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Production Performance and Profitability of Small-scale Commercial Poultry Farms in Arsi and East-Showa Zones, Central Ethiopia

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ABSTRACT

Poultry farming and the demand for chicken meat and eggs are growing due to their quality protein, essential nutrients, affordable price, and low investment cost. The current study was designed to investigate the productivity and profitability of small-scale commercial poultry enterprises. Data were collected from 221 poultry farms using a semi-structured questionnaire. The results were presented using descriptive statistics. Farm performances were measured by total-factor-productivity (TFP), benefit-cost-ratio (BCR), and net-profit-margin (NPM). The majority of the poultry farm owners were male (69.68%) and married (77.4%). Around 55.2% of poultry farmers aged 31-45 years. Group-owned farms had 4.59 ± 1.77 individual members. On average, a batch of layer chickens was kept for 17.0 ± 3.87 and 18.12 ± 4.25 months on individual and group-owned farms, respectively. Moreover, the mean selling ages of pullet and broiler chickens were 2.55 ± 0.71 and 2.18 ± 0.51 months, respectively. The flock size of layer chickens in sole-proprietor farms (562 ± 724) was significantly lower than in partnership farms (1165 ± 877). The average numbers of produced pullets by sole-proprietorship and partnership farms were 3177 ± 2360 and 3137 ± 1826, while the mean numbers of broilers produced were 2257 ± 1875 and 3269 ± 1669, respectively. The average egg and broiler weights in sole-proprietorship farms were significantly higher compared to group-owned farms. Annual egg production rates in individual and group-owned farms were 76.5% and 70.4%, respectively. The cost of feed, chicken, housing, labor, and medication were the top five production expenditures, while feed cost shares 60.4%. Egg producers had NPM, BCR, and TFP indices of 38.99%, 1.03, and 2.03, respectively, with notable differences by ownership types. The NPM, BCR, and TFP indices for broiler and pullet farms, respectively, were 42.78%, 0.93, and 1.93 for broilers and 35.21%, 0.92, and 1.67 for pullets. The results indicated that poultry firms performed optimally, regardless of ownership type. To further improve the efficiency and profitability of poultry enterprises, farmers need technical, finance, and management skills and input supply chains.

Keywords: Broiler, Layer, Poultry, Production, Profitability, Pullet

INTRODUCTION

Livestock makes an essential contribution to global calorie and protein supplies. According to some projections, average global animal protein consumption is expected to increase by 14% by 2030, compared to the base period average of 2018-2020, mainly due to income and population growth. By 2030, it is anticipated that the availability of protein from beef, pork, poultry, and sheep meat will increase by 5.9%, 13.1%, 17.8%, and 15.7%, respectively (OECD/FAO,2021). Globally meat consumption has been shifting toward poultry sources. Meat from poultry accounts for about 33% of global meat consumption and is expected to grow by 2 to 3% per year in the world (Teshome et al., 2019). This is due to poultry's cheaper cost, compared to other meats in low-income developing nations, while white meat consumption has increased in high-income nations due to its simplicity of preparation as a healthy food option (OECD/FAO, 2021). In 2030, poultry meat is anticipated to account for 41% of all the protein from meat sources globally, an increase of 2% from the baseline (OECD/FAO, 2021). In Ethiopia, chicken is the dominant type of poultry kept under the traditional production system with a population

of around 57 million chickens, of which 78.85% are indigenous, 12.02% are hybrid, and 9.11% are exotic breeds (CSA, 2021). The national mean annual egg production of Ethiopia was about 369 million in the year 2020 (CSA, 2021). In the year 2016, Ethiopia's poultry meat production reached 13,000 tonnes, constituting 2%, 0.2%, and 0.01% of the total poultry meat production in East Africa, Africa, and the world, respectively. Additionally, Ethiopia's share in egg production rates, when compared to East Africa, Africa, and the world, stood at 11%, 1.7%, and 0.07%, respectively (FAO, 2019).

The traditional family poultry production system is the dominant production system in Ethiopia and has served households as a source of income, nutrients, employment, and as a means of empowering women (Habte et al., 2017). To transform such a production system, the country has promoted small, medium, and large-scale commercial poultry production that involves unemployed youth, women, and entrepreneurs by providing some financial support to make use of the sector for wider job opportunities, food security, and economic values through the promotion of micro and small enterprises (MSE) (Ayele, 2018; Endris and Kassegn, 2022). Such agribusiness interventions contribute to broad economic growth, generating new employment, alleviating poverty, enhancing competition and entrepreneurship, empowering women, and strengthening nutritional status in most countries (Agyapong, 2010; Khatun et al., 2016; Tarfasa et al., 2016). In Ethiopia, the sector contributes 3.4% to the gross domestic product (GDP) and accounts for 90% of the workforce (Gebrehiwot and Wolday, 2006), while in Kenya MSEs contribute 40% to the GDP and account for 80% of the workforce; (Mwarari and Ngugi, 2013; Muriithi, 2017). Despite such initiatives, in Ethiopia, among commercial poultry farms, the number of large-scale commercial poultry farms with flock sizes of > 10000 chickens was small, compared to the country's potential (Woldegiorgiss et al., 2017). The combined number of large-scale and medium-scale commercial poultry farms in Ethiopia was reported as nearly 15 farms (Vernooij et al., 2012). On the other hand, the flock size of small-scale and medium-scale commercial poultry farms in Ethiopia was reported to be < 1000 and between 1000 and 10,000 chickens, respectively, owned either as sole proprietorships or partnerships (Tirfie, 2021).

In Ethiopia, a significant number of micro-and small-scale enterprises are engaged in poultry enterprises, mainly in egg, broiler, and pullet production. However, the majority of these small-scale enterprises who engaged in poultry businesses were not competent and sustainable in their production and productivity; they failed to thrive and meet expectations. Many SMEs in Africa confront a variety of obstacles, including a lack of electricity, finance, weak management skills and competencies, insufficient information, and corruption (Muriithi, 2017). To make such small-scale poultry enterprises the engine of economic growth and a means of poverty alleviation and unemployment reduction, it is very essential to know what factors dictate performance, growth, investment, and sustainability. Therefore, the current study was designed to investigate the poultry production practices and profitability of individual and group-owned small-scale commercial poultry farms in Ethiopia.

MATERIALS AND METHODS

The research was carried out in the Arsi and East Showa zones of the Oromia regional state, which is located in central Ethiopia. Tiyo, Dodota, and Hetosa districts in Arsi zone and Adama, Bishoftu, and Boset districts in East Showa zone were selected for the study. The study areas were an ideal location for poultry farming, due to their market opportunity, proximity to Addis Ababa, favorable weather conditions, and access to road and extension services.

