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Review on Poultry Production Status and Economic Contribution of the Sector in Ethiopia

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Abstract
This review focused on the poultry production status, breed/ecotype characterization, genetic improvement trends and economic value of the poultry sector in Ethiopia. The poultry production system in Ethiopia can be classified into four categories, large scale commercial, medium scale commercial, small scale commercial and village or backyard commercial production system. Chickens play an important role in the human economy, supplying food, creating wealth through job creation for the booming population. About 78.85% of the Ethiopian poultry population consists of indigenous chickens, while the remaining 21.14% consists of exotic and hybrid breeds of chickens. The indigenous chickens of Ethiopia have various names and characterized based on their ecological or main habitat, depend on qualitative characteristics. The molecular characterizations of some Ethiopian indigenous chicken ecotype were conducted. The improvements of the productivity of indigenous chicken ecotype are mainly focused on the introduction of high yielding exotic chickens. Exotic chickens were first introduced into Ethiopia in 1953. The genetic improvement through introduction of exotic breeds was failed due to less adapted to local environment conditions, poor management; lack of input and output markets; and shortage of quality feeds, vaccines and veterinary inputs. Chickens are the backbone economy base of poor resource households in Ethiopia. The economic contribution of the poultry production sector is not still proportional to the huge chicken numbers, due to the presence of many productions, reproduction and infrastructural constraints. To use full potential of poultry sector, it requires the development of proper poultry breeding program and strategy.
Keywords:breed, chicken, economy, exotic, genetic improvement, indigenous chicken, phenotypic characterization
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Introduction

In Ethiopia, the word poultry is synonymously used with the word chicken. The domestication of poultry (chicken) was mainly for the production of meat and eggs for sale in order to obtain income and domestic consumption all over the world. The rearing of birds originated many years ago, which started by a collection of their eggs and young ones from their natural habitat, which later resulted into domesticating them as farm animals with people. Domestic chickens come from the Red Jungle Fowl (Gallus Gallus), which originate in parts of India and South-East Asia (Zeuner, 1963). Domestication probably began in India and China around 8000 years ago and extended geographically with trade to countries in the Mediterranean region. Spanish explorers brought domesticated poultry into the New World in the 16th century and large-scale commercial poultry production began in the 19th century (Sawaj et al., 2010; Xiang et al., 2014; Lotvedt, 2017).

Keeping poultry, particularly domestic chickens is the backbone economy base of poor resource households in developing countries like Ethiopia and the world as whole. The impact of village chicken in the national economy of developing countries and its role in improving the nutritional status, income, food security and livelihood of many smallholders is significant owing to its low cost of production (Abubakar et al., 2007). The economic contribution of the poultry production sector is not still proportional to the huge chicken numbers, due to the presence of many productions, reproduction and infrastructural constraints (Aberra, 2000; Halima, 2007). Therefore, this review covered the status of production and the economic value of Ethiopian poultry production.

Poultry production system in Ethiopia

Chickens make up the largest portion of the global economy in terms of poverty reduction and job creation. Poultry production system can be subdivided into four major distinct parts named small, medium and large scale based on the breed, flock size, housing, feeding, health and technology used. Poultry production systems are defined according to the social and physical conditions in the Ethiopian environment (Alemu, 1995).

Based on the objective, breed, flock size, housing, feeding, health, Biosecurity level and technology used, the poultry production system in Ethiopia can be classified into four categories, large scale commercial, medium scale commercial, small scale commercial and village or backyard commercial production system (Wondmeneh et al., 2017, FAO, 2019). The integrated large-scale commercial production system contains over 10,000 birds with a high level of Biosecurity, modern housing with concrete walls and regulated internal environment, use

commercially compounded feeds, has standard and regular animal health program with the market characteristics of cold chain system for input-output distribution. A medium-scale commercial system has raised a capacity of 1,000 to 10,000 birds with a moderate to high level of biosecurity and kept permanently indoors with the housing system varies from modern houses to simple housing made from locally available materials, use commercially compounded, homemade mixtures and scavenging feed, has disease control and health program at varying levels and market input and output distribution is based on existing trading centers. The small-scale commercial system has a capacity of 50 to 1000 birds and a minimal level of biosecurity, the house made from local martials, scavenging with regular supplementations feeding, has access to veterinary service and the major source of birds are commercial day-old chicks or natural incubation. The production system in villages or backyards has kept few birds, specific poultry houses are rare, scavenging and occasional feeding with home grains and refuse, no regular health program with no biosecurity and no formal marketing channel. Birds kept in this system are usually native, dual-use breeds that are adapted to the scavenging production environment. From small to large scale, with the exception of villages or backyards, the production system has maintained hybrid and exotic breeds (Alemu, 1995; Emebet and Kidane, 2016; Wondmeneh et al., 2017; FAO, 2019).

Ethiopian households own poultry holdings of variable size. However, approximately 80 per cent of households with poultry keep 1 to 9 chickens. The sector is indeed dominated by the indigenous breed, extensive scavenging and small extensive scavenging family poultry production systems (FAO, 2019; CSA 2020).

