed resources in the study areas (on farm and on station)

Feed stuff	Nutrient composition of feed stuff				
	DM (%)	CP (%)	ME (MJ/kg)	Ca (%)	P (%)
Teff grain	90.6	9.43	14.62	0.040	0.65
Wheat grain	91.3	10.11	14.62	0.015	0.58
Maize grain	91.2	8.04	14.60	0.004	0.59
Sorghum grain	90.8	7.68	14.61	0.057	0.58
Mixed layers ration*	95.1	15.61	13.68	1.20	0.92
Mixed chicks ration*	95.1	15.75	13.65	0.20	1.03

DM = Dry matter, CP = Crude protein, ME = Metabolizable Energy, Ca= Calcium, P=Phosphorus
* Poultry feed produced and used by Bedelle Poultry Breeding and Multiplication Center

The Bedele Poultry Breeding and Multiplication Center provides mixed ration produced at the station. The average daily feed ration for each bird was 45.21 g (SE=2.24) for chicks and 127.94 g (SE=0.30) for layers. The nutrient content of mixed ration produced

by the Center is presented in Table 8. The mixed ration of both layers and chicks at the Center had higher values of DM (95.1%), CP (15.61-15.75%), Calcium (0.20-1.2%) and Phosphorous (0.92-1.03%) but lower values of ME (13.68-13.65 MJ/kg of DM).

4.2.3. Poultry flock size and composition

The poultry flock size and composition in terms of breed and type is indicated in Table 9. The average poultry flock size was 19.05. The total flock size ranged from 1 to 65 heads of poultry. Hens represent the highest proportion (43.52%) of the flock followed by chicks (26.77%), cocks (11.4%), pullets (10.81%) and cockerels (7.5%). With regard to breed of poultry, very close proportions of the flock were represented by RIR (39.93), crosses of RIR and local poultry (31.01) and local poultry (29.06%). The average male to female ratio in the flock was 1: 5.82.

Table 9. Mean, standard errors and proportions of poultry flock size and composition

Type of poultry	N	Flock size			Proportion of breeds (%)		
		Mean	SE	Proportion (%)	RIR	RIR x Local	Local
Cocks	120	2.17	0.16	11.40	36.78	22.22	41.00
Cockerels	120	1.43	0.21	7.50	28.07	42.69	29.24
Pullets	120	2.06	0.24	10.81	30.36	41.70	27.94
Hens	120	8.29	0.48	43.52	56.58	10.86	32.56
Chicks	120	5.10	0.52	26.77	47.88	37.58	14.54
Total	120	19.05	0.98	100	39.93	31.01	29.06

N= number of respondents

The study of the poultry flock dynamics showed that there were a total of 19.06 poultry added to the flock due to hatching (11.55) and purchases (7.51). Hens represent the highest proportion (73.10%) of purchased poultry. On the other hand, on average a total of 11.09 poultry were disposed from the flock due to mortality (7.26), sales (2.24) and consumption (1.59). Chicks (49.04%) and hens (34.71%) were the most affected by mortality. The detail of the poultry flock dynamics is presented in Table 10.

Table 10. Means and standard errors of determinants of poultry flock dynamics

Determinants of flock dynamics	N	Mean	SE	Proportion from current flock size (%)
Hatching	120	11.55	0.90	60.63
Purchase	120	7.51	0.35	39.42
Mortality	120	7.26	0.55	38.11
Sell	120	2.24	0.26	11.76
Consumption	120	1.59	o.15	8.35