Study participants

Small-scale commercial poultry farms owned by groups and individuals were included in the research. First, a list of poultry farms in the six study districts was collected from the respective study districts' livestock and fishery offices. Then, the farms were segregated into sole-proprietorship and partnership based on ownership type. A total of 221 poultry farms that were actively running their businesses and raising improved commercial breeds of layer and broiler chickens were sampled; of these, 122 were owned by individuals (sole-proprietorship) and 99 were owned by groups (partnership) either in the form of micro-and small-scale enterprises or cooperatives. Finally, the farms were regrouped into three production farms depending on the type of chicken reared (layer, broiler, and pullet). As a result, 132 layers, 56 pullets, and 33 broilers chicken-producing farms were sampled. Accordingly, 221 farm managers and/or owners were selected as research participants based on their willingness.

Methods of data collection

A descriptive research design was employed in this study using cross-sectional survey techniques to collect accurate and comprehensive data on the characteristics,

production, productivity, and profitability of commercial poultry farms. The data was collected using a semi-structured questionnaire prepared for this purpose after pre-testing the tool for its suitability for the selected farms. Pre-scheduled one-to-one interview was administered with farm owners or managers at the farm gate after a comprehensive discussion with the owners on the purpose, objectives of the study, and confidentiality of the information and data. The interview was conducted after obtaining informed consent from the participant farmers. Then one respondent from each poultry farm either owner or manager was interviewed based on their availability. Accordingly, data regarding; socio-economics, farm characteristics, farm management practices, feeding and feed resources, disease management, mortality, housing, production, productivity, cost of production, marketing, finance, and farm performances were collected through the interview process.

Farm budget model

The farm budget model adopted for this study was the costs and returns analysis. Indicators, such as net farm income, percentage profit margin, and benefit-cost ratio, were analyzed (Onuwa, 2022).

$$\text{Net farm income (NFI)} = \text{GFI} - \text{TC}$$

Where, GFI is Gross farm income and TC denotes Total cost.

Total cost (TC) is mathematically expressed as

$$\text{TC} = \text{TVC} + \text{TFC}$$

Where, TVC is the total variable cost which includes feed, medication, labor, chicken, litter costs, and cost of chicken loss, and TFC signifies the total fixed cost which includes the cost of housing rent. To further validate the profitability of this enterprise, profitability ratios, such as percentage of profit margin/net profit margin (PPM/NPM) and benefit-cost ratio (BCR), were analyzed using the following mathematical equations.

$$\text{PPM} = \frac{\text{NFI}}{\text{TR}} \times 100$$

Where, PPM defines the percent profit ratio, NFI is net farm income, and TR determines Total revenue.

$$\text{BCR} = \frac{\text{NFI}}{\text{TC}}$$

Where, BCR refers to the benefit-cost ratio, and TC is the total cost.

Total factor productivity

Total factor productivity is a method of calculating agricultural productivity by comparing an index of agricultural inputs to an index of outputs (Bamidele et al., 2008;Onuwa, 2022), as indicated in the following equation.

$$\text{TFP/TVC} = \text{Y}/\text{TVC} = \text{Y}/\sum \text{PiXi}$$

Where, Y is the quantity of output, TFP denotes total factor productivity, TVC refers to the total variable cost, Pi is the unit price of the i^{th} variable input, and Xi signifies the quantity of i^{th} variable input. The interpretations of the TFP index are given as < 1.0 for Sub-optimal, 1.0-1.09 for Optimal, and ≥ 1.10 for super-optimal according to (Bamidele et al., 2008).

Data analysis

Descriptive statistics, t-test, total-factor-productivity (TFP), BCR, and NPM were used to analyze the primary data. Descriptive statistics, such as mean, standard deviations, percentages, frequency counts, and graphs were used to present farm characteristics and husbandry practices. The TFP analysis was used for broiler, layer, and pullet-producing farm enterprises, to independently estimate agricultural productivity by comparing an index of agricultural inputs to an index of outputs. To analyze the costs, returns, and profitability of chicken production enterprises in the area, the farm budget technique (costs and returns analysis) was utilized. A t-test using SPSS version 26 was used to determine whether the difference between the means of individual-owned farms and group-owned farms is statistically significant or not at the 5% significance level.

RESULTS

Socio-economic characteristics

Evidence in Table 1 demonstrated that men (69.68%) made up the majority of the poultry farms' managers. The data showed that 46.7% of privately owned poultry farms and 33.3% of collectively held poultry farms had managers with lower-level educations. Regarding farm managers' previous poultry production experience, 18% of privately owned farms and 21.2% of farms owned by partnerships had no prior experience.

Farm characteristics

Among the total farms considered in this study, 59.7% were egg-producing farms, while 25.3% and 14.9% were pullet and broiler-producing farms, respectively. The age of the farms varies substantially depending on ownership type; the mean ages of the farms were 4.08 ± 1.55 years for sole-proprietor farms and 3.61 ± 1.55 years for farms owned in partnership. The study indicated that the members of partnership-based poultry enterprises range from 3-12 people with a mean value of 4.59 ± 1.77. Farm managers of sole-proprietorship farms significantly spent less time than farm managers of partnership farms

on a daily basis in terms of hours. The number of production cycles, age of production of different groups of chicken (layers, pullets, and broilers), daily labor consumption for layers, pullets, and broilers, and time spent on the farm by managers are presented in Table 2.

Flock sizes of the farms

According to the study, farms owned in partnerships often have larger flock sizes than farms operated as privately held businesses. The annual flock size of the farms was significantly different with the nature of their business ($p < 0.05$), where egg-producing farms had less flock size than broiler and pullet-producing farms. The study showed that group-owned farms had a significantly higher number of layers compared to privately owned farms ($p < 0.05$).