Importance of poultry and poultry product

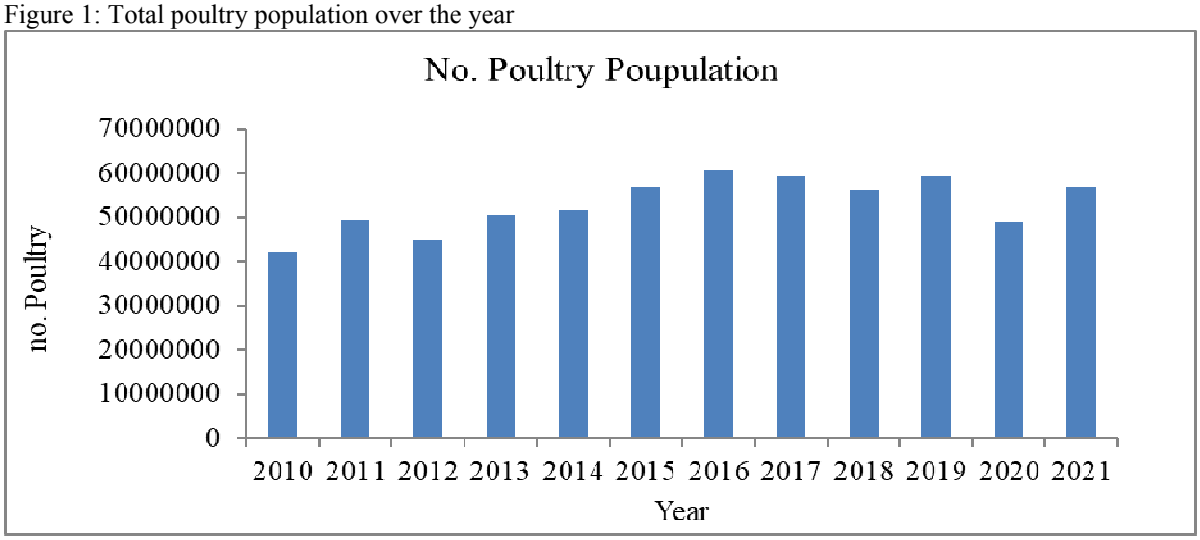
Poultry plays an important role in the human economy, supplying food, creating wealth through job creation for the booming population. The nutritional benefits derived from poultry products include animal proteins, minerals, fat-soluble vitamins, carbohydrates, pigments, fluids, and cholesterol are attributable to its relevance as the world major source of food. It is also relevant for industrial uses in the supply of vaccines, fertilizers, animal feed, pharmaceuticals, including preservatives during semen storage, in paint and adhesives, varnishes, printing ink, etc (Tadelle et al., 2003; Dilger et al., 2016; Alder et al., , 2019; Ugbe et al., 2020).

Chicken production is a major livestock subsector in Ethiopia. It plays an important role in job creation, family nutrition improvement and women's empowerment. This is an appropriate enterprise for poor households because of the small amount of land needed and the low investment costs involved in starting and managing the farm (FAO, 2019).

Ethiopia chicken population

Ethiopia has about 60% of the total chicken population of East Africa, which includes local, exotic and hybrid chicken breeds (Fuals et al., 2018). About 78.85% of the Ethiopian poultry population consists of indigenous chickens, while the remaining 21.14% consists of exotic and hybrid breeds of chickens (CSA, 2021). The total number of poultry at country level is estimated at around 57 million. The largest proportion of poultry consists of laying hens (34.26%), followed by chicks (32.86%). Pullets account for an estimated 11.36% of the country's population. Cocks and cockerels are estimated about 11.2% and 5.74%, respectively. The rest is non-laying hens, which represent about 4.59% of the country's total poultry population (CSA, 2021). The total poultry population from 2010 to 2021 is presented in Figure 1. The chicken population growth over the year almost stagnant because of high chicken mortality due to lack of adaptation of introduced exotic chicken, diseases, predators prevalent in the scavenging production systems and limited expansion of commercial poultry production both in terms of number of operators and volume of operation. The chicken population distribution was high in Oromia and Amhara region followed by South Nation and Nationality People of Ethiopia (SNNP) and Tigray region. According to report of CSA (2021) Oromia, Amhara and South Nation and Nationality People of Ethiopia regions has about 33.62%, 33.44%, 16.91% and 12.28% of the total chicken population of the country, respectively.

Figure 1: Total poultry population over the year



Source: CSA, 2010-2021

Table 1: Chicken population by region in Ethiopia

Region	Year					
	2016	2017	2018	2019	2020	2021
Oromia	21,201,122	20,408,299	19,014,114	20,766,720	16,668,657	19,160,388
Amhara	19,958,894	19,961,861	17,705,026	20,501,879	16,827,119	19,060,608
SNNP	10,851,155	11,197,124	10,491,131	9542274	7,347,204	9,638,571
Tigray	6,329,501	5,735,973	6,190,640	6,032,251	48,955,675	7,000,785
Benishangul Gumuz	1,363,061	1,249,578	1,672,084	1,480,468	884,660	1,155,535
Gmbela	358,288	385,768	301,531	490,448	229,151	314, 680
Somalie	177,300	161,265	250,418	250,418	354,264	318,567
Afar	106,355	197,825	215,768	185,372	92,941	91,562
Dire Dawa	85,318	102,963	118,376	93,444	129,575	122,328
Hareri	74,331	94,371	97,690	76,992	104,585	129,963

