

Production and Productivity Performance of Crossbred Chickens under Smallholder Farmers in Ethiopia: A Review

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ABSTRACT

This initiative aimed to review, document, and share information about the production and productivity performance of crossbred chicken for Ethiopian smallholder farmers as well as the future poultry production plan of the country. The four types of commercial poultry production systems in Ethiopia that are now recognized include village production systems, small scale-commercial systems, and medium-scale commercial systems and large-scale commercial systems. In Ethiopia, chicken crossbreeding has been attempted to enhance productivity by improving growth rate, feed conversion efficiency, reproductive traits, adaptability, and disease resistance and promising result has been gained as growth and egg production performance of the cross breed is higher than that of the indigenous breed under various production systems. Regardless of their breed, chickens play a significant role in the livelihood of smallholder chicken growers, mostly by providing nutritious food with little waste, producing high-quality organic fertilizer, as a source of income and family savings, and as a means of employment for landless farmers and women. Owing to the low potential of indigenous chicken, it is difficult to satisfy the increased egg and meat demand, and the government of Ethiopia has developed a livestock master plan to support household poultry production by increasing the adoption of hybridized semi-scavenging birds and crossbreeding to improve the livelihoods of poor farmers.

Keywords: Crossbreeding; Exotic; Indigenous; Production; Productivity; Smallholder

INTRODUCTION

In emerging nations like Ethiopia, poultry production contributes significantly to family nutrition and has substantial economic, social, and cultural benefits. According to estimates, traditional scavenging systems are home to 80% of the African poultry population [1]. Scavenging production systems constitute the fundamental basis of most tropical countries, and play a momentous role in the food security of households in the developing world [2]. In addition to the vast population of poultry and other animals, the diverse agroecology Ethiopia presents a potential opportunity to grow the sector, increase its share of the country's agricultural output, and improve the standard of living for impoverished livestock keepers [3]. Currently, there are an estimated 41.35 million chickens in Ethiopia, the majority of which (39.24%) are laying hens, followed by chicks (28.51%). In terms of breed composition, 78.04%, 17.58%, and 4.34% are indigenous, crossbred, and exotic poultry, respectively [4].

Compared with indigenous breeds, the number of hybrid and

exotic breeds in the country is minimal. However, the proportion of exotic breeds in this sector has also increased, and according to in 2016, almost 27% of all eggs produced in the country are from exotic breeds [5]. Economic empowerment, food security, and socio-cultural importance are among the significant contributions of village poultry to the livelihoods of poor households [6].

It is challenging to meet Ethiopian inhabitants' need for eggs and chicken meat due to the poor potential of native chicken [6]. The government of Ethiopia has developed the Livestock Master Plan (LMP) to support family poultry production systems and improve the livelihoods of poor farmers. As clearly indicated by LMP, crossbreeding is considered as one of the ways to improve livestock genetic gains in general and poultry breeding, particularly under selection programs [7]. This study aimed to review, record, and disseminate information regarding the production, productivity and advantages of crossbred chicken for Ethiopian smallholder farmers as well as the country's future poultry production roadmaps.

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Received: 13-Aug-2024, Manuscript No. PFW-24-33483; **Editor assigned:** 16- Aug-2024, PreQC No. PFW-24-33483 (PQ); **Reviewed:** 30-Aug-2024, QC No. PFW-24-33483; **Revised:** 06-Sep-2024, Manuscript No. PFW-24-33483 (R); **Published:** 13-Sep-2024, DOI: 10.35248/2375-446X.24.12.276

Citation: Ijara F, Mijena D (2024). Production and Productivity Performance of Crossbred Chickens under Smallholder Farmers in Ethiopia: A Review. *Poult Fish Wild Sci.* 12:276.

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LITERATURE REVIEW

Poultry production systems in Ethiopia

Based on production goals, biosecurity measures, and the number of chickens kept, the poultry industry in Ethiopia can be divided into four categories: village production systems, small-scale commercial, medium-scale commercial, and large-scale commercial [8]. In addition, the majority of the country's chicken meat and eggs are produced by free-range rural farming systems with low-yielding native breeds. Other scholars divided the Ethiopian poultry industry into three main production systems (village or backyard poultry production system, small-scale poultry production system, and commercial poultry production system) based on particular criteria like breed, flock size, housing, feed, health, technology, and biosecurity. Generally, poultry production systems in Ethiopia characterized as below (Table 1) [9,10].

