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Indigenous chicken in Ethiopia: their genetic potential, attempts made in the past for improvement and future areas of research

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Abstract

This paper analyses the rural poultry production systems and the role of scavenging chicken in rural household economy in Ethiopia. Past attempts that have been made in the country to improve the production and productivity of local birds through upgrading (distribution of exotic birds) and cross breeding are discussed. The merits and demerits of the different indigenous chicken and their crosses in line with the important traits such as mothering ability, broodiness, immunity and hardiness are reviewed. The significance of indigenous birds in the household economy in the face of extensive importation of exotic birds to improve the production and productivity of local birds are assessed. Future areas of research in relation to characterisation of the different poultry production systems, characterisation and evaluation of the different ecotypes for egg and meat production potential are highlighted. The need to study genetic distance among local birds in the different ecotypes to determine genetic variances that may have importance for future development of the poultry industry are discussed.

Key words: Rural poultry; systems; evaluation; improvement; Ethiopia

1. Introduction

Rural poultry production in Ethiopia represents a significant part of the national economy in general and the rural economy in particular and contributes 98.5 % and 99.2 % of the national egg and poultry meat production, respectively (AACMC, 1984). This is equivalent to an annual output of 72,300 metric tonnes of meat and 78,000 metric tonnes of eggs (ILCA, 1993). This is derived from the 56 million indigenous chicken in the country. However, the per capita egg and poultry meat consumption in the country is one of the lowest in the world (Sida, 1985).

One of the reasons for the low level of performance of the traditional poultry production system is the fact that comparatively little research and development work has been carried out on indigenous chickens. This is despite the fact that they are more numerous than commercial chickens, accounting for about 99% of the total number of birds in the country (AACMC, 1984). The traditional poultry production based on low input-output levels which represents a part of a balanced farming system, has a unique position in the rural household economy as supplier of high quality protein to the family food supply system, provides small cash income and plays a significant role in the religious and cultural life of the society (Tadelle and Ogle, 1996).

The objective of this paper is to review the merit and demerit of indigenous and exotic birds and assess the significance of indigenous birds in the face of extensive importation of exotic birds. The other objective is to identify future areas of research on indigenous chicken and contribute to the development of appropriate improvement and utilization strategies.

2. The rural poultry production systems

2.1. Description

According to Yami (1995) and Tadelle and Ogle (1996) the village poultry production systems in Ethiopia is based on low input-output levels and is part of balanced farming system. Village poultry occupies a unique position in rural communities through their contribution to the supply of valuable protein food to the families of the smallholder farmers. This is particularly true in Ethiopia, because there are few alternative animal protein sources and no cultural or religious taboos of any kind relating to the consumption of eggs and poultry meat unlike those of pig meat. Moreover, poultry rearing is one of the most appropriate activity for rural women, land less and marginalied farmers and it provides cash income, generates employment opportunities for the poor and at the same time increases the supply of high quality animal protein.

This system of production, although appearing primitive can be economically efficient because even if the output from the individual birds is low the inputs are even lower or virtually non-existent. This low output of local birds is expressed as low egg production, small sized eggs, slow growth and low survivability of chicks (Smith,1990 and Tadelle and Ogle, 1996). The feed resource base for rural poultry production is scavenging, and consists of household waste, anything edible found in the immediate environment and small amounts of grain supplements provided by the women. As indicated by Tadelle and Ogle (1996), the scavenging feed resource base (SFRB) is not constant. 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 (more than 60 %) (Tadelle and Ogle, 1996), unsuccessful brooding (because most of the broods died) and periodic decimation of birds by disease reduces the efficiency of the system. Past approaches of improving the genetic potential of local birds through distribution of cockerel, pullet and fertile eggs from birds of exotic origin have had ill- effect because of: reducing the brooding ability of hens, reducing adaptation to low input feeding system and endangering the the genetic base of indigenous chicken population. However, since most of these approaches were implemented over a short time span only the lasting effect has been negligible. From the population genetics point of view this minimal effect can be described as follows: one may picture the village poultry population as a pool of genes under pressure from many directions. Disease, predators, lack of feed, poor housing and poor drinking water are the main pressures. Throw a few "high egg number" genes into the pool and what happens? Their negative correlation with low broodiness will reject them when they try to multiply and establish themselves. Even before this happens, association of high egg number with lack of alertness to predators, poor colour camouflage against predators, and short legs for fast running will likely cause their number to quickly reduce in the gene pool. We should not assume village farmers can not understand the concept that commercial poultry lay many eggs but make poor mothers. This is the result of a well known negative genetic correlation between egg number and broodiness. Farmers quickly realise: that these "foreign laying machines" can not look

after themselves very well, but will produce many eggs if fed and cared for properly. Farmers are usually well aware of the risks involved in losing mothering and survival ability to gain more egg numbers. Thus the concern about loss of local genetic material is fully justified.