Source: (CSA, 2016-2021)

Chicken ecotype/breed characterization

Breed characterization can be important to identify breeds at risk of extinction or which are highly desired by farmers, and hence is an important input into nation's chicken development planning (Halima et al., 2007). In Ethiopia, chickens are widely distributed in almost all over part of the country and reared by rural family, in some private chicken producers and governmental institutions like universities and agricultural research centers (Shumuye et al., 2018). About 78.85% of chicken found in the country is indigenous and the others 12.03% and 9.11% are the hybrid and exotic breeds (CSA, 2021). A huge amount of phenotypic diversity for various traits in the indigenous chicken genetic resources of Ethiopia is predictable due to diverse agro-ecology, ethnic groups and cultures, migration following natural and man-made challenges and the strategic location of the country in the Horn of Africa midway to Asia and western countries (Halima et al., 2007).

The indigenous chickens of Ethiopia have various names and characterized based on different criteria. One based on their ecological or main habitat, chickens are named after their area of geographical origin and depend on qualitative characteristics for identification of the breeds especially body size and shape, feather type, comp type and color (Tadelle et al., 2003; Halima, 2007; Bogale, 2008; Nigussie, 2011; Mearg, 2016). The major indigenous chicken ecotype found in different part of Ethiopia were characterized by different scholars are Chefe, Jarso, Tilili, Horro, Tepi, Gelila, Debre-Elias, Melo-Hamusit, Gassay, Guangua, Mecha, Farta, Konso, Mandura, Sheka,Tikur, Key, Gebsima, Netch, Serrano, Libe work, Teterma, Tikur-Teterma and Key-Teterma (Sharawany and Banerjee, 1991; Tadelle et al., 2003; Halima, 2007; Bogale, 2008; Nigussie, 2011).

Besides the evaluation of the performance traits, genetic characterization using genetic markers has been recognized as a valuable tool to characterize the genetic variability within and the genetic distance between local chicken populations, to identify genetic, to give information for the use of heterosis in crossbreeding programs and to preserve genetic diversity (Tadelle, 2003). The molecular characterizations of Ethiopian indigenous chicken ecotype were conducted by different scholars (Tadelle, 2003; Halima, 2007, Embet, 2015; Nigussie, 2011). Molecular characterization is DNA-based methods which are independent of environmental factors and

provide useful information about genetic diversity to support the global management of genetic resources (FAO, 2011). Genetic characterization contributes to breed definition, populations which are not well defined and provide an indication of the genetic diversity of these lines. It has potential to identify unique alleles in the breeds or lines studied (Halima, 2007). Tilili, Gelila, Debre-Elias, Melo-Hamusit, Gassay/Farta, Guangua and Mecha indigenous chicken populations were molecular characterized by Halima (2007). The five chicken ecotypes Tilili, Horro, Chefe, Jarso and Tepi were characterized by Tadelle (2003) and four indigenous chicken populations Dawo, Seden Sodo, Mehale Amba and Mehurena Aklile were characterized by Embete (2015).

Chicken genetic improvement in Ethiopia

There are different types of interventions to improve chicken breed/genetics for enhancing the existing chicken productivity. This including introduction of Exotic breed and crossbreeding and selection of indigenous. Lack of addressing to productive and adaptable chicken breeds still remain one of the most critical challenges to increasing the economic contribution of the sector (FAO, 2019). The chickens kept by smallholder farmers are unimproved indigenous flocks, well-adapted to the local environments but having slow growth rates and very poor egg productivity (Tadelle et al., 2001; Addis and Aschalew, 2014). In Ethiopia, the improvement of the productivity of indigenous chicken ecotype are mainly focused on the introduction of high yielding exotic chickens to replace indigenous stocks, but it is still limited due to the failure of imported exotic breeds due to less adapted to local environment conditions, poor management; lack of input and output markets; and shortage of quality feeds, vaccines and veterinary inputs (Teklewold, 2006; Fulas et al., 2018, FAO, 2019).

Exotic chickens were first introduced into Ethiopia in 1953 and 1956 by Jimma Agricultural and Technical School and Alemaya College of Agriculture, respectively (Tamirat 2015; Wondmeneh et al., 2016). Four breeds of chickens (Rhode Island Red, Australorp, New Hampshire and White Leghorns) were imported. Later, the Debre Zeit Agricultural Research Centre (DZARC) was also involved in evaluating the performance of these breeds including additional introductions such as the Brown Leghorn, Light Sussex and Barred Rock (Wondmeneh et al., 2016; FAO, 2019). The Fayoumi chicken from Egypt introduced in 1996 and in the mid 2000s, DZARC introduced the Lohman Silver and Koekoek breeds (Wondmeneh et al., 2016). In 2010, a layer grandparent (GP) generation was imported. Three dual purpose (Red barred, Lohman Dual and Novo color) and three layer (Lohman brown, dominant Sussex and Novo brown) breeds were introduced in 2015 and are being kept at Debre Zeit research center (Nigussie, 2011; Wondmeneh et al., 2016; FAO; 2019). The importing of exotic chicken for genetic improvement schemes is failed (Nigussie, 2011). Therefore, breeding programs requires defining production environments and identifying the breeding practices, production objectives and trait choices of village farmers as inputs for developing appropriate breeding strategies.