Table 1. Socio-economic profile of respondents in selected districts of Arsi and East-Showa zones in 2022 (n=221)

Criteria	Category	Individual-owned farms		Group-owned farms		Total	
		Number	Percentage	Number	Percentage	Number	Percentage
Sex of respondent	Male	85	69.7	69	69.7	154	69.68
	Female	37	30.3	30	30.3	67	30.32
Age of the respondent	15-30	23	18.9	29	29.3	52	23.5
	31-45	77	63.1	45	45.5	122	55.2
	46-60	22	18.0	25	25.3	47	21.3
Marital status of respondents	Married	91	74.6	80	80.8	171	77.4
	Unmarried	25	20.5	14	35.9	39	17.6
	Divorced	6	4.9	5	5.1	11	5.0
Previous chicken production experience	≤ 1 year	47	38.5	33	33.3	80	36.2
	2-3 years	44	36.1	35	35.4	79	35.7
	Above 3 years	9	7.4	10	10.1	19	8.6
	No experiences	22	18.0	21	21.2	43	19.5
Educational level of the respondents	Illiterate	14	11.5	12	12.1	26	11.8
	Grade 1-8	57	46.7	33	33.3	90	40.7
	Grade 9-12	34	27.9	40	40.4	74	33.5
	Diploma and above	17	13.9	14	14.1	31	14.0

Table 2. Farm characteristics by type of ownership in selected districts of Arsi and East-Showa zones in 2022

Variables	Measurements	Individual-owned farms	Group-owned farms	Total farms	P-value
Age of layers for one production phase (month)	Mean ± SD	17.0 ± 3.87[a]	18.12 ± 4.25[a]	17.43 ± 4.04	0.12
	Min-Max	10 - 26	12 - 24	10 - 26	
Production cycle of pullets per year	Mean ± SD	3.24 ± 0.50[a]	3.13 ± 0.76[a]	3.20 ± 0.62	0.51
	Min-Max	2 - 4	2 - 6	2 - 6	
Age of pullet (month)	Mean ± SD	2.53 ± 0.76[a]	2.58 ± 0.64[a]	2.55 ± 0.71	0.77
	Min-Max	1.5 - 4	1.5 - 4	1.5 - 4	
Production cycle of broilers per year	Mean ± SD	2.71 ± 0.49[a]	2.88 ± 0.91[a]	2.85 ± 0.83	0.64
	Min-Max	2 - 3	2 - 5	2 - 5	
Age of broiler (month)	Mean ± SD	2.14 ± 0.48[a]	2.19 ± 0.53[a]	2.18 ± 0.51	0.83
	Min-Max	1.5 - 3	1.5 - 3	1.5 - 3	
Age of poultry enterprises in years	Mean ± SD	4.08 ± 1.55[a]	3.61 ± 1.55[b]	3.87 ± 1.57	0.03
	Min-Max	2 - 8	1 - 7	1 - 8	
Number of labors /days for layer	Mean ± SD	1.31 ± 0.54[a]	1.52 ± 0.84[a]	1.39 ± 0.67	0.08
	Min-Max	1 - 3	1 - 6	1 - 6	
Number of labors /days for broiler	Mean ± SD	1.71 ± 0.95[a]	1.65 ± 0.85[a]	1.67 ± 0.85	0.87
	Min-Max	1 - 3	1 - 4	1 - 4	
Number of labors /days for pullet	Mean ± SD	1.65 ± 0.96[a]	1.48 ± 0.51[a]	1.59 ± 0.80	0.39
	Min-Max	1 - 6	1 - 2	1 - 6	
Time spent on the farm by managers in hours per day	Mean ± SD	2.92 ± 1.78[a]	4.55 ± 2.60[b]	3.65 ± 2.33	0.01
	Min-Max	0 - 8	1 - 12	0 - 12	

Means with [a, b] different superscript in the same raw indicate significantly at $p < 0.05$; SD: Standard deviation, Min: Minimum, Max: Maximum

Table 3. Flock sizes of different farms by chicken types in selected districts of Arsi and East-Showa zones in 2022

Variables	Measurements	Individual-owned farms	Group-owned farms	Total farms	P-value
Number of layers per year	Mean ± SD	561.88 ± 723.94[a]	1165.22 ± 876.83[b]	790.42 ± 835.43	0.01
	Min-Max	100-3000	100-4000	100-4000	
Number of broilers produced per year	Mean ± SD	2257.1 ± 1875.2[a]	3268.9 ± 1669.4[a]	3054.3 ± 1735.8	0.18
	Min-Max	1000-5000	1000-6000	1000-6000	
Number of pullets produced per year	Mean ± SD	3176.7 ± 2360.2[a]	3136.9 ± 1825.6[a]	3160.4 ± 2138.8	0.95
	Min-Max	900-9000	1200-6000	900-9000	
Weight of pullets (kg)	Mean ± SD	1.52 ± 0.17	1.47 ± 0.23	1.49 ± 0.21	0.69
	Min-Max	1 - 1.7	1.2 - 2	1 - 2	
Weight of broilers (kg)	Mean ± SD	2.55 ± 0.33[a]	2.23 ± 0.27[b]	2.28 ± 0.30	0.04
	Min-Max	2.2 - 3	2 - 3	2 - 3	
Egg production per year	Mean ± SD	154,802[a] ± 23411	295,307[b] ± 30839	208024 ± 19512	0.01
	Min-Max	20000-800000	27000-820000	20000-820000	
Egg weight (gm)	Mean ± SD	60.21 ± 8.72[a]	54.00 ± 10.04[b]	58.27 ± 9.50	0.03
	Min-Max	45 -75	40-75	40-75	

Means with [a, b] different superscript in the same raw indicate significantly at $p < 0.05$; SD: Standard deviation, Min: Minimum, Max: Maximum

Management practices of farms

The study revealed that, at the farm gate, the mean weights for broilers, pullets, and eggs were 2.28 ± 0.30 kg, 1.49 ± 0.21 kg, and 58.27 ± 9.50 gm, respectively. Notably, there were significant differences ($p < 0.05$) in the weights of eggs and broilers between individual and group-owned farms (Table 3). The mean weight of pullets in individual-owned farms (1.52 ± 0.17 kg) and group-owned farms (1.47 ± 0.23 kg) was not statistically different between the two groups ($p > 0.05$).

According to the survey, the most common forms of financing for most poultry farms were credit from a public institute (39%) and self-finance (28%), as shown in Figure 1. The findings revealed that there were unexpected deaths and culling of hens for various reasons, such as disease and fear of disease outbreaks in farms. In the case of unanticipated chicken culling, there were many intervention measures to handle the situation. The most important of which was the selling of hens for meat purposes (81%) at reduced prices (Figure 2).

The study indicated that the major sources of chicken for small-scale poultry businesses in the area were large-scale commercial poultry-producing companies (Alema, Ethio-chicken, Genesis, Golden, and ELFORA) farms (68%), as indicated in Figure 3. The contribution and share of each large commercial farm in supplying day-old chickens and pullets to chicken farms are presented in Figure 4.