Available commercial chicken breeds in Ethiopia

Based on reports, Ethiopia has breeds of chicken that are both native and exotic [11]. Exotic breeds were previously restricted to commercial farms under strict management, while native varieties were kept in backyard chicken production systems. Currently, exotic and crossbreeds are maintained in backyard chicken production systems using certain inputs. Commercial breeds (including layers or broilers) have been developed based on consumer demand. Pure exotic varieties exist as well, albeit they are not now offered in Ethiopia's commercial marketplaces. White Leghorns and Rhode Island Red were once available in Ethiopia.

As stated by, while research institutes import exotic breeds for crossbreeding, the Ethiopian Ministry of Agriculture and non-governmental organizations import them to improve the egg and meat output of the country [12]. As a result, more than 20 exotic chicken breeds were consequently imported into Ethiopia. Originally, a project funded by the United States Agency for International Development brought four exotic chicken breeds (Rhode Island Red, Australop, New Hampshire, and White Leghorns) to Jimma and Alemaya Agricultural Colleges (now known as Jimma and Haramaya University) in 1953 and 1956,

respectively [13]. Then came the introduction of commercial breeds such as Issa Brown, Bovan Brown, SassoT44, Brown Leghorn, Sussex, and the Egyptian breed Fayoumi [12].

Chicken crossbreeding

Crossbreeding is the process of mating multiple animal breeds to produce the desired traits and compensate for deficiencies in one breed with those of the other [14]. It can be applied to the production of crossbred animals, improvement of native chickens, and development of new (synthetic) breeds that blend the best qualities from many breeds [15]. Crossbreeding primarily aims to promote fitness, improve reproductive capacity, and combine many economically relevant features to generate superior species (by utilizing hybrid vigor) [16]. Crossbreeding local chicken genotypes with exotic genotypes that have been adapted would allow producers to create more productive and adaptable genetic types by utilizing the crossbred potency of the indigenous chicken and productive performance of the exotic [17]. Crossbreeding is superior to selective breeding, as it can quickly reach target production [18]. Strong crossbreeding abilities produce birds with improved performance, particularly in growth rate, feed conversion efficiency, and reproductive traits, without necessarily compromising the capacity of native chickens for scavenging, adaptability to their surroundings, or the quality of their meat and eggs [19].

By importing, evaluating, and establishing superior exotic breeds that can withstand harsh and demanding management conditions, Ethiopians can enhance the genetic makeup of their native chickens [20]. According to both synthetic breeding (dz-white) and selective breeding (horro chicken breed) have been developed, and have shown better performance in research stations and on-farm conditions [12]. The DZ-white synthetic breed is in the fifth stage of selection, whereas the enhanced horro breeds are currently in the eleventh generation. Depending on the form of crossbreeding, farmers can crossbreed at little or no additional expense. Crossbreeding indigenous chickens with better exotic breeds can increase production in management settings, but care must be taken when selecting the right breeds for the crossbreeding process [21].

Table 1: Characteristics of poultry production systems in Ethiopia.

Characteristics	Production systems		
	Traditional/scavenging	Small scale/market oriented	Intensive/commercial
Breed	Indigenous	Specialized and dual-purpose birds	Specialized birds
Flock size	<50	50-1000	2,500-50,000
Housing	Specific poultry houses are rare	Varies from modern houses to simple housing made from locally available materials	Modern housing, Generally, with concrete walls and regulated internal environment
Feed resource	Scavenging and occasional feeding with home grains and refuse	Commercially compounded, homemade mixtures and scavenging	Commercially compounded feeds
Health program	No regular health program of disease control measure	Disease control and health program at varying levels	Standard and regular animal health program
Markets	No formal marketing channels	Input and output distribution are based on existing trading centers	Cold chain system for input-output distribution

DISCUSSION

Production performance of crossbreeds

A number of factors, including the breed and strain of chickens employed, the atmospheric conditions in poultry houses, applied management systems, and feed and feeding management, have an impact on poultry production [22]. An attempt has been made to improve the performance of indigenous chickens in terms of egg and meat production by crossbreeding exotic commercial cocks with native hens [23]. In addition to being used for the development of new breeds, indigenous chickens offer genetic resources for genetic improvement and chicken diversity exploration [24]. Compared to pure exotic or native chickens, crossbred chickens perform better and are more suited to tropical conditions because they are raised in scavenging, semi-intensive, or intensive settings [25]. The number of eggs produced and body weight of F1 crosses were higher than those of indigenous chickens kept under farmers' conditions, indicating that crossbreeding has the potential to improve economically important traits [26]. The greater egg production and the heavier body weight of the hens will benefit the villagers' farmers financially; therefore, this improvement is probably quite significant.