The importation of exotic chicken breeds in to Ethiopia change the number of indigenous chicken population over year. The current chicken populations by breed from 2012 to 2021 are presented in Table 2. The introduction of exotic breed had an effect on the country chicken genetic erosion. The total estimated chicken population in 2016 was about 60.5 million and in 2021was about 56.9 million. This indicated the population of chicken was decreased. But the breed composition of indigenous, exotic and hybrid chicken population in the country changed from 94.33%, 2.47 % and 0.32% in 2016 to 78.85%, 9.11% and 12.03 % in 2021, respectively. This indicated the presence genetic erosion and dilution of indigenous ecotype by introducing of exotic chicken genotype to the country.

Table 2: The current chicken populations by breed

Year	Total	Indigenous (%)	Hybrid (%)	Exotic (%)
2012	44,893,099	43,304,090(96.46)	256,330(0.57)	1,332,589(2.97)
2013	50,377,142	48,815,313(96.9)	271,465(0.54)	1,290,364(2.56)
2014	51,350,738	49,723,605(96.83)	411,809(0.8)	1,215,324(2.57)
2015	56,866,719	54,510,523(95,86)	1,586,144(2.79)	770,052(1.35)
2016	60,505,327	57,072,596(94.33)	1,939,479(0.32)	1,493,251(2.47)
2017	59,495,026	54,053,925(90.85)	2,823,619(4.76)	2,610,482(4.39)
2018	56,056,778	49,436,720(88.19)	3,004,020(5.36)	3,616,039(6.45)
2019	59,420,266	50,157,556(85.68)	4,157,556(7)	4,348,459(7.32)
2020	48,955,675	40,001,033(81.71)	5,317,392(10.86)	3,637,250(7.43)
2021	56,992,987	44,940,924(78.85)	5,194,345(9.11)	6,857,718(12.03)

Source: CSA, 2012-2021

Contribution of poultry sectors on Ethiopian economy

The human population in Ethiopia shows a growing trend with an alarming rate that in turn increases the demand for food, particularly of animal origin (Figure 2). Ethiopia has an estimated rural and urban population of 80.5% and 19.5%, respectively (FAO 2016, Demissu et al., 2019). Over the past few years, an emerging middle-class

urban society and urbanization with better incomes and greater purchasing power have increased demand for chicken and chicken products. This has resulted in the expansion of poultry production, particularly in urban and peri-urban areas (Tadelle et al., 2001; Pedersen, 2002; Demissu et al., 2019). Family chicken meat and eggs contribute 20–30% to the total animal protein supply in low-income and food-deficit countries (Matawork, 2016). Chicken production is playing an important role in increasing socio-economic status of community and employment (Ahmed, 2018). Small scale and semi-commercial poultry production is a vital tool in reducing poverty and hunger in developing countries (Embete, 2015). Poultry keeping is making an important contribution to the livelihoods of the most vulnerable rural households in developing countries. During the last decade, the consumption of poultry products in developing countries has grown by 5.8 percent per year (FAO, 2000). In Ethiopia, chicken meat and egg consumption less significant and smaller than other African country (Kenya, Uganda and South Africa) (Figure 3 and 4).