N=number of respondents

4.2.4. Poultry breeding practices

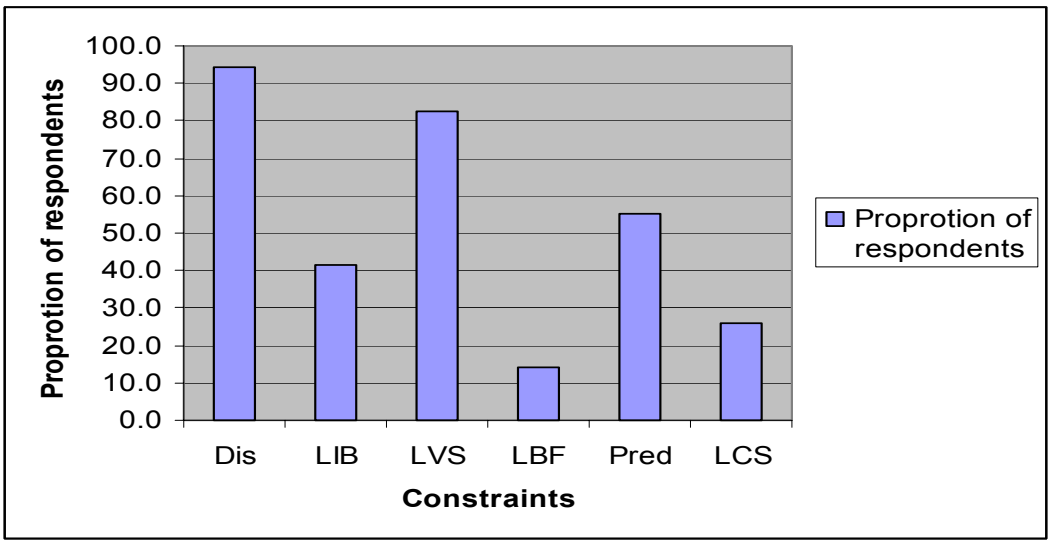
Most of the households prefer to select the females (56.67%) than the males (14.17%). The remaining households select both females and males (29.17%). Most of the households tended to select for both egg production and body size (70.83%). But egg production capacity (26.7%) was the preferred trait than body size (2.5%). Eggs to be set for brooding were selected on the basis of size (36.7%), color (0.8%) and both size and color (46.7%). The remaining proportion did not give regard to either size or color of eggs (15.8%). Teff straw was the most commonly used (76%) setting material followed by wheat straw (24%). About 73.60% of the households did not mind about the position of the eggs while setting and 26.4% of them positioned the eggs on their sides. Culling of poultry for different reasons was practiced by 84% of the households. The main reasons for culling were old age, low egg production and disease.

4.2.5. Poultry health problems and management practices

According to the responses of selected farm households, rainy seasons are the times when high disease problems exist (97.5%). Chicks were mentioned as the most susceptible age groups to diseases by more than half of the respondents (53.3%). This is followed by adults (27.5%), growers (11.67%) and pullets (7.5%). The most commonly used disease management methods include use of modern medicaments (64%) and traditional medicines (70%).

4.2.6. Constraints on chicken production

The most important constraints mentioned by the selected households are illustrated in Figure 1. The most important constraints were disease (94.2%), lack of veterinary supplies (82.5%), and the presence of predators in the areas (55%)



Dis= diseases, LIB=lack of improved breeds, LVS=lack of veterinary supplies, LBF, lack of balanced feed, Pred=presence of predators, LCS=lack of credit schemes

Figure 1. Major constraints mentioned by selected households

4.3. On station performance of RIR chicken

The results of the follow-up study at Bedelle Poultry Breeding and Multiplication Center are presented in Tables 11. The average laying percentage for the study period was 60.53%; the maximum and the minimum being 67.80 and 53.80%, respectively. Fertility rate of eggs ranged from 76.55 to 86.90% while gross hatchability (considering set eggs) ranged from 13.62 to 48.95%. When hatchability was calculated for fertile eggs, it ranged from 16.20 to 59.10%. The proportion of dead in shell embryos ranged from 40.94 to 83.85%. From 89.51 to 98.71% of the hatched chicks were of good quality (fit). The maximum and minimum egg weight recorded were 62.11 gm and 55.00 gm, respectively.

There was no disease outbreak in the Center during the study period. However, there were mortalities in chicks (4.96%), layers (12.25%) and adult males (1.00%).

Table 11. Mean and standard errors of on station performance of RIR chicken

Variables	N	Mean	SE
Laying /Hen day egg production/ percentage (%)	758*	60.53	1.53
Fertility rate (%)	41,376**	83.56	0.83
Hatchability for set eggs (%)	41,376**	39.98	3.24
Hatchability for fertile eggs (%)	34,565**	47.79	3.78
Proportion of dead in shell embryos (%)	41,376**	53.58	4.08
Proportion of fit chicks (%)	16,710*	96.96	0.76
Egg weight	190**	55.96	0.59

N= number of observations, * chicken, **eggs

Regarding egg quality, average values of 43.23g (SE=0.55), 0.31 mm (SE=0.01), 6.88g (SE=0.15), 14.85g (SE=0.19) were found for albumin weight, shell thickness, shell weight and yolk weight, respectively. The average score of yolk color for RIR chicken managed on station was 4.8 (SE=0.18).