2.2. Research and development efforts

Development and research in poultry 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 distribution of these genotypes to farmers with recommendation on appropriate feeding, housing, health care and other husbandry practices. This was expected to have a considerable positive influence for the expansion of large scale commercial farms in the country. However, after 40 years of effort the contribution of exotic birds in terms of egg and meat production is less than 2%. A number of factors can be sited as causes for this low rate of adoption. First, one should recognise that poultry, particularly exotic birds, are food converters' not food producer. The food stuffs 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. Unless the grain production in the country is improved considerably such a system cannot be economically sustainable and socially acceptable.

On the other hand semi-scavenger poultry production system which maximise utilisation of resources which can not be used for direct human consumption would benefit the whole society.

3.Evaluation of local chicken

3:1. Existing performance levels

The local birds in Ethiopia are entirely nondescript breeds closely related to the jungle fowl *(Gallus gallus*) (AACMC, 1984); show a great variation in their body size, plumage colour and conformation. Their use is largely limited to home consumption and generation of small cash income to the household. However, they have a great value in the cultural and religious life of rural communities. Very little scientific work has been done to characterise the local stock under either traditional or improved management conditions. The studies carried out so far generally attempted to establish the performance potential of the indigenous birds under conditions of confinement, an environment to which the birds are not adapted. Furthermore, the studies lacked co-ordination, depth and continuity (Alemu and Tadelle, 1997).

Studies on the traditional poultry production system have indicated that farmers prefer to raise birds with different plumage colours for different purposes such as for egg production, meat production, healing ceremony and cultural purposes. For example traditional birds with light plumage colour are sought for egg production while birds with black and red plumage for meat production, etc. (Tadelle and Ogle, 1996). However, these claim are not confirmed through results of performance testing. Furthermore, considerable morphological variation is observed between populations in the lowland (1500 m.a.s.l.) and highland (2800 m.a.s.l.) areas (Tadelle and Ogle, 1996). The few attempts made to evaluate the egg and meat production potentials of different local strains of chickens will be discussed below:

3:2. Egg production

Research studies on some of the indigenous birds have shown that their potential for egg production is very low. Previous study at the College of Agriculture, Alemaya , has indicated that the average annual egg production of a native chicken was 40 eggs under farmers management, but under experimental conditions the level of production was elevated to 99 eggs per hen per year (Bigbee, 1965). In a study at Soddo, by Wolaita Agricultural Development Unit (WADU) (Kidane, 1980), it was reported that the egg production of indigenous birds was reported to be 84 eggs /bird/year. According to the study by the Ministry of Agriculture (1980), average annual egg production of the native chicken is 30 to 40 eggs under village conditions and that this could be increased to 80 eggs when birds are provided with an improved feeding, housing and health care. A more recent study at the Assela Livestock Farm revealed that the average production of local birds in Arsi was 34 eggs/hen/year, with an average egg weight of 38 g under scavenging conditions. This is equivalent to a total yearly egg production of 1.3 kg. Feed utilisation efficiency of local hens was also low (Brännäng and Pearson, 1990). About 20 kg of poultry feed was needed to produce 1 kg of eggs. These results are extremely low when compared with production levels of egg type exotic birds which were observed to produce over 200 eggs/hen/year with an average egg weight of 60 grams. For example, the White Leghorn were observed to produce over 236 eggs per hen per year at Debre Zeit Agricultural Research Centre (DZARC, 1991).

In depth studies to determine variation in egg and meat production and productivity between different poultry ecotypes did not take place in Ethiopia. A study in Southern Ethiopia whereby birds were identified and characterised into different ecotypes based on their plumage colours and feather cover as Tikur (for black), Kei (for red), Gebsima (for greyish mixture), Netch (for white) and Melata (for naked neck) showed a considerable variation in egg production (Table 2). Of the five ecotypes the Melata ecotype were found to be superior. Although the average performance of the different ecotypes was 18% as compared to 26% in Leghorns, the indigenous birds had the capacity of sustained egg production at times of increased environmental temperatures and in the second year of laying (Teketel, 1986). A similar study at Alemaya University of Agriculture, showed that local chicken from eastern Ethiopia were found to produce 70 % of the hen-day and hen-housed egg production of what is achieved by White Leghorn stock (Abebe, 1992). This study also revealed a considerable variation in egg laying performance between different ecotypes (Table 1). In addition the different study results suggest that there is a considerable variation between local birds (Table 5).