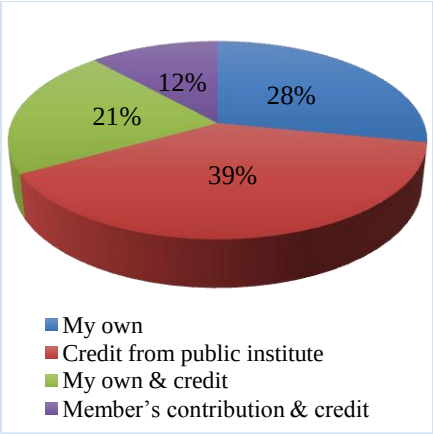


Figure 1. Initial finance sources of the farms in Arsi and East-Showa zones in 2022 during establishment.

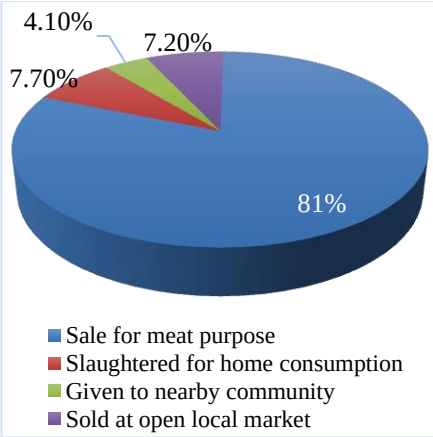


Figure 2. Actions taken on chickens culled unexpectedly by farm owners in Arsi and East-Showa zones in 2022

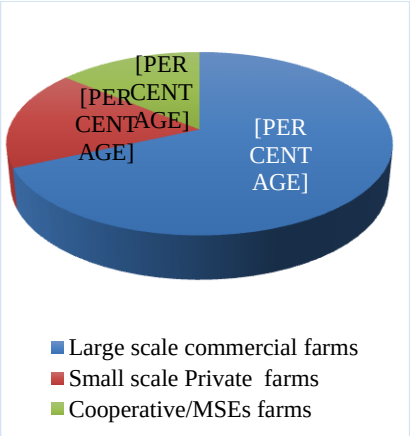
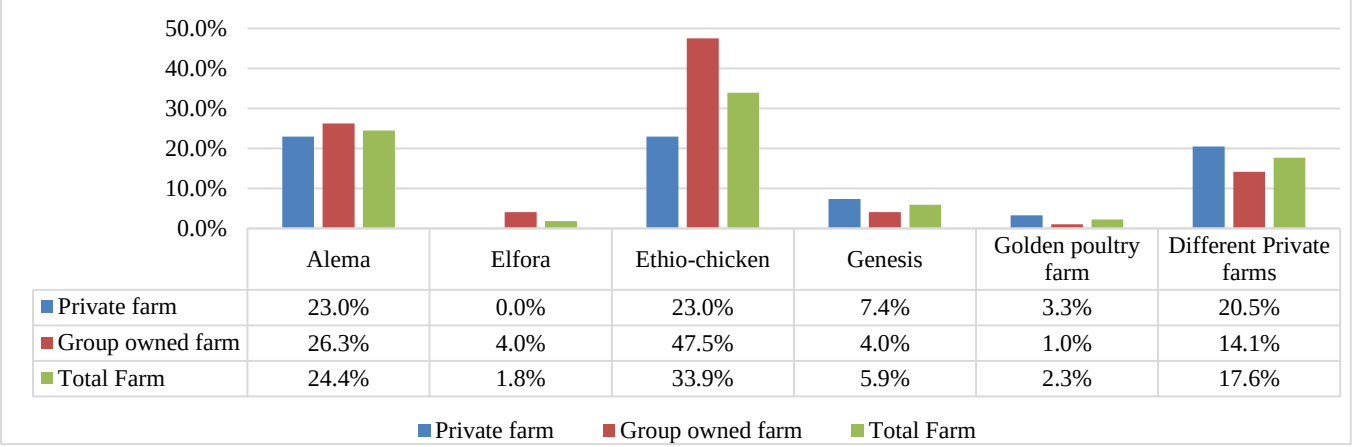


Figure 3. Type of farms that serve as a source of chickens for small-scale farms in Arsi and East-Showa zones in 2022



	Alema	Elfora	Ethio-chicken	Genesis	Golden poultry farm	Different Private farms
Private farm	23.0%	0.0%	23.0%	7.4%	3.3%	20.5%
Group owned farm	26.3%	4.0%	47.5%	4.0%	1.0%	14.1%
Total Farm	24.4%	1.8%	33.9%	5.9%	2.3%	17.6%

Figure 4. Large commercial farms that supply chickens for small poultry enterprises

Housing system and working premises

The current study found that the most common kind of poultry house was deep litter housing. Regardless of the kind of ownership, a negligible portion of farms grew chicken in cage systems, whereas 97.5% of farms owned as sole proprietorships and 93.9% of farms held as partnerships have been rearing their chicken in deep litter houses. Most farms (76%) used straw, and 19.9% utilized wooden shivering (sawdust) as a bedding material. Formalin (14%), Barakina/Sodium hypochlorite (23.5%) and both (60.6%) were used as disinfectants at the farm gate occasionally. According to the report, a sizable portion of farm owners do not have their own working spaces. Around 23% of sole-proprietorship and 56.6% of partnership farms have no own working space; instead, they utilize rented homes. The density of layer chickens per m^2 area differed significantly between individual and group-owned farms ($p < 0.05$); however, there was no significant difference in the density of pullet and broiler chicks based on ownership type ($p > 0.05$).

Feeding system and feed cost

The majority (97.05%) of respondents reported substantial feed price fluctuation throughout months and production cycles in the study region, independent of supplier type or market niche. The study confirmed that the major sources of feed for all types of farms were feed processing industries, retailing agents, both agents and industries, and homed-made feed resources as shown in Figure 5. Regarding the feeding frequency per day in each farm, the majority (75.10%) of the farms fed their chicken three times per day, though there was slight variability between the farms depending on the type of ownership as presented in Figure 6. The result indicated that daily feed provided in group and individual-owned farms was 90.86 ± 10.37 and 96.23 ± 15.56 grams per day per laying chicken, respectively, with a significant difference between the two farm ownership types ($p < 0.05$). The amount of feed, daily feed supply, and price of feeds in the study area are presented in Table 4.