4.4. On farm performance of RIR, hybrid and local chickens

The results of the on-farm performance of RIR, hybrid and local chicken is presented in Table 12. The results of univariate analysis of variance revealed that the differences in the performance of the three breeds of chicken were significant except for hatchability. According to this finding, the mean clutch size was highest in RIR chicken (27.38 eggs) than in hybrids (22.17) and locals (14.23 eggs) ($p<0.001$). Regarding clutching frequency, the hybrids (5.4) performed better than RIR (5.03) and locals (3.58) ($p<0.001$). Local chicks had the highest number of eggs incubated (12.88 eggs) followed by hybrids (11.09 eggs) and RIR (10.51 eggs) ($p<0.001$). RIR chicken matured earlier (20.34 weeks) than hybrids (21.46 weeks) and locals (22.14 weeks) ($p<0.001$) and hybrids weaned at earlier age (12.41 weeks) than the RIR (12.49 weeks) and locals (13.04 weeks) ($p<0.001$). Chick survival rate was higher in locals (61.84%) than hybrids (61.50%) and RIR (57.32%) ($p<0.01$). Regarding reproductive life, local chicken stayed longer (2.27 years) than hybrids (2.01 years) and RIR (1.82 years).

Table 12. Means and standard errors of on farm performance of poultry

Variable	Group	N	Mean (SE)	P-value
Eggs per clutch	Overall	120	21.36 (0.38)	
	Local	105	14.23 (0.14) a	0.000
	RIR	116	27.38 (0.28) b	
	Hybrid	63	22.17 (0.51) c	
Clutch frequency	Overall	120	4.58 (0.07)	
	Local	105	3.58 (0.08) a	0.000
	RIR	116	5.03 (0.07) b	
	Hybrid	63	5.40 (0.112) c	
Number eggs incubated	Overall	120	11.59 (0.123)	
	Local	98	12.88 (0.17) a	0.000
	RIR	96	10.51 (0.14) b	
	Hybrid	45	11.09 (0.22) c	
Hatchability (%)	Overall	120	78.96 (0.59)	
	Local	98	80 (0.57) a	0.208
	RIR	96	78.77 (0.76) ab	
	Hybrid	45	77.10 (2.39) abc	
Age at sexual maturity (week)	Overall	120	21.26 (0.18)	
	Local	100	22.14 (0.33) a	0.000
	RIR	107	20.34 (0.25) b	
	Hybrid	56	21.46 (0.31) ac	
Chicks survival rate (%)	Overall	120	59.96 (0.58)	
	Local	98	61.84 (0.88) a	0.001
	RIR	96	57.32 (0.82) b	
	Hybrid	45	61.50 (1.59) ac	
Weaning age of chicks (week)	Overall	120	12.70 (0.07)	
	Local	99	13.04 (0.12) a	0.000
	RIR	97	12.49 (0.10) b	
	Hybrid	46	12.41 (0.12) bc	
Length of reproductive life	Overall	120	2.03 (0.03)	
	Local	118	2.27 (0.05) a	0.000
	RIR	120	1.82 (0.02) b	
	Hybrid	115	2.01 (0.06) c	

N= number of respondents, means with the same alphabetical suffix do not different significantly

The results of analyses of the on farm egg quality of local, hybrid and RIR chicken showed that there was significant difference in all the parameters considered except for shell thickness (Table 13). The heaviest egg was that of RIR (56.41 g) followed by hybrids (50.23 g) and locals (42.76g) ($p<0.001$). The same trend was observed for albumin weight ($p<0.001$) and shell weight ($p<0.001$). In the case of yolk weight, the highest value was found for hybrids (14.79 g) followed by RIR (14.34 g) and locals (12.67 g) ($p<0.05$).