Table 1. Productivity of two exotic breeds and their crosses with local hens at Assela; Ethiopia

Parameter	WL	Y	L	CROSSES	
				Y*L (50%)	Y*L (75%)
Wt.(kg) at 5 mo.	1.05	1.20	.71	na	na
Mature wt.(kg)-hens	1.4	1.5	1.2	1.4	1.5
Mature wt.(kg)-Cocks	1.7	2.5	1.5	na	na
Egg prod./hen/year	167	160	32	129	114
Average egg wt.(g)	58	61	39	48	53
Egg prod.(kg/hen/year)	9.6	9.8	1.2	6.1	6.0
Mortality, Chicks (%)	12	53	93	na	na
Mortality, mature (%)	11	14	34	na	na

Source:- Brännänng and Pearson (1990)
Y= Yarkon; WL= white leghorn L= local

Table 2. Egg production (% hen day) and age at first egg (Days) by different local ecotypes and White Leghorn in two studies in Ethiopia

Ecotypes	% hen day	Age at first egg (Days)
Kei (red)	13.63	141
Tikur (black)	15.23	140
Kokima (Red brownish)	15.30	149
Wossera (Black and white)	14.89	149
Gebsima (greyish mixture)	14.99	147
Netch (white)	12.9	na
Melata (nacked neck)	19.2	na
White leghorn	46.43	148

Source: Teketel (1986) and Abebe (1992)

Table 5. Egg production traits of five Ethiopian ecotypes of chickens

Performance traits	Tikur	Melata	Kei	Gebsima	Netch
Age at 1st egg, days	173	204	166	230	217
Mature body weight, kg	1.3	1.7	1.6	1.5	1.4
- Male - Female	1.0	1.2	1.2	1.1	1.1
Feed intake, kg/ bird/ year	50.9	53.2	37.0	36.4	39.1
Egg/ bird/ Year	64	82	54	58	64
Egg weight, g	44	49	45	44	47
Egg mass, kg/ bird/ year	2.8	4.0	2.4	2.6	3.0
Egg shape index	75.4	69.3	70.7	-	69.0
Shell thickness, mm	0.374	0.311	0.383	-	0.317
Albumen, % egg	50	49	51	49	49
Yolk , % egg	36	38	38	36	36
Fertility, %	56	60	57	53	56
Hatchability, %	42.0	41.8	44.3	39.3	39.0

Source : Mebratu (1997) as compiled from different sources

The average egg weight of local birds was found to be about 40g (AACMC, 1984; Abebe, 1992 and Tadelle and Ogle, 1996), but 46 g was reported by Teketel (1986). Predictably, in view of their lower rate of production, local stocks produce eggs with thicker shells than White Leghorns (Abebe, 1992).

3.3. Meat production

Only a few research results are available on the meat production abilities of local stocks. The AACMC(1984) reported that local males may reach 1.5 kg of live weight at 6 months of age and females about 30 % less. Teketel (1986) also found that under station conditions local stocks reach 61% and 85% of White Leghorn body weights at 6 months of age and at maturity. Abebe (1992) reported that local birds in Eastern Ethiopia attain 71.5% of weights of White Leghorn at 6 months of age. The carcass weights of local birds at 6 months of age was 559 g which was significantly lower than that of the White Leghorn at 875g (Teketel, 1986). However, the local stock had a higher dressing percentage than the Leghorn. As it is indicated in Table 3 and 5, there was a wide variation in meat production potential and body weight of different ecotypes (Teketel, 1986 and Abebe, 1992).

Table 3. Body weight development of different local ecotypes and White Leghorn in two study sites (Awassa and Alemaya) in Ethiopia

Ecotype	Day old(g)		8 Weeks of age (g)		24 Weeks of age (g)	
	Alemaya	Awassa	Alemaya	Awassa	Alemaya	Awassa
Kei	27	32	237	209	1003	1360
Tikur	27	32	240	199	775	1350
Kokima	27	na	256	na	850	na
Wossera	26	na	225	na	1013	na
Gebsima	26	31	228	200	968	1300
Netch	na	32	na	223	na	1420
Melata	na	35	na	242	na	1480
White leghorn	32	43	333	294	1291	1620

Source: Teketel (1986) and Abebe (1992)

3:4. Mortality and survival rate

Teketel (1986) and Abebe (1992) found higher moralities and morbidities among local stocks compared to White Leghorn birds when raised under intensive management in Awassa and Alemaya, respectively (Table 4). Similarly, Brännäng and Pearson (1990) observed a high mortality, among local birds when kept in confinement in the livestock farm at Assela (Table 1). However, the fertility rate of eggs from local stocks was found to be higher than that from White Leghorns (Teketel, 1986).