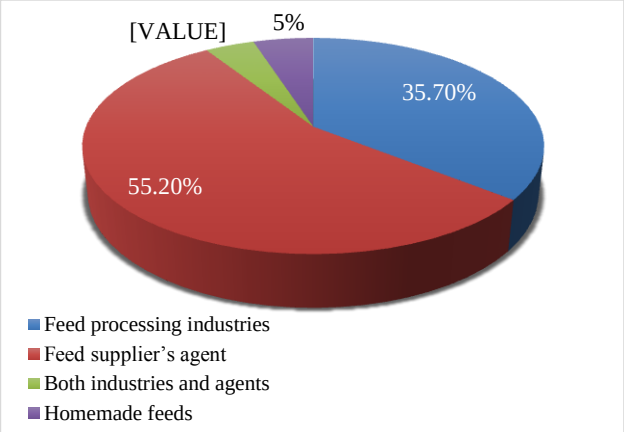


Figure 5. Sources of commercial feeds for farms in Arsi and East-Showa zones in 2022

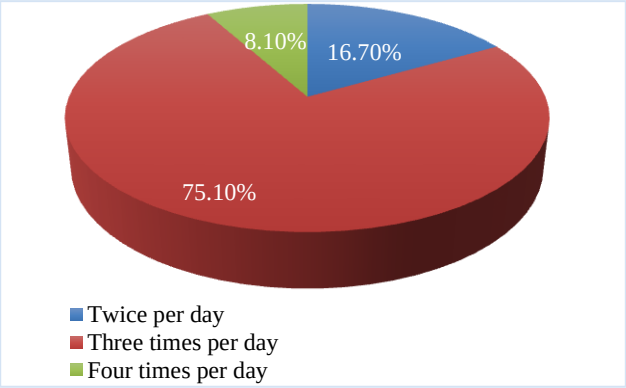


Figure 6. Frequency of feeding in each farm per day in Arsi and East-Showa zones in 2022

Table 4. Price of layer, broiler, and pullet feed and daily feed supply of farms in Arsi and East-Showa zones in 2022

Variables	Measurements	Individual-owned farms	Group-owned farms	Total farm business	P-value
Price of layer feed per quintal (Birr)	Mean ± SD	2697.99 ± 424.3[a]	2689.4 ± 429.6[a]	2694.73 ± 424.7	0.91
	Min-Max	1850 - 4000	1800 - 4000	1800 - 4000	
Price of starter feed per quintal (Birr)	Mean ± SD	2468.18 ± 441.38[a]	2418.7 ± 436.8[a]	2447.86 ± 436.21	0.68
	Min-Max	1750 - 3050	1750 - 3200	1750 - 3200	
Price of broiler feed per quintal (Birr)	Mean ± SD	2242.86 ± 544.23[a]	2530.31 ± 446.16[a]	2469.33 ± 474.65	0.16
	Min-Max	1500 - 3200	1800 - 3200	1500 - 3200	
Daily feed supply for pullets (gm)	Mean ± SD	60.78 ± 12.90[a]	59.09 ± 17.63[a]	60.09 ± 14.87	0.69
	Min-Max	40 - 85	30 - 100	30 - 100	
Daily feed supply for broilers (gm)	Mean ± SD	113.75 ± 15.98[a]	124.46 ± 35.70[a]	121.94 ± 32.27	0.42
	Min-Max	90 - 140	70 - 200	70 - 200	
Daily feed supply for layers (gm)	Mean ± SD	96.23 ± 15.56[a]	90.86 ± 10.37[b]	94.21 ± 14.04	0.03
	Min-Max	70 - 130	70 - 120	70 - 130	

Means with [a, b] different superscript in the same raw indicate significantly at $p < 0.05$; SD: Standard deviation, Min: Minimum, Max: Maximum

Production performances

According to the results of the current study, sole-proprietorship layer farms' egg productivity was 76.5%, producing close to 154,802 eggs annually, whereas egg productivity of group-owned farms was 70.4% with an annual egg output of 295,307 eggs, which is lower than that of individual-owned farms as evaluated by the hen day production index. The annual physical productions of eggs, pullets, and broilers by privately owned and group-owned farms are presented in Table 3. The study found that farm ownership type did not significantly affect the annual pullet and broiler chickens produced by the enterprises ($p < 0.05$).

Costs of production

In this study, both variable and fixed expenses were taken into account to gauge how well the farms were performing. Costs of feed, chicken, litter, labor, medicine, and chicken losses were taken as variable costs. The housing rental cost, which includes working facilities and land resources, was considered a fixed cost. The annual mean values of measurements of variable and fixed costs were presented in Table 5 based on the types of farms and kind of ownership. The average prices of layer, pullet, and broiler feed per quintal during the study period in the study area were 2694.73 ± 424.7 (1800-4000), 2447.86 ± 436.21 (1750-3200), and 2469.33 ± 474.65 (1500-3200) Ethiopian birr (EBR), respectively. Similarly, the mean daily feed supplies for layers, pullets, and broilers at the mid-age of the chickens in the area were 94.21 ± 14.04, 60.09 ± 14.87, and 121.94 ± 32.27 g, respectively. The study showed that high feed costs and price fluctuations over seasons were the major bottlenecks for chicken enterprises in the area. The total costs of production of different farm enterprises such as layer, broiler, and pullet were 781,828 ± 51,686; 664,374 ± 73,275, and 377,432 ± 28,490 EBR per year, respectively. The total cost of production in egg-producing farms was statistically different between individual and group-owned farms ($p < 0.05$), costing 635,343 ± 61,111 and 1,022,063 ± 82,673 EBR, respectively, due to the higher flock size in group-owned farms.

Profitability measurements

Gross income, total cost, and net income estimation for each farm business were used as the metrics by which the profitability of the farms was assessed. The gross revenue and net income in layer farms were statistically different ($p < 0.05$) between individual-owned farms (1,510,022 ± 234,955 and 874,679 ± 180,804) and group-owned farms (2,815,642 ± 317,386 and 1,793,579 ± 247,052) EBR, respectively. The result indicated that group-owned farms gain higher gross and net income due to the larger flock sizes of the farms. However, there was no statistically significant difference between individual and group-owned farms in the gross revenue and net income in broiler and pullet-producing enterprises ($p > 0.05$).

The gross income and net income of broiler-producing farms were 1,228,388 ± 129,510 and 564,014 ± 80,228 EBR, whereas, for pullet-producing farms, the gross and net income were 668,741 ± 64,534 and 291,309 ± 38,945 EBR, respectively (Table 6). The total factor productivity (TFP) technique compares an index of agricultural inputs to an index of outputs to determine agricultural productivity. Between farms held as sole proprietorships and partnerships, there were statistically substantial differences in the TFP index, PPM, and BCR

of layer farms ($p < 0.05$). As indicated in Table 6, these productivity measuring variables were insignificantly different for farms producing broilers and pullets.