Table 13 . Least squares means and standard errors of on farm egg quality parameters

Variable	Group	N	Least squares mean (SE)	P-value
Eggs weight (g)	Overall	45	49.80 (1.15)	
	Local	15	42.76 (1.02)a	0.000
	RIR	15	56.41 (1.41)b	
	Hybrid	15	50.23 (1.66)c	
Albumin weight (g)	Overall	45	28.76 (0.81)	
	Local	15	24.13 (0.63)a	0.000
	RIR	15	33.73 (1.09)b	
	Hybrid	15	28.43 (1.15)c	
Shell thickness (mm)	Overall	45	0.31 (0.123)	
	Local	15	0.31 (0.01)	0.652
	RIR	15	0.31 (0.01)	
	Hybrid	15	0.32 (0.01)	
Shell weight (g)	Overall	45	7.11 (0.20)a	
	Local	15	5.96 (0.20)b	0.000
	RIR	15	8.34 (0.23)c	
	Hybrid	15	7.01 (0.30)	
Yolk weight (g)	Overall	45	13.93 (0.31)	
	Local	15	12.67 (0.45)a	0.014
	RIR	15	14.34 (0.60)ab	
	Hybrid	15	14.79 (0.46)c	

N= number of observations, means with the same alphabetical suffix do not different significantly

Roche Fan Color Scale was (ranged 1-16 that is from pale yellow to deep orange).

Regarding yolk color, the three breeds had very close average scores ranging from 10.20 (SE=0.34) in locals to 10.67 (SE=0.33) in hybrids. Eggs from RIR chicken had an intermediate score of 10.33 (SE=0.44).

4.5. Comparison of on-station and on-farm performance of RIR chicken

The results of univariate analysis of variance for selected parameters to compare the on-farm and on-station performances of RIR chicken are presented in Table 14. Based on these results, RIR chicken kept on station had significantly better performances in egg production per year ($p<0.001$), adult mortality ($p<0.05$) and chick mortality ($p<0.001$). On the other hand, RIR chicken kept on-farm had significantly better performance only in hatchability ($p<0.001$).

Table 14. Least squares means and standard errors of selected performance parameters for comparison of on farm and on-station performances of RIR chicken

Variable	Group	N	Least squares mean (SE)	P-value
Egg production per year per hen	On farm	563	132.61 (2.92)	0.000
	On-station	1200	240.00 (18.44)	
Fertility (%)	On farm	57	87.35 (3.56)	0.419
	On-station	52,632	83.99 (1.67)	
Hatchability	On farm	57	79.22 (1.15)	0.000
	On-station	52,632	56.81 (1.05)	
Adult chicken mortality	On farm	159	48.82 (8.78)	0.025
	On-station	1582	15.26 (2.51)	
Chick mortality	On farm	146	50.02 (5.08)	0.000
	On-station	10,402	10.72 (0.89)	
Egg weight	On farm	15	56.41 (0.76)	0.759
	On-station	40	55.97 (0.78)	

N= number of observations

5. DISCUSSION

In this study the majority of sampled households were led by males. A similar result was reported from the costal part of Kenya (Muchadeyi *et al*., 2004). This is mainly due to the long prevailing cultural and religious norms, which undermine the role of females in decision-making. The total land holding per household found in this study (2.03ha) is small as it is the case in most parts of Ethiopia, reported by (Solomon, 1996; Getnet, 1999; Kelay, 2002), which were 5.2, 3.9 and 3.8 ha respectively.

The use of poultry for multiple purposes (income generation and household consumption) (78.30%), which has been found in this study, was in line with reports in different parts of the world (Sonaiya, 1990; Tadelle and Ogle*,* 2000; Namondo, 1999; Kyvsgaard, 1999; Dolberg, 2001).

The majority of the households in this study had separate poultry houses made of local materials. This finding is in not in agreement with the finding of Tadelle (1996) who reported that about 88.5 % of the households in his study area had no separate houses for poultry. The predominant involvement of wives in attending poultry (71.7%) in this study is in agreement with the report of Tadelle and Ogle (1996a)**.** This is due to the fact that poultry keeping is usually a backyard activity where women spend much of their time.

The dependence of farm households in this study on scavenging poultry feed resources is similar to the report of Tadelle (1996). It has been reported that the quality and quantity of the scavenging feed resource is seasonal in nature (Savory, 1989; Cumming, 1992). According to same authors, the diet of scavenging poultry is usually adequate in protein especially in the rainy season due to the abundance of large numbers of invertebrates.