A study was carried out in Ethiopia using two native and two exotic chicken breeds in a four-way crossbreeding experiment to create a chicken population and under village management settings; in terms of body weight and egg production, the ultimate four-way chicken crosses are believed to perform better than the native population. The odds of survival were higher than those of exotic chickens. Through crossbreeding, village chicken productivity may be raised, improving farmers' livelihoods through a higher output of chicken products. However, to enable chickens to reach their full genetic potential, improved management techniques such as better housing, higher-quality nutrition, and disease prevention should coexist alongside genetic advancements [27].

According to since 2004, coordinated research activities between the Ethiopian Institute of Agricultural Research (EIAR), Wageningen University and Research Centre (WUR), and the International Livestock Research Institute (ILRI) have increased the production of native Horro chickens, and after eight generations of mass selection, the technique effectively raised the egg output of 11-month-old chickens from 34 eggs to 79 eggs [28]. The production and efficiency of five native and exotic chicken breeds at the Debrezeit Agricultural Research Center (DZARC) in Ethiopia were documented by another researcher and are described as follows (Tables 2 and 3) [28,29].

Table 2: On station and on farm productivity performance of Horro chickens.

Measured economic traits	On-station		On-farm
	Un-improved	Improved (G7*)	Improved (G7*)
Hen housed egg production (12 months)	23.3	48.7	-
FCR (kg feed/kg gain)	15.3	12.4	-
Fertility (%)	-	77	-
Hatchability from set eggs (%)	-	43.4	-
Body weight (g) at 20 weeks (female)	684.8	964.2	-
Survival 20 weeks male	88.8	98.8	-
Survival 20 weeks (female)	-	-	88.8

Note: * = 7th generation

Table 3: Feed consumption and productivity/efficiency of local and exotic chickens at DZARC.

Measured variables	Breeds				
	Hubbard JV	Koekoek	Local Horro	DZ1	DZ2
Average weekly feed intake (gram/bird)	144.1	109.9	105.9	111	104.4
Approximate monthly feed intake (gram/bird)	576.3	439.6	423.6	443.8	417.4
Approximately yearly feed intake (gram/bird)	6915.6	5275.2	5083.2	5325.6	5008.8
Average egg weight (gram)	63.3	57.5	47.5	58.5	53.8
Approximately monthly production (egg/bird) in gram	1088.7	875.8	583	663	827.7
Feed Conversion Ratio (FCR)	3.71	3.47	5.09	4.5	3.53
Feed consumption	high	moderate	low	moderate	low
Productivity (eggs produced)	high	moderate	low	low	moderate
Efficiency (based on FCR)	moderate	high	low	moderate	high

Growth performance

Because of their significant economic effects, body weight and weight increase are significant characteristics in the breeding of chickens. Growth can be viewed as a direct fitness feature in terms of productivity efficiency and production costs [30]. According to genotype has a beneficial impact on body weight increase at different ages [31]. When improved horro chickens were crossed with koekoek and kuroiler chicken breeds, the maximum body weight observed at hatch in both cases indicated that the hatch weight was greatly increased. At 16 weeks of age, the selection of Horro-chickens led to a 95% increase in body weight development and the Rhode Island Red cross also has a high body weight [32,33]. According to at 16 weeks of age, the DZ-white body weight was similar to that of koekoek, which was between 1.4 and 1.70 kg at 20 weeks of age [34]. Under on-station care, DZ-White's body weight (1.38 kg) at 16 weeks of age was greater than Bovan Brown's (1.23 kg) [21]. In terms of cumulative body weight over a six-month period, dz-white (1272.98 g–1522.83 g) and improved horro (1211.22 g–1362.69 g) both had greater body weights than koekoek (1432.96 g at on-farm and 1592.48 g at on-station), respectively. Other scholars reported that the koekoek breed at the DZARC research farm can produce males (2.65 kg) with higher body weight than females (1.87 kg) at the end of production [35].

Performance of egg production

A number of factors negatively impact the ability of chickens to produce eggs. The type of breed, amount and quality of feed intake, water intake, duration and intensity of light, parasite infestation, illnesses, management, and environmental conditions can all have an impact on the number of eggs produced [36]. The total number of eggs produced was used to measure the economic success of the flocks [37]. The egg production performance of the Rhode Island Red crossbreed is higher than that of the Rhode Island Red breed under traditional production systems in Ethiopia [38]. In addition, there was an average egg weight (41.00 g) in crosses between White Leghorn and Nigerian indigenous chickens [39].

Another scholar recorded that, 129.00 eggs from crossbred hens of yarkon and any local chicken, 119.00 eggs from fayoumi and necked neck crossbreed, 90.80 from Rhode Island Red, and any local chicken crossbreed in Ethiopia [40]. Under on-station conditions, the improved horro breeds produced more eggs (171.00 eggs/year) than the unimproved horro ecotypes (66.50 eggs/year), and the selection of horro-chickens led to a 123% increase in egg production in Ethiopia at 45 weeks of age. In the semi-intensive management system, crossbred chickens in Northern Uganda lay more eggs than indigenous chickens, whereas under the free-range management system, crossbred chickens deposited 18.60 eggs per clutch, which is greater than the 12.80 eggs laid by indigenous chickens [41].