According to Bamidele et al. (2008), the TFP index value was interpreted as sub-optimal (< 1.0), optimal (1.0-1.09), and super-optimal (≥ 1.10). The study showed that 81.06%, 100%, 89.29%, and 86% of layer, broiler, pullet, and aggregate of all chicken farms, respectively, have TFP indices of ≥ 1.10, indicating that they are super-optimal farm enterprises in terms of productivity (Table 7).

Table 5. Mean annual costs of measurements of variable and fixed costs poultry farms in Arsi and East-Showa zones in 2022

Variables measured in Ethiopian Birr	Individual-owned farms		Group-owned farms		Total farm business		P-value
	Mean	SD	Mean	SD	Mean	SD	
Chicken cost of a layer farm	106375[a]	109982	186066[b]	123691	136561	121265	0.01
Chicken cost of a broiler farm	125429[a]	101459	170967[a]	93810	161307	95722	0.27
Chicken cost of a pullet farm	164748[a]	114827	156578[a]	88978	161393	104186	0.78
Feed cost of layer farm	470506[a]	440910	764976[b]	459378	582048	468718	0.00
Feed cost of a broiler farm	353571[a]	342812	459858[a]	331749	437313	331609	0.64
Feed cost of a pullet farm	149395[a]	107421	164066[a]	130065	155421	116338	0.65
Medication cost of a layer farm	2206[a]	1812	3318[b]	2858	2627	2319	0.01
Medication cost of a broiler farm	5071[a]	3735	6373[a]	4224	6097	4105	0.37
Medication cost of a pullet farm	6088[a]	5115	6152[a]	3641	6114	4531	0.98
Litter cost of a layer farm	913[a]	822	1284[b]	932	1054	881	0.02
Litter cost of a broiler farm	1278[a]	931	1404[a]	917	1371	908	0.73
Litter cost of a pullet farm	1247[a]	1116	1039[a]	832	1166	1012	0.45
Mortality cost of a layer farm	4031[a]	3566	4859[a]	3544	4344	3567	0.20
Mortality cost of a broiler farm	7243[a]	3535	10535[a]	8628	9836	7897	0.34
Mortality cost of a pullet farm	3236[a]	3506	4591[a]	4361	3793	3900	0.20
Labor cost of a layer farm	19273[a]	9685	23112[a]	15423	20727	12266	0.08
Labor cost of a broiler farm	9229[a]	5063	11950[a]	8468	11373	7880	0.43
Labor cost of a pullet farm	11900[a]	6753	13578[a]	6051	12589	6471	0.34
Rental cost of a layer farm	36687.8[a]	4462	38448.0[b]	5649.14	37354.55	4998.4	0.04
Rental cost of a broiler farm	37371.43[a]	6588.3	36507.69[a]	5958.32	36690.91	6000.22	0.74
Rental cost of a pullet farm	37345.45[a]	5838.51	36240.00[a]	5483.83	36891.43	5671.26	0.48
Total cost of a layer farm/year	635343[a]	61111	1022063[b]	82673	784716	51686	0.00
Total cost of a broiler farm/year	539414[a]	167822	698017[a]	81791	663988	73275	0.39
Total cost of a pullet farm/year	374077[a]	37620	382245[a]	44556	377367	28490	0.89

Means with different superscripts (a, b) in raw differ significantly at $p < 0.05$; SD: Standard deviation

Table 6. Gross revenue, net income, total factor productivity index, percent profit margin, and benefit-cost ratio of poultry farm enterprises in Arsi and East-Showa zones in 2022

Variables	Individual-owned farms		Group-owned farms		Total farms		P-value
	Mean	SD	Mean	SD	Mean	SD	
Gross income (egg)	1,510,022[a]	2,127604	2,815,642[b]	2,244,261	2,004,575	2255457	0.00
Gross income (broiler)	1,018,000[a]	930338	1,285,031[a]	696,444	1,228,388	743,982	0.41
Gross income (pullet)	669,455[a]	526,673	667,717[a]	423,767	668,741	482,928	0.99
Net income (layer)	874,679[a]	1637245	1,793,579[b]	1746925	1,222,747	1731806	0.00
Net income (broiler)	478,586[a]	534,487	587,013[a]	448,018	564,014	460,872	0.59
Net income (pullet)	295,378[a]	320,777	285,472[a]	250,211	291,309	291,435	0.90
PPM Egg producers	30.0[a]	26.23	53.75[b]	18.22	38.99	26.14	0.00
BCR of Egg producers	0.75[a]	0.96	1.48[b]	0.94	1.03	1.01	0.00
TFP index of layer farm	1.75[a]	0.96	2.48[b]	0.94	2.03	1.01	0.00
PPM of broiler producers	42.32[a]	12.98	42.91[a]	18.28	42.78	17.11	0.94
BCR of broiler producers	0.82[a]	0.45	0.96[a]	0.74	0.93	0.68	0.63
TFP index of broiler farm	1.82[a]	0.45	1.96[a]	0.74	1.93	0.68	0.63
PPM of pullet producers	35.17[a]	16.51	35.26[a]	21.09	35.21	18.34	0.99
BCR of pullet producers	0.64[a]	0.40	0.71[a]	0.55	0.66	0.46	0.57
TFP index of pullet farm	1.64[a]	0.40	1.71[a]	0.55	1.67	0.46	0.57
PPM all Chicken farms	32.09[a]	23.51	46.61[b]	20.27	38.59	23.22	0.00
BCR of all chicken farms	0.72[a]	0.81	1.17[b]	0.87	0.92	0.87	0.00
TFP index of all farms	1.72[a]	0.82	2.17[b]	0.87	1.92	0.87	0.00

TFP: Total factor productivity, PPM: Percent profit margin (ratio, net profit margin), and BCR: Benefit-cost ratio; Means with different superscripts (a, b) in raw differ significantly at $p < 0.05$; SD: Standard deviation.