The nutrient content of the different poultry feed stuffs under smallholders' conditions and even the mixed ration at Bedelle Poultry Breeding and Multiplication Center were below the recommended values for egg production requirements. Similar condition was reported by Tadelle (1996). Lower values of CP in maize bran is also reported by Aganga

et al. (2000) who reported a 10.1% CP in maize bran, where as the requirement for laying birds is known to be about 20%. Maize bran cannot therefore fulfill the CP nutrient requirements of the chickens. The recommended values of nutritional contents for layers are 90.77% DM, 13.75 MJ/Kg DM, 18.16% CP and 3.5% calcium (Chamal, 2005).

The average chicken flock size found in this study (19.05) is higher than the reports of Tadelle (1996) (4-10 birds per household) in the central highlands of Ethiopia, AACMC (1984) in Ethiopia in general (6 chicken), Sonaiya (1990) in Africa in general (5-10 chicken) and Moerad (1987) for a village in Indonesia (2-5 chicken). On the other hand, the total flock size in this study is close to the reports of Tadelle and Ogle (1996a) in Ethiopia and Gunaratne *et al*. (1992) and Cumming (1992) in village poultry flocks in Asia (10-20 chicken of different ages per household).

Furthermore, Moerad (1987) reported that all families in the villages kept native chickens. This report is not in line with our finding that almost comparable proportions of RIR, hybrid and indigenous chicken comprise the poultry flock. The number of cocks found in a flock in this study (2.17) is in line with the findings of Tadelle (2003) (2.2). However, the number of hens (8.29) and chicks (5.10) in a flock in this study are higher than the reports of Tadelle (2003) (5.4) for hens and smaller than the same report of Tadelle (2003) (8.5) for chicks.

In this study farmers gave more regard to females while selecting for breeding and egg production capacity was the most preferred trait. This is mainly due to the fact that chickens are kept in the area for egg production purpose. The most commonly used bedding material in this study was teff straw which is similar to the reports of Dereje (2001), who found teff straw to be the most commonly used bedding material, and Tadelle (1996) who reported straws as the most important bedding materials. The position of egg during storage has effects on the quality and hatchability of eggs. Proudfoot (1967) evidenced that packing eggs with the small end up and storing in the upright position, with out turning, results in improved embryo survival at all stages of storage time. However, the results of this study indicated that most of the respondent

never cared about the position of eggs during setting. This could be due to lack of awareness of farmers about positioning of eggs during setting and storage.

According to the responses of selected farm households in this study, rainy seasons are the times when high disease problems exist (97.5%). Chicks were mentioned as the most susceptible age groups to diseases by more than half of the respondents (53.3%). Sonaiya (1990), after summarizing the reports from six African countries, reported that the severity of the impacts of Newcastle disease is higher in the dry season. Whereas the disease is more widespread in the rainy season in the central highlands of Ethiopia according to the reports of Tadelle and Ogle (1996). In this study most of the farmers were using traditional medicine (70%) as an intervention method against poultry health problems. This is in line with the reports of Tadlle and Ogle (1996) for the central highlands of Ethiopia. This is mainly due to lack of reliable veterinary service to farm households in the rural areas and poor financial capacity of rural farmers to buy the limited veterinary service available.

The major constraints mentioned by respondents in this study were disease (94.2%), lack of veterinary supplies (82.5%), presence of predators (55%) and lack of improved breeds of chicken (41.7%). Some of these constraints (disease and predation) were mentioned as important by the reports of Tadelle (1996) for the central highlands of Ethiopia.

The degree of multiplication of any breeding stock is essential factor to determine success of poultry operations. In this study, on-station fertility and hatchability rates of 83.56% and 47.79%, respectively, were found. The on-station fertility rate was very close to the reports of Salahuddin *et al.* (1990) for Deshi chicken under station conditions (80.79%). On the other hand, the on-station hatchability was lower than the report of same authors (Salahuddin *et al*., 1990) (71.73%). A much higher hatchability (more than 80%) was reported by Murad *et al*. (2001) and Farooq *et al*. (2001) on the basis of total eggs set. Fertility and hatchability performance of eggs depend on a number of factors like genetic, physiological, social and environmental (Jull, 1970). The very low level of

on-station hatchability found in this study was mainly due to the continuous interruption of electric power and the low quality of feed supplied to chicks and layers.