Table 4. Mortality (%) at starter and grower age by different local ecotypes and White Leghorn in two studies in Ethiopia

Ecotype	Starter		Grower	
	Alemaya	Awassa	Alemaya	Awassa
Kei	23	30	36	none
Tikur	8	13	28	33
Kokima	27	na	54	na
Wossera	30	na	31	na
Gebsima	22	39	33	25
Netch	na	18	na	none
Melata	na	13	na	40
White leghorn	16	17	33	7

Source: Teketel (1986) and Abebe (1992)

The major reason for the high mortality rate of local birds could be due to the fact that they are not used to confinement. Diseases which are important under confinement such as coccidiosis may have a most serious effect in local stock than in exotic stock. In a survey study conducted in the central highlands of Ethiopia by Tadelle and Ogle, (1996), it was

reported that farmers believe that birds with a colour plumage of Gebsma (greyish mixture) and Kokema (Red brownish) are believed to have disease resistant, though it is not confirmed scientifically.

4. Past attempts for genetic improvement

4:1. Distribution of exotic birds to the traditional system

The general conclusion that one can make from the above (implemented) studies and observations is that the local birds are poor in their growth and egg laying performance and their survival ability under intensive type of management is poor. "Upgrading" the blood level of local birds using exotic birds through distribution of cockerels to farmers was considered as the most important strategy to effect improvement. The extension system of the Ministry of Agriculture has promoted schemes in which cockerels from selected strains are reared up to 15 to 20 weeks of age and then exchanged for local cockerels owned by rural subsistence farmers in order to „upgrade“ the genetic potential of local birds. In addition, exotic pullets were introduced to boost egg production to farmers cooperatives and distributed to individual farm households in rural Ethiopia. However, the impact of this strategy is not assessed carefully. The imperical evidence suggests that these approaches were met with a limited success due to high mortality rate of the exotic breeds. The mortality rate of exotic birds was high because the birds lacked adaptation to rural environment, poor management and disease conditions in the new environment. The low impact of exotic birds distributed to rural Ethiopia could be due to their inability to brood, their lack of alertness to predators, poor colour camouflage against predators, and their short legs which are unsuitable for fast running.

The study by Tadelle and Ogle (1996), in the central highlands of Ethiopia shows that there has been an introduction of exotic breeds to the three study villages at various times and in different forms, such as through the introduction of cockerels, pullets, and fertile eggs, but their impact in upgrading the village chicken has been minimal. This is because the programs were usually planned without the participation of the farmer and parallel improvement in feeding, housing and health care. Usually the farmers were given advice on improved feeding and housing and were asked to remove all remaining local cockerels. But throughout the length and breadth of the country, success has not been achieved, mainly because chances are very high that the exotic bird will die, leaving the farmer with no cockerel at all. Some geneticists argue that it can lead to a loss in hatching ability in the flock and therefore it could result in the breakdown of the self-sustaining system of production at village level. From past experience, it seems that the improvement of rural poultry production involve only breed improvement but other husbandry practices as well should have equal importance.

4.2. Cross breeding studies

Evaluation of the egg production performance of crossbreeds between local and exotic birds was conducted by different research and development organisations. A study at Debre Zeit Agricultural Research Centre compared birds with different level of inheritance from White Leghorn. The result showed that the overall performance including egg production of the crosses was better than either the native or exotic parents under the prevailing condition of production. The 50% and 62.5% Leghorn crosses produced 146 and 193 eggs, respectively. The other crossbreeding study involving Yarkon as an exotic breed which was carried out at Assela (Brännäng and Pearson, 1990), in terms of egg production, 50% crosses produced 129

eggs and were found to be better than 75% crosses which produced 114 eggs. In the same study it was observed that crossbred hens (50 and 75% exotic) had almost entirely lost their broodiness. Some started to brood but left the eggs a few days later. However, studies to evaluate the comparative performance of crossbred, local and exotic birds is lacking.

5. Future areas of research

So, characterising and testing the production and productivity of the different strains or ecotypes of birds in Ethiopia for their egg and meat production potential will help to give recommendation for further improvement of rural poultry production system in a sustainable way and to identify genetic variance that may have importance for development of the poultry industry in the future.