Table 7. Total factor productivity index for all kinds of poultry farm enterprises in Arsi and East-Showa zones in 2022

Item	Category	Individual-owned farms		Group-owned farms		Total	
		Number	Percentage	Number	Percentage	Number	Percentage
TFP index of layer farm	< 1	10	12.20	1	2.0	11	8.33
	[1-1.09]	14	17.07	0	0.0	14	10.61
	≥ 1.10	58	70.73	49	98.0	107	81.06
TFP index of broiler farms	≥ 1.10	7	100.00	26	100.00	33	100.00
TFP index of pullet farm	< 1	0	0.00	1	4.35	1	1.8
	[1-1.09]	3	9.09	2	8.70	5	8.93
	≥ 1.10	30	90.91	20	86.96	50	89.29
TFP index of all farms	< 1	10	8.2	2	2.0	12	5.4
	[1-1.09]	17	13.9	2	2.0	19	8.6
	≥ 1.10	95	77.9	95	96.0	190	86.0

TFP: Total factor productivity, Number of observations

DISCUSSION

Socioeconomic factors

Numerous factors, including technical, farm management, institutional, socio-economic, climatic, and regulatory considerations, affect the productivity and profitability of agricultural enterprises (Kahan, 2013). These factors are very integrated in their effect, and the impact of some may be greater than others depending on the location, ownership, farm type, and other factors (Bamidele et al., 2008). The productivity of agricultural companies was impacted by education, experiences, technical know-how, and skill, which had an impact on technological adoption and management effectiveness (Bamidele et al., 2008; Ukoha et al., 2010). In Ethiopia, both individual and group-owned poultry farms are very common, where group poultry farming has recently developed in the form of cooperatives and micro-and small-scale enterprises to exploit the urban market (Ibrahim and Goshu, 2020). Group farming may be able to provide farmers with economies of scale, a reliable labor force, more investable capital and expertise, increased bargaining power in input and output markets, and improved integration with governmental and non-governmental organizations that provide technological assistance, training, and advice (Agarwal, 2018). The farm owners were all dominated by men which might be related to the financial capability of the males rather than the female counterparts and the socio-economic and cultural practices of the community that empower the males. A study conducted in Ethiopia reported that 86% of poultry producers were male farmers (Gemechu and Abiy, 2019).

The results of the current study showed that, in contrast to group-owned farms, those who are self-sufficient in terms of their means of subsistence tend to operate as private farmers. While the majority of those without jobs engaged in group farming. A higher proportion of individual farmers and employees engaged in poultry farming as sole-proprietorship, whereas the majority of unemployed communities engaged in partiner farming which is attributed to lack of start-up capital and other resource limitations. This is consistent with findings reported by Agarwal (2018) and Agarwal and Dorin (2019), who stated group farming helps to mobilize and pool resources to enhance the performances of agricultural enterprises.

Farm characteristics and husbandry practices

Regardless of the kind of ownership, the study found that layer-producing farms were the most common poultry enterprises in the study area when compared to pullet and broiler farms attributed to poor awareness of broiler farming, lack of broilers DOC supply, and poor preference of the communities to meat from improved breeds of broiler chickens compared to the indigenous breeds. A similar finding was reported elsewhere in Ethiopia, where layer farms were dominating (Amare and Tesfaye, 2020). It was reported that only 3% of the commercial farms in Ethiopia were broiler producers, while 74% were engaged in layer production (Woldegiorgiss et al., 2017). Poor market access, low product demand, limited supply of day-old pullets and broilers, expensive and high-standard management, and infrastructure requirements for pullet and broiler husbandry practices could all be contributing factors (Woldegiorgiss et al., 2017). The current study indicated that poultry farmers lack basic knowledge of poultry husbandry practices and the required inputs across the value chains. The other reasons for having a small number of broiler farms in Ethiopia were, that the market was concentrated in central Ethiopia around Mojo, Bishoftu, and Addis Ababa, and there were poor extension services in promoting broiler production across the

country by concerned offices, institutions, and extension workers. Amare and Tesfaye (2020) reported that a shortage of day-old chicken supply, high prices of feed, and a lack of land constrained small-and medium poultry production in Ethiopia.

The current study showed that the average age of layers, pullets, and broilers per single production cycle were 17.43 ± 4.04, 2.55 ± 0.71, and 2.18 ± 0.51 months, respectively, regardless of significant variability between sole-proprietor and partnership farms ($p > 0.05$). The age of layer chickens in the current study is in contrast to the report by Woldegiorgiss et al. (2017), who reported that 35% of the commercial layer producers in Ethiopia keep layers for 2 years. The result of the current study for the age of layers is inconsistent with the recommendations set by different breeders' guides (72-84 weeks) (Lohmann, 2021). A study in Cosovo southeast Europe reported that the age of layer chickens ranges from 13.5-15.5 months with egg productivity of 79.3-80.4% (Ymeri et al., 2017). As layer chickens get older, their feed conversion efficiency and egg quality decrease which affects the profitability of the enterprises (Woldegiorgiss et al., 2017). In the case of broiler-producing enterprises, the age of broiler chickens was longer than the average economically feasible age recommended as 38 to 47 days (Brown et al., 2009; Aviagen, 2018; Compassion in World Farming, 2019), incurring additional costs. The longer length of production implies the profitability of poultry enterprises (Brown et al., 2009; Aviagen, 2018). The longer age of broiler chickens in the current study might be because of poor quality husbandry practices implemented by farm operators in the study area. Regarding layer farms in the current study, the average annual egg productivity per hen and mean weight of a broiler chicken were 275 eggs and 2.55 kg in individual-owned farms and 253 eggs and 2.23 kg in group-owned farms. Global statistics showed that commercial layer breeds lay nearly 300 eggs per bird per year, while broiler chickens reach a body weight of 2 - 2.5 kg by 45 days of age (Habte et al., 2017).

The study found that the annual frequencies of production cycles for firms producing pullets and broilers were 3.20 ± 0.62 and 2.85 ± 0.83 times, respectively. A study conducted in India reported a mean annual number of production cycles per year of 6.27 and 5.32 in contract and non-contract broiler farms, respectively, and a production length of 40.5 days in contract farming and 45.40 days in non-contract broiler farms (Singh et al., 2018). The results indicated that increasing the frequency of the production cycle per year is important to maximize the profitability of farm enterprises. However, poultry farmers are concerned about the seasonal shift in weather conditions over a year, which results in a severe cold environment, a high prevalence of diseases, expensive feed, and a scarcity of feed resources. Poultry enterprises were challenged by disease and parasites, uncertainty and dynamic weather conditions, a low capital base, inefficient financial management practices, housing, and marketing constraints in general, which increased the farmers' fear (Folajinmi and Peter, 2020).