The average egg weight found in this study for RIR chicken (on station=55.97g and on-farm=56.41g) was very close to the on-station reports of Madkour *et al.* (1982) for Rhode Island Red (RIR) and higher than the values reported for Fayoumi (45.9g) by same authors. The shares of shell, albumin and yolk in egg weight were 12.29%, 61.16% and 26.54%. This is very similar to the findings of Stadelman and Cotterril (1977). The report indicated shell, albumen and yolk comprises 8 to 12, 56 to 61, and 27 to 32 percents of the egg weight.

The average clutch size and frequency found in this study for RIR chicken were 27.38 eggs and 5.03 times, respectively, which is by far higher than the reports of Faranisi (1995) in Sanyati (annual production of 34 eggs laid in 2-3 clutches) and slightly higher than the range reported by Sonaiya *et al*. (1999) and Guèye (2000) (20-100 eggs per year) under village conditions. The on-farm hatchability rate for RIR chicken found in this study (78.77%) is close to the reports from Senegal (80%), Burkina Faso (60-90%), Tanzania (50-100%) and Ethiopia (71.00%); and lower than the values found in Sudan (90%) and Guinea (87.5%) Missohou *et al*. (2002).

The on-farm sexual maturity age of RIR chicken (20.34 weeks) found in this study is in agreement with the reports of Horst (1999) (23 weeks) for Nigerian local chicken and Aganga *et al*. (2003) (23 weeks) for Tswana chickens. Higher value was reported by Gunaratne *et al*. (1993) (28 weeks) for Sri Lankan chickens.

Guèye (2000) reported that under village conditions mortality could reach up to 53% until four weeks of age. The result of this study showed that the average survival rate of RIR chicks was 57.32%, which is slightly higher than the above report.

Birds in a free-range system have a higher yolk color score than other conditions since they can get forage leaves which can supply xanthophylls (Pavlovski *et al.*, 1981;

Pavlovski *et al*., 1994; Teguia, 2000). In this study, RIR chicken kept under village conditions had more than double yolk color intensity score than those kept on-station.

The result of this study on the on-farm adult mortality rate (48.82%) and chick mortality rate (50.02%) is comparable to the reports of Tadelle (1996) (over 60%) for chicken under scavenging condition and Amin *et al.* (1992) for crosses of RIR and Fayoumi (50%) under semi-scavenging conditions.

The results of comparison of on-station and on-farm performances of RIR chicken revealed that RIR chicken kept on station had significantly better performance in terms of annual egg production, adult mortality and chick mortality. On the other hand RIR chicken under on-farm condition had significantly better performance in hatchability. A slightly better hatchability performance by chicken kept on-farm was also reported by Farooq *et al*. (2000) in Pakistan.

6. CONCLUSIONS AND RECOMMENDATIONS

The most important objective of poultry keeping was production of mainly egg and poultry meat to some extent both for household consumption and income generation. Poultry feeding was based mainly on scavenging feed resource with very little supplementation of grains and household leftovers. The results of this study indicated that the supplemented feedstuffs at farm level had low nutrients contents and hence were inadequate for egg production. Although better than the on-farm condition, the mixed ration prepared at the Bedelle Poultry Breeding and Multiplication Center was also deficient in essential nutrients.

The average poultry flock size found in this study was large and was almost a balanced mixture of locals, hybrids and RIR chicken. Disease was the most important constraint affecting poultry production in the study areas.

The on-farm performance of RIR chicken was comparable to locals and hybrids in terms of hatchability, eggshell thickness and yolk weight. But they performed better in clutch size, clutch frequency, age at sexual maturity, egg weight, shell weight and albumin weight. On the other hand they performed worse in chick survival, length of production life and yolk weight.

Under on farm conditions, Rhode Island Red chicken performed better in hatchability while under on-station conditions they performed better in annual egg production, adult mortality and chick mortality.

Based on the above conclusions the following are recommended:

- Rural poultry production deserves greater attention from government, research and development organizations;
- Awareness should be created among smallholder farmers as to the importance of feed supplementation (with energy and protein sources) to improve the on-farm performance of chicken;

- Distribution of improved genotypes of pullet and cockerel shall be done along with packages improved management conditions such as feeding, disease control and housing;
- Poultry breeding and multiplication centers should have ideal management conditions (feeding, electricity supply, water supply and disease control) which would help animals express their genetic potential to a better extent;
- Farmers are encouraged to provide extra care to their chicks by the use of proper brooding facilities made of locally made hay-box brooders and disease control measures like vaccination to reduce chick mortality;
- Further studies should be carried out to compare the performances of improved breeds (hybrids and exotics) under different management conditions.