Objectives

To characterise, evaluate performance and identify the different poultry production systems and genetic relation between population of local chickens of Ethiopia (with diverse agro-ecology) and hence provide base for further endeavours.

To identify and characterise the different poultry production systems in the country
To describe the bio-physical, economic outputs and socio-cultural aspects of poultry production in the selected communities.
To identify and analyse with the residents the problems and constraints impeding the development of their community, with particular emphasis on poultry production.
To list together with the residents the possible opportunities and strategies that could solve the above mentioned problems. To suggest possible entry points in introducing sustainable poultry development in the area.
To collect strains (eco-types) of local birds from different agro-ecological zones, altitude ranges and market shades and study their phenotypic variation.
To identify and characterize different strains of birds on the basis of their egg and meat production potentials and related traits.
To estimate the genetic distances between and within the different strains (eco-types) in relation to a test population.

Materials and methods

The study will be carried out in Ethiopia, in five villages at five different altitudes, to include >3000 m.a.s.l., 2200-3000 m.a.s.l., 1400-2200 m.a.s.l., 800-1400 m.a.s.l. and <800 m.a.s.l. altitudes and from each altitude range three market shads will be considered. The study will be repited in three seasons, namely dry, short rainy and main rainy.

Characterisation of the poultry production systems

For this purpose topical PRA (Participatory Rural Appraisal) techniques will be applied and an approach for integrating both PRA, a checklist adopted from a training manual for baseline data collection on rural poultry production by the African Network for Rural poultry Development (ARPD) and a year round case study in individual households will be used.

Identification, characterisation and evaluation of different ecotypes of local chicken

Animals

It is planned to collect eggs from five different ecotypes of local chickens.
Seven hundred eggs of local chicken will be collected from five altitude ranges and within each of the five attitudinal ranges three market shed areas will be considered at the first stage of the study and then after eggs will be collected from one representative market shed from one altitude range. The chicks hatched will be raised in Debre Zeit Agricultural Research Center and all the production and Productivity data will be collected.

Data to be collected

Reproductive traits (Fertility, Hatchability, Weight at hatch, Weight and age at start of lay Age and weight at 50% lay (maturity), Age of cockerels at 1.5 kg weight Broodiness (length), onset, clutch size, Viability of chicks, growers and layers).
Egg production traits (Egg production, Egg weight, Daily feed consumption of layers (Feed consumed (kg) / kg of egg), Molting behavior and forced molting after one year under egg production and its effect).
Egg quality parameters (Albumen height, Albumen thickness, Shell thickness and quality, Yolk to albumin ratio and Yolk color).
Growth and carcass traits (Live weight every four weeks interval, Daily feed consumption at different stages of growth and production , Carcass weight, Circumference of the upper leg (thigh) muscle, Breast angle (live at four weeks interval and killed birds at different age) Length of GIT, Caecum length, Plunked dressed carcass and bone weight)

Measuring the genetic distance.

In order to estimate the genetic distances of different ecotypes a subset of 25 individuals from each eco-type will be typed by microsatellite markers. In order to obtain high quality DNA, duplicate fresh blood samples of 10 ml from each animal will be collected. The microsatellite analysis will be done by using an ALF DNA-Sequencer.
Expected outputs:

At the end of the proposed study:

1. Different poultry production systems in the country will be identified and characterised
2. The bio-physical, economic outputs and socio-economic aspects of poultry production in different poultry production systems and communities will be described
3 Problems and constraints of the community in relation to poultry production will be identified and constraint analysis will be made with the participation of the community
4. The possible opportunities, strategies and entry points that could solve the constraints and problem of this production system will be listed out with the community
5. Various strains will be identified and characterised; and the different strains (eco-types) will be known and it is expected to obtain scientific information about fertility, hatchability, survival, age at maturity, egg and meat production potentials, broodiness, feed requirement and other economically important traits of different strains of local birds.
6. Different ecotypes of birds on the basses of their egg and meat production potentials and related traits will be identified

7. The genetic distances between the different strains (eco-types) will be known
8. This information will be used for further improvement of village poultry production systems through management, selection and/or crossbreeding between different strains or with exotic germplasm if necessary.
9. In addition to the above scientific information to international knowledge base for example to FAO Initiative for Domestic Animal Diversity (iDAD) and further improvement guidelines, used to develop breeding goal and plan breeding strategy for the country.
10. Birds collected and characterised in this study will be kept at Debre Zeit Agricultural Research Centre and will be used as a parent material for farther improvement.

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