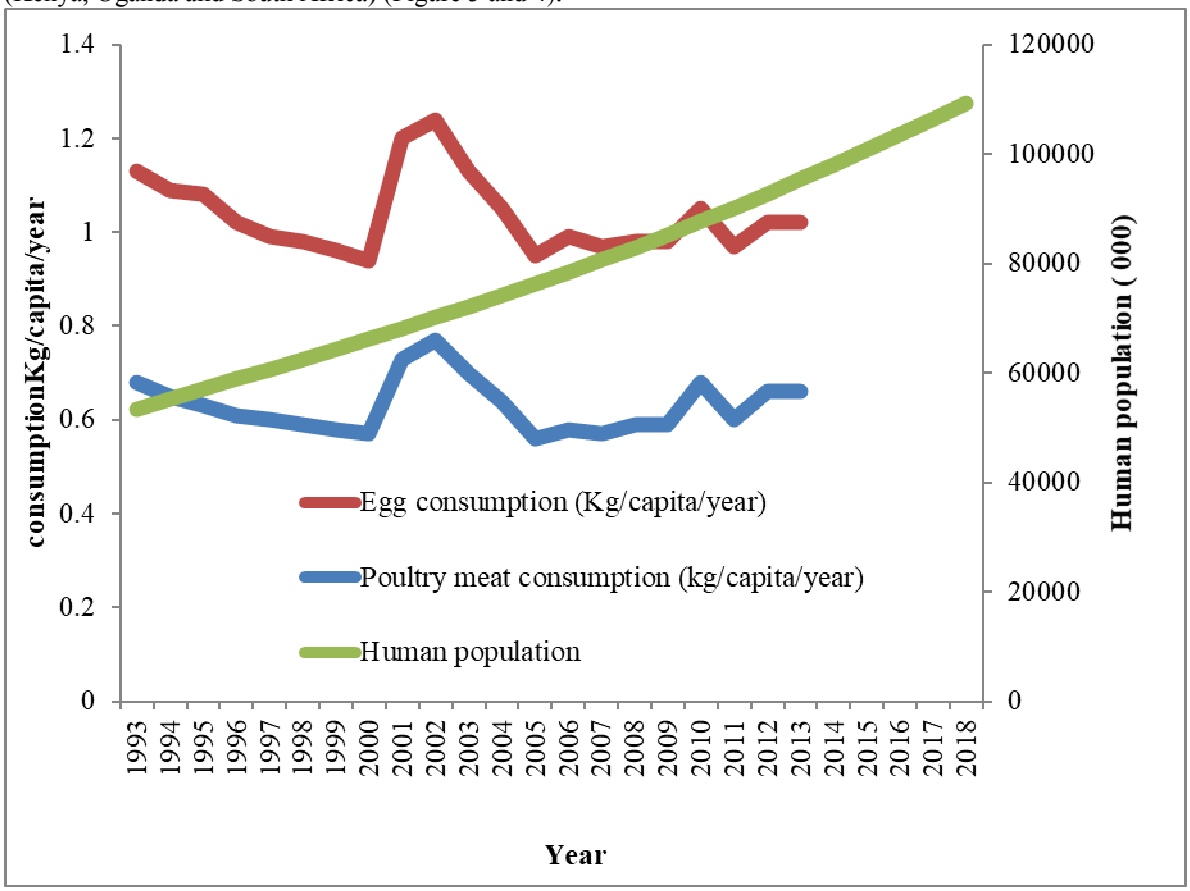


Figure 2: Trend of chicken meat and egg consumption with human population growth in Ethiopia
Source (FAOSTAT, 2021)

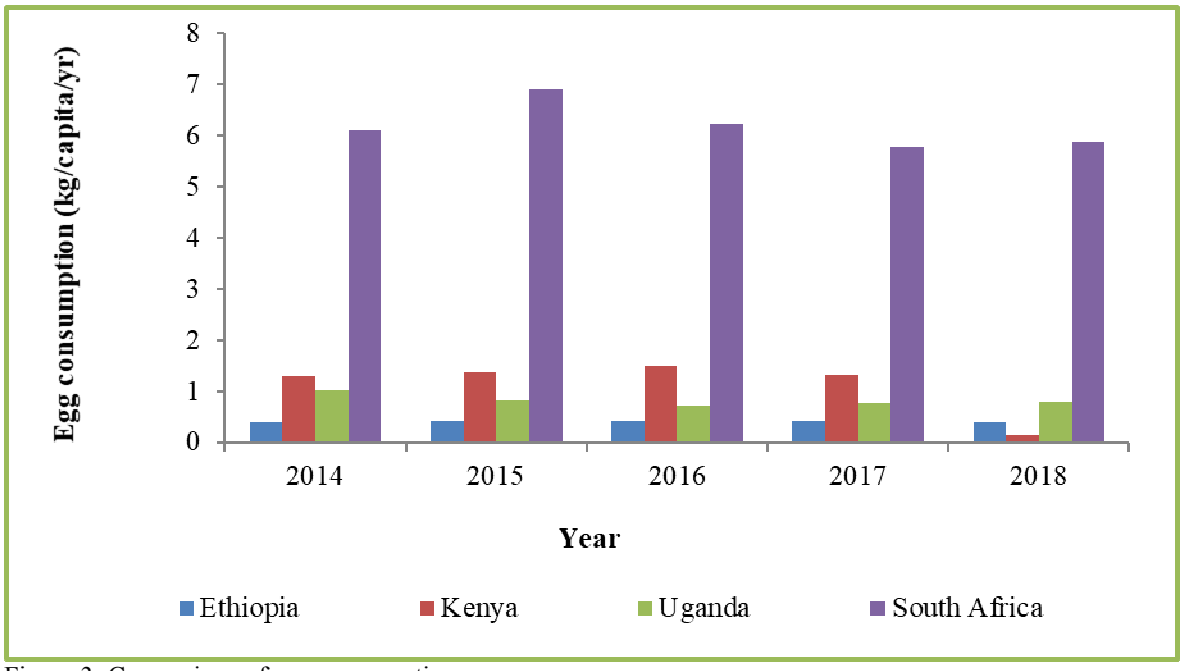


Figure 3: Comparison of egg consumption
Source (FAOSTAT, 2021)