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8.ANNEX

Annex 1. Questionnaire survey of chicken production in West Soha Zone

I. Socio-economic and farming system characteristics

1. FARMERS NAME ----------
   NAME OF INTERVIEWEE ----------
   ZONE ----------
   DATE OF INTERVIEW ----------
   WOREDA ---------- Altitude ----------
   PEASANT ASSOCIATION ----------
   FARMER NUMBER----------
2. Level of Education of Respondent ----------
3. Age group of Respondent ----------
   (a) Less than 30 (b) 31-50 (c) Above 50
4. Sex of the respondent: (a) Male (b) female
5. Farm size & household structure
   5.1. Farm size
   Total farm size ha____ Cultivated land ha____
   5.2. Household structure
   Household head Name_____ Sex --------M / F Age---------
6. Type of farming 1/ Crop-Livestock 2/ Livestock Only 3. Crop
7. Main Crop and livestock products:----------
8. Type and number of livestock kept

Species	Number
Cattle	
Sheep	
Goat	
Donkey	
Horses	
Mules	
Chicken	

II. Poultry flock characteristics and management

1. How long has poultry been kept in the household?

2. What is your source of foundation stock?

3. What is the objective of keeping chicken?

4. What are the inputs you incur on the poultry business?

a) Stock of chicken b) Poultry feeds

c) Veterinary inputs (medicaments, vaccines and services

5. Is there any taboo /regulation concerning the rising of a special type of birds?

(a) Yes (b) No

6. Chicken flock composition

Chicken type	Number of chicken		
	Exotic	Hybrids	Indigenous
Cocks			
Cockerels			
Pullets			
Hens			
Chicks			

7. Chicken flock dynamics

	Births	Purchases	Mortalities	Sells	Household Consumptions
Cocks					
Hens					
Chicks					
Total					

8. Poultry Management systems

1) Intensive 2) Semi-intensive 3) Extensive

9. Who is primarily responsible for managing poultry in the household?

10. What is the role of each member of the household in poultry keeping?

Family members/hired labour	Responsibility
Husband	
Wife	
Daughters	
Sons	
Elders	
Hired labour	

11. How do you house chickens?

a). Share the same room with the family b). Have a different shelter for night enclosure

c). Separate house constructed entirely for poultry d). Others

12. What are the materials the house is made of?

13. Do you practice culling birds? a) Yes b) No

14. If yes, reasons for culling

15. What do you do with the culled birds?

III. Feed resources & feeding strategy

1. How do poultry get their feed?

a) Scavenging b) Supplementation c) Both

2. If your birds are scavenging, what are the items the birds scavenge on?

3. If you provide supplemental feeds, specify the type feeds your chicken.

Type of bird	Type of supplemental feed
Chicks	
Pullets	
Matura male	
Mature female	

4. How frequent do you feed birds per day

5. Do you provide water for your birds regularly?

a) Yes b). No

6. What is the source of water?

a) Bore hole b) River c) Other _____

III. Breeding practice

1. Do you practice selection within your flock? a) Yes b) No
2. On which sex do you practice selection?
3. For which character(s) do you select?
   a). Colour b). Egg productivity c). Weight (live body weight) d) others
4. What type of breeding do you practice to obtain the characteristic you selected for?
   a) Pure breeding b) Cross breeding
5. Which breeds of chicken have you ever crossed and for what purpose (for which characteristics?)
6. Are you interested to have exotic birds? a) Yes b). No
7. If you are given the opportunity to buy exotic chickens, which breed do you like to have?
   a) White leghorn b). Rhode Island Red 3) Both 4) Other
8. Do you limit the number of males running with females? a) Yes b). No
9. If yes, would you mention the ratio of male: female you normally have in your farm? ----
10. From where did you get the RIR breed?
11. How is the broodiness of the indigenous, hybrid and exotic chicken?
12. What is the setting material?
    a) Clay pot & straw bedding b) clay pot only without bedding
    c) others, specify
13. If you use a bedding material along with the setting material what do you prefer?
    a) teff straw b) wheat straw c) other
14. Do you select eggs for incubation? a) Yes b) No
15. If yes, which ones are selected in terms of size and colour?
16. How do you position the eggs while setting?
17. Do you have any other criteria for selecting broody hens? ----------