According to white leghorn, Rhode Island Red, and fayoumi chickens raised under on farms condition produced 173.00, 185.00, and 144.00 eggs/year/hen, respectively, in their yearly egg yield [42]. Another study by showed that, the koekoek breed at the dzarc research farm can produce up to 200.00 eggs/hen/year with 55.50 a mean egg weight in Ethiopia [35]. Under on-farm conditions, crossbred Rhode Island Red breed with indigenous breed in the West Shewa zone produced greater laying percentages, clutch sizes (crossbred 22.17 and indigenous 14.23 eggs), and egg weights (crossbred 50.23 g and indigenous 42.76 g) [43]. Similarly,

reported that, 49.10, 117.00, 134.00 and 138.00 eggs/hen/years for local, Bovans Brown, Sasso and Koekoek breeds, respectively under farmers' management system [44].

Benefits of keeping crossbred chickens for smallholder farmers

Poultry plays an extremely significant role in providing both food and income to smallholder farmers and countless communities in the majority of developing countries. Owing to the fact that they produce meat and eggs, act as a source of revenue and savings for the family, and offer women and landless farmers a means of employment, chickens are essential to the livelihoods of smallholder farmers. According to landless workers, smallholder farmers, and those with incomes below the poverty line can grow hens with minimal input and use feed resources to scavenge eggs and meat [45]. As indicated by in countries with low income and food insecurity, family chicken meat and eggs make approximately 20%-30% of the overall animal protein supply [46]. In Ethiopia, chicken is widely available and practically owned by rural families, making it a vital source of revenue and protein for the family [47]. In addition to food and income supply, chicken production is beneficial for smallholder farmers as eggs and poultry meat are nutritious food with very little waste, produce high quality organic fertilizer, produce something for self, self-sufficient (independent), obtain fresh eggs every day, recycle household scraps (poultry are good scavengers), enrich life with their beauty and behavior, and enjoy observing and feeding hens for smallholder farmers.

Future poultry production roadmap of Ethiopia

Within the Ethiopian Livestock Master Plan, a poultry development roadmap was designed in light of the potential for chicken production to decrease poverty and hunger. Implementing the second growth and transformation plan was made possible in part by the livestock master plan. The Ethiopian LMP's poultry development roadmap places a high priority on distribution and adopting crossbred, semi-scavenging chickens to increase family poultry output. In rural Ethiopia, there are two types of family poultry production systems: large-scale scavenging, which comprises five to fifty crossbred and indigenous birds, and small-scale scavenging, which comprises up to five hens that are primarily indigenous and rarely crossbred [48]. The LMP prioritizes promoting a shift toward better family poultry production while reducing conventional small-extensive scavenging poultry farming in rural regions. To accomplish this enhanced system, exotic breeds are imported and primarily used for crossbreeding with indigenous breeds to crossbreed free-range breeds. If conventional family poultry are successfully transformed, they would provide a more market-oriented and fruitful crossbred chicken production system as long as they receive the required feed and vaccinations.

CONCLUSION

The poultry sector in Ethiopia has been characterized by large-scale commercial, medium-scale commercial, small-scale commercial, and village production systems based on production objectives, flock size, housing, feed, health, technology, and biosecurity. The growth performance (body weight and weight gain) and egg production of poultry are influenced by various factors, including the kind and strain of chicken utilized, the environmental conditions in poultry houses, the management techniques employed, and the feed and feeding management. All breeds of chickens contribute significantly

to the livelihood of smallholder farmers, mostly through producing high-quality organic fertilizer, delivering wholesome food with minimal waste, serving as a source of income and family savings, and giving landless farmers and women a job.

To narrow the gap between demand and supply for poultry products (eggs and meat) in the country, the Ethiopian government has developed a poultry development roadmap, and the adoption and distribution of crossbred semi-scavenger chicken is prioritized in the roadmap strategy as a means of enhancing family poultry output. In Ethiopian rural areas, family poultry production can be divided into large-scale scavenging (involves five to fifty crossbred and indigenous birds) and small-scale scavenging (involving up to five mostly indigenous and very seldom crossbred breeds). Importing exotic breeds, which are mostly used to crossbreed indigenous breeds to create crossbred semi-scavenging breeds, will enhance this system. If traditional family poultry are successfully transformed, the resulting crossbred poultry production system would be more productive and focused on the market, as long as it receives the required immunization and nutrition.

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