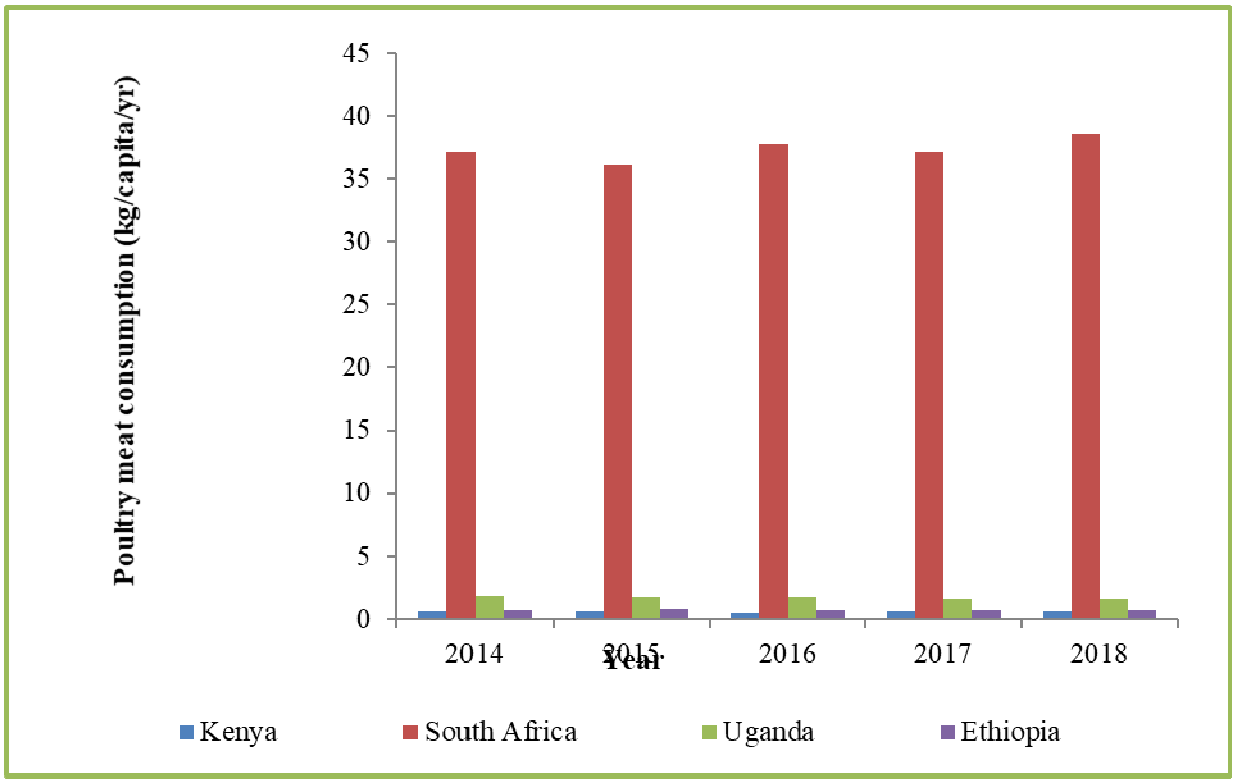


Figure 4: Comparison of chicken meat consumption
Source (FAOSTAT, 2021)

Conclusion and recommendation

The economic contribution of the poultry production sector is not still proportional to the huge chicken numbers, due to the presence of many productions, reproduction and infrastructural constraints. The poultry in Ethiopia keeping in large scale commercial, medium scale commercial, small scale commercial and village or backyard commercial production system. Poultry plays an important role in the human economy, supplying food, creating wealth through job creation for the booming population. Chicken population growth over the year almost similar

because of high chicken mortality due to diseases and predators. Breed characterization can be important to identify breeds at risk of extinction or which are highly desired by farmers. In Ethiopia, chickens are widely distributed in almost all over part of the country and reared by rural family, in some private chicken producers and governmental institutions. The indigenous chickens of Ethiopia have various names and characterized based on different criteria. The genetic improvement chicken in Ethiopia focused on introduction of exotic breeds, but it is failed due to less adaptation of exotic chicken, poor management; lack of input and output markets; and shortage of quality feeds, vaccines and veterinary inputs. Chicken production is playing an important role in increasing socio-economic status of community and employment.

To enhance the poultry sectors in Ethiopia, clear and full package breeding programs is required which defining production environments, identifying the management (husbandry) and breeding practices, production objectives and trait choices of farmers (chicken keepers).

References

Aberra Melesse. 2000. Comparative studies on performance and physiological responses of Ethiopian indigenous (”Angete-melata”) chicken and their F1 crosses to long term heat stress. PhD Thesis. Martin-Luther University, Halle-Wittenberg, Berlin.pp.182.

Abubakar M.B., Ambali A.G. and Tamjdo T. 2007. Rural chicken production: Effects of gender on ownership, and management responsibilities in some parts of Nigeria and Cameroon. International Journal of Poultry Science, 6(6). Pp.413–416.

Addis Getu and Aschalew Tadesse. 2014. Phenotypic and Genetic Characterized Indigenous Chicken Ecotypes in Ethiopia. International Journal of Genetics 4(1). Pp. 04-10.

Ahmed Mohammed. 2018. Major Constraints and Health Management of Village Poultry Production in Ethiopia: Review. International Journal of Research Studies in Microbiology and Biotechnology. 4(1), PP. 1-10. DOI: http://dx.doi.org/10.20431/2454-9428.0401001

Alders, R., Costa, R., Gallardo, R.A., Sparks, N., and Zhou, H. 2019. Small holder poultry: Leveraging for sustainable food and nutrition security. Encyclopedia of food security and sustainability 3. pp.340-346.