---

18. How do you store eggs?

IV. Poultry products

1. Poultry productivity

Poultry productivity	Values		
	Indigenous	Exotic	Hybrid
Egg per clutch (clutch size) (number)			
Number of clutches per year			
Average No. of eggs incubated/brooded			
Hatchability of clutches (%)			
Approx. age of sexual maturity, wk			
Rate of chicks surviving to adulthood			
Weaning age of chicks (in weeks)			
Length of reproductive life (years)			

2. Use pattern of eggs:

3. For what purpose do you use the money from sell of poultry or eggs?

4. Where do you sell chickens and eggs?

   a) Local markets b) Regional markets

   How long (in terms of time) do you travel to sell your poultry products?

5. To whom are you selling your poultry products?

   a) Private consumers b). Retailers c). Hotels 4) Others ----------

V. Poultry health

1. Do you practice vaccination of your chicken? a) Yes b) No if yes, specify

2. Do you apply any modern drugs and medicaments? a) Yes b) No if yes, specify

3. What type of disease (s) do you frequently observe in your flock?

4. Which age group has the highest mortality? (Rank)

   a). Chicks b). Pullets c). Growers d). Adults

5. How do you dispose dead birds?

VI Extension service to poultry production

1. Do you have access to extension services? a) Yes b) No
2. If yes, what are the extension services you get?
3. Are you provided with improved and/or exotic breeds of poultry?
4. If yes, which chicken breeds you received? ----------
5. Are there any institutions giving credit services for poultry production?
   a). Yes b). No
6. Do you discuss your poultry production problems with extension agents ?
   (a) Yes (b) No
7. If no, state the reasons:
   a) Have not heard of them b) Can not easily reach them
   c) There is no need d) Other reason(s)
8. If you, how long does it take you to reach to the extension agent?

_____

9. How frequently do you see the agent?

VII Constraints

_____

1. What are the constraints of poultry production in the area?

_____

THANK YOU VERY MUCH FOR YOUR SINCERE COOPERATION!!

Annex 2. Laboratory analytical producer

Laboratory analyses were made on the wheat, maize, sorghum and teff supplements on farm level and chicks and layers feed mixed at Bedelle Poultry Breeding and Multiplication Center. Dry matter or moisture, ether extract, mineral water or ash and crude protein were determined according to proximate analysis method of the A.O.A.C. (1980). Organic matter (OM) was calculated as 100- Ash content of the samples and Nitrogen Free Extract (NFE) was determined by difference. Kjeldahl procedures of nitrogen analysis were used to determine CP (CP=6.25xN). The ME value (ME) were calculated from adopting the equation proposed by Wiseman (1987).

The acid detergent fiber method dissolves only part of protein and hemicellulose, leaving cellulose, lignin and insoluble ash, which is mainly silica (Van Soest et al., 1963). The difference between NDF and ADF values provides an estimate of hemicellulose. The lignin and cellulose contents may be determined gravimetrically from the ADF residues through removal of lignin by $KMnO_4$ oxidation, or removal of cellulose by acid hydrolysis (Goering and Van Soest, 1970). The determination of calcium (Ca) was using the atomic absorption Spectrophotometer (Perkin Elmer, 1982). Phosphorous (P) was determined by auto analysis (Chemlab, 1978).

9. DECLARATION SHEET

I, the under signed declare that this thesis is my original work, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged.

Name: Negawo Lemma

Signature_____

Date of submission_____

Advisor

Name: Dr. Kelay Belihu

Signature_____

Date_____

BIOGRAPHY

The author was born in 1965 in Gindaberat district, West Shoa, Oromiya region, Ethiopia. He completed his Elementary and Secondary School at Kachise and Ginchi Secondary School in 1982 and 1986 respectively.

In 1986 he successfully passed the Ethiopian School Leaving Certificate Examination and joined the then Alemaya University of Agriculture in 1986 and Graduated with a Bachelor of science Degree in Animal Science in 1990.

Since September 1990 he was employed by the Ministry of Agriculture and served at different positions in the Ministry. After fifteen years of service, he joined the School of Graduate Studies of Addis Ababa University, Faculty of Veterinary Medicine for his Master of Science Studies in Tropical Animal Production and health.

He is Married and a father of three children.