Alemu Yami. 1995. Poultry production in Ethiopia, World's Poultry Science Journal, 51:2, 197-201, DOI: 10.1079/WPS19950014

Bogale K.2008. InSitu Characterization of Local Chicken Eco-Type for Functional Traits and Production System in Fogera District, Amhara Regional State. MSc Thesis Harmaya University, Haramaya, Ethiopia.

CSA (Central Statistical Agency of the Federal Democratic Republic of Ethiopia). 2010. Agricultural Sample Survey of 2009/10 (2002 E.C).Volume II. Report on Livestock and Livestock Characteristics (Private Peasant Holdings), Central Statistical Agency, Addis Ababa, Ethiopia.

CSA (Central Statistical Agency of the Federal Democratic Republic of Ethiopia). 2011. Agricultural Sample Survey of 2010/11 (2003 E.C).Volume II. Report on Livestock and Livestock Characteristics (Private Peasant Holdings), Central Statistical Agency, Addis Ababa, Ethiopia.

CSA (Central Statistical Agency of the Federal Democratic Republic of Ethiopia). 2012. Agricultural Sample Survey of 2011/12 (2004 E.C).Volume II. Report on Livestock and Livestock Characteristics (Private Peasant Holdings), Central Statistical Agency, Addis Ababa, Ethiopia.

CSA (Central Statistical Agency of the Federal Democratic Republic of Ethiopia). 2013. Agricultural Sample Survey of 2012/13 (2005 E.C).Volume II. Report on Livestock and Livestock Characteristics (Private Peasant Holdings), Central Statistical Agency, Addis Ababa, Ethiopia.

CSA (Central Statistical Agency of the Federal Democratic Republic of Ethiopia). 2014. Agricultural Sample Survey of 2013/14 (2006 E.C).Volume II. Report on Livestock and Livestock Characteristics (Private Peasant Holdings), Central Statistical Agency, Addis Ababa, Ethiopia.

CSA (Central Statistical Agency of the Federal Democratic Republic of Ethiopia). 2015. Agricultural Sample Survey of 2014/15 (2007 E.C).Volume II. Report on Livestock and Livestock Characteristics (Private Peasant Holdings), Central Statistical Agency, Addis Ababa, Ethiopia.

CSA (Central Statistical Agency of the Federal Democratic Republic of Ethiopia). 2016. Agricultural Sample Survey of 2015/16 (2008 E.C).Volume II. Report on Livestock and Livestock Characteristics (Private Peasant Holdings), Central Statistical Agency, Addis Ababa, Ethiopia.

CSA (Central Statistical Agency of the Federal Democratic Republic of Ethiopia). 2017. Agricultural Sample Survey of 2016/17 (2009 E.C).Volume II. Report on Livestock and Livestock Characteristics (Private Peasant Holdings), Central Statistical Agency, Addis Ababa, Ethiopia.

CSA (Central Statistical Agency of the Federal Democratic Republic of Ethiopia). 2018. Agricultural Sample Survey of 2017/18 (2010 E.C).Volume II. Report on Livestock and Livestock Characteristics (Private Peasant Holdings), Central Statistical Agency, Addis Ababa, Ethiopia.

CSA (Central Statistical Agency of the Federal Democratic Republic of Ethiopia). 2019. Agricultural Sample Survey of 2018/19 (2011 E.C).Volume II. Report on Livestock and Livestock Characteristics (Private

Peasant Holdings), Central Statistical Agency, Addis Ababa, Ethiopia.
CSA (Central Statistical Agency of the Federal Democratic Republic of Ethiopia). 2020. Agricultural Sample Survey of 2019/20 (2012 E.C).Volume II. Report on Livestock and Livestock Characteristics (Private Peasant Holdings), Central Statistical Agency, Addis Ababa, Ethiopia.
CSA (Central Statistical Agency of the Federal Democratic Republic of Ethiopia). 2021. Agricultural Sample Survey of 2020/21 (2013 E.C).Volume II. Report on Livestock and Livestock Characteristics (Private Peasant Holdings), Central Statistical Agency, Addis Ababa, Ethiopia.
Demissu Hundie, Gebeyehu Goshu , Berhan Tamir and Gemeda Duguma. 2019. Assessment on rural poultry production and marketing system of Horro chicken ecotypes in Western Ethiopia. Journal of Agricultural Extension and Rural Development.11(12), pp. 248-259. https://academicjournals.org/journal/JAERD/article-full-text-pdf/D80B25762430
Dilger, A.C., Schroeder, A.L., and Moseky, W.M. 2016. Barriers to global implementation of current and development of new performance, enhancing technologies in meat production. Frontiers, 6 (4): 50-55.
Emebet Moreda Bekerie. 2015. Phenotypic and genetic characterization of indigenous chicken in southwest showa and gurage zones of Ethiopia. PhD Dissertation. Addis Ababa University, Deber Zeit, Ethiopia.pp.127
Emebet Moredaa and Kidane G. Mesekel. 2016. Importance of Traditional, Small Scale and Commercial Poultry Production in Ethiopia: A Review. British Journal of Poultry Sciences. 5 (1). https://idosi.org/bjps/5(1)16/1.pdf
FAO. 2011. FAO. Statistical database of Food and Agriculture Organisation of the United Nations, Rome, Italy. FAO. 2000. FAO. Statistical database of Food and Agriculture Organisation of the United Nations, Rome, Italy.
FAO. 2019. Poultry Sector Ethiopia. FAO Animal Production and Health Livestock Country Reviews. No. 11. Rome. 15/08/2021/11:42 http://www.fao.org/3/ca3716en/ca3716en.pdf
FAOSTAT. 2021. Food and agricultural organization of the United Nations, statistical division.
Fulas Hinsemu, Yohannis Hagos, Yobsan Tamiru and Abriham Kebede. 2018. Review on Challenges and Opportunities of Poultry Breeds. Review Article. Journal of Dairy & Veterinary Sciences. 7 (2). DOI: 10.19080/JDVS.2018.07.555706.
Halima Hassen Mogesse. 2007. Phenotypic and genetic characterization of indigenous chicken populations in North-West Ethiopia. PhD Thesis Submitted to the faculty of natural and agricultural sciences department of animal, wildlife and grassland Sciences. University of the Free State, Bloemfontein, South Africa.
Halima Hassen, F. W. C. Neser, E. van Marle-Koster, A. de Kock. 2007. Phenotypic variation of native chicken populations in northwest Ethiopia. Trop Anim Health Prod (2007) 39. Pp.507–513.
Matawork Milkias. 2016. Review on Exotic Chicken Status, Production Performance and Constraints in Ethiopia. Journal of Biology, Agriculture and Healthcare. 6 (15).
Mearg, F. E. A. R. G. 2016. Phenotypic characterization of local chicken ecotypes in the Central Zone of Tigray in northern Ethiopia. M.ScThesis, Jimma University, Jimma, Ethiopia .
Nigussie Dana. 2011. Breeding programs for indigenous chicken in Ethiopia: analysis of diversity in production systems and chicken populations. PhD .Thesis. Wageningen University, Netherlands. 148pp.
Pedersen CV, Kristensen AR, Madsen J. 2002. On-farm research leading to a dynamic model of a traditional chicken production system. In Proceedings of the joint 17th Scientific Conference of the Tanzania Society for Animal Production and the 20th Scientific Conference of the Tanzania Veterinary Association held in Arusha, Tanzania on 3rd to pp. 237-247.
Lotvedt, Pia Katrine. 2017. Domestication and early experiences in chickens: Behavior, stress and gene expression. Thesis. Linköping University, Linköping, Sweden.pp41. 1:1013/04/2021 http://www.diva-portal.org/smash/get/diva2:1158180/FULLTEXT01.pdf
Sawai H, Kim HL, Kuno K, Suzuki S, Gotoh H. 2010. The Origin and Genetic Variation of Domestic Chickens with Special Reference to Junglefowls Gallus g. gallus and G. varius. PLoS ONE. 5(5). doi:10.1371/journal.pone.0010639
Sharawany and Banerjee. 1991. Indigenious chicken genotype of Ethiopia. Animal genetic resources information.8.pp.84-87.
Shumuye Belay , Mehari Resom , Haftom Yemane and Haileslassie Amare. 2018. Production performance evaluation of koekoek chicken under farmer management practice in Tigray region, northern Ethiopia. International Journal of Livestock Production. 9(9). pp. 232-237.
Tadelle D, Ogle B. 2001. Village poultry production system in the central high lands of Ethiopia. Tropical Animal health and production. 33. Pp.521-537.
Tadelle Dessie. 2003. Phenotypic and genetic characterization of local chicken ecotypes in Ethiopia. Ph.D. Thesis, Humboldt-University in Berlin, Germany.
Tamirat D. 2015. Overview and background paper on Ethiopia's poultry sector Relevance for HPAI research in

Ethiopia. ILRI report p. 17.

Teklewold H. 2006. Determinants of adoption of poultry technology: a double-hurdle approach. Livestock Research for Rural Development 18(3). Pp.115-127.

Ugbe, Lawrence A., Ukelina, Christopher U., Agim, Marcel U., and Unim, Mathias U. 2020. Comparative analysis of the economic returns to management in single crop, fish, poultry and an integrated farming system in Obudu, Cross River State. Tropical Journal of Science and Technology, 1(2). http://doi.org/10.47524/tjst.v1i2.4.

Wondmeneh Esatu , Negussie Dana and Alemu Yami. 2016. Poultry Research in Ethiopia: Past, Present and the Future. Ethiopian journal of agricultural sciences. EIAR 50th Year Jubilee Anniversary Special Issue:pp.157-168.

Wondmeneh Esatu, Alemayehu Amare, Bewket Siraw and Tsigereda Fekadu. 2017. Status of Commercial Poultry Production in Ethiopia. Poultry working group, ministry of livestock and fisheries.Addis Abeba, Ethiopia.

Xiang, H., Gao, J., Yu, B., Zhou, H., Cai, D., Zhang, Y., Chen, X., Wang, X., Hofreiter, M., Zhao, X. 2014. Early Holocene chicken domestication in northern China. 111(49). 1:04pm 13/4/2021 https://www.pnas.org/content/pnas/111/49/17564.full.pdf

Zeuner, F.E. 1963. A history of domesticated animals. Hutchison, London.