The flock sizes of privately owned and group-owned layer farms were 561.88 ± 723.94 and 1165.22 ± 876.83 chickens, where there was a significantly larger flock size in group-owned farms. Contrary to the current findings, a study conducted in Bishoftu area of Ethiopia reported a farm flock size of 2134 pullets and 2381 layers, in an intensive commercial farm (Ebsa et al., 2019). The flock size in the current study in individual-owned farms was lower because private farmers started their business with minimal start-up capital and on a small plot of land without substantial emphasis on flock size. In contrast, group-owned farms pay particular attention to determining the optimal flock size for their establishments. Accordingly, partnership farms mobilize their startup capital either from their members or through loans from financial institutions, and they attempt to have a larger farm size to begin their business with a larger flock size. The mean weight of eggs in private farms (60.21 ± 8.72 gm) was statistically higher than that of group-owned farms (54.00 ± 10.04 gm), which could be attributed to the more stringent management practices implemented and close follow-up made by individual farmers than group-owned farms. In agreement with the current finding, an average egg weight of 60 grams was reported from hens producing 250 eggs per year in Ethiopia (Mengesha et al., 2022). Management, nutrition, genetics, age, body weight, and lighting factors determine the weight of eggs produced in poultry farms.

The study indicated that the mean weights of broiler chickens produced by individual-owned farms and group-owned farms were 2.55 ± 0.33 and 2.23 ± 0.27 kg, respectively. The difference was statistically significant between the two ownership types, attributed to the higher commitment made in the management of the chickens and better competing determination by individual farmers than those farms owned in groups. Flock size and management intensity affect the productivity of the farms, by improving the efficiency of input costs (Kawsar et al., 2018; Khan and Afzal, 2018).

The majority of group-owned farms (56.6%) and a sizeable fraction of individually owned farms (23%) did

not have their own working premises; instead, they operated their poultry farming in rented farmsteads or housing. In the present study, a lack of land resources for poultry farmers has limited the use of existing potential and discouraged farmers' motivation and engagement in chicken farming. The limited availability of land inhibited the potential of chicken enterprises (Bao Truong et al., 2021). The density of layers per m^2 area in private farms and group-owned farms was 8.52 ± 3.53 and 10.45 ± 4.11, respectively. In contrast, the number of pullets and broilers per unit area at mid-age was 13.74 ± 5.32 and 9.41 ± 3.11, respectively. The result implies overstocking and overpopulation per unit area of land as a result of scarcity of land resources and an unpredictable land supply system. The density of the three groups of chickens in the current study was greater than the standard recommendations set by different guidelines. Reports in Ethiopia indicated that, though there are few feed processing plants around urban areas such as Addis Ababa and Bishoftu, the feed is often poor in quality, expensive in price, and not easily accessible for farmers at nearby as they are located at a distance from the farms (Sambo et al., 2015; Habte et al., 2017). The result implies that the daily feed provided for different classes of chickens was below the standard requirements of the chicken, which is attributed to a high feed price, seasonal fluctuations in feed costs, and a limited number of suppliers. Such a trend of feeding would affect farm productivity and gradually lead to the failure of farm enterprises. Rising costs of raw materials and a lack of raw resources are the reasons for the rising trend in feed prices.

Farm production and productivity

According to the results of the present study, sole-proprietorship layer farms' egg productivity and egg production were 76.5% and 154,802 eggs annually, whereas the productivity and production of group-owned farms were 70.4% and 295,307 eggs, as evaluated by the hen day production index. The productivity of an individual-owned farm was higher than that of a group-owned farm, which might be because of better management as the farm is private. A sole proprietorship is a business owned by a single person, who has complete control over the business, makes all important decisions, is responsible for all day-to-day activities, and uses personal skills to manage business affairs (Senevirathne, 2019; Santoso, 2020). However, the result confirmed that the physical eggs produced from group-owned farms were higher because of the larger number of chickens reared in group-owned farms.

The study findings showed that, among the production expenses, the cost of feed, chickens (day-old chickens and pullets), housing rent, labor, and medicine were the top five expenditures in that order, with feed cost being the highest. This is probably due to the absence of adequate commercial feed milling industries, sufficient commercial hatcheries that supply day-old chickens (DOCs), and limited access to all inputs at nearby in the study areas. A shortage of feed processing industries and a shortage of supply were reported as the main causes of high feed costs in Vietnam (Bao Truong et al., 2021). The study found that the cost of feed accounted for 60.4% (ranging from 41.2-74.2%) of total expenses, making it the primary source of financial concern. In relation to the overall farm costs, the feed cost shares in Pakistan (58.1 – 63.6%), Indonesia (70%), and Vietnam (49.5%) were nearly comparable to the results of the current study (Afzal and Khan, 2017; Coyne et al., 2020; Bao et al., 2021).

Gross and net revenues were statistically higher ($p < 0.05$) in group-owned farms than in individual-owned farms because of the larger flock size. The net profit of the chicken enterprises is maximized with increasing flock size, which is in line with the finding, which stated that financial profit generated from chicken farms generally increases with flock size (Bao Truong et al., 2021). According to Bamidele et al. (2008), TFP index values were interpreted as sub-optimal (< 1), optimal (1.0 –1.09), and super-optimal (≥ 1.10). Accordingly, the study revealed that 81.06%, 100%, and 89.29% of layer, broiler, and pullet farms, respectively, laid in a range of super-optimal (≥ 1.10) TFP index ratings, with only layer farms showing substantial variations by ownership type. This implied that most of the small-scale poultry (layer, broiler, and pullet) enterprises performed at a higher productivity index and have promising profitability.

The benefit-cost ratio (BCR) is a profitability metric used in cost-benefit analysis to assess the viability of cash flows produced by an asset or project. A BCR greater than or equal to one indicates that, when a project benefits are discounted at the opportunity cost of capital, they outweigh project costs, and its value reflects the efficiency of the project and indicates that the project evaluated is economically advantageous (Delp, 1977; Kahraman et al., 2000). In addition, the profitability ratio, known as NPM, compares net income to sales. It calculates the amount of net income or profit as a proportion of sales, describing how much of each dollar in sales a firm receives turns into profit. It is the ratio of net profits to revenues for a company or business segment, illustrating that a firm with a high NPM can generate high profits (Nariswari and

Nugraha, 2020). The higher the value of NPM, the better the profitability of the enterprise. Furthermore, the NPM ratio measures the efficiency of production, management, and tax administration (Setiadi et al., 2018). In light of this, the current study found that the NPM and BCR of farms that produced eggs varied significantly between the two ownership types ($p < 0.05$), with the values for individual-owned farms being 30% and 0.75 and for group-owned farms being 53.75% and 1.48. Such a result was indifferent to the study, which reported an absence of profitability differences between sole proprietors and partnerships in broiler farms (Khan and Afzal, 2018). However, under the two ownership types, the ratios indicated that the farms were generating high profits although there was a significant difference in their efficiency in earning profit. Group-owned farms were more efficient as their BCR was greater than one.

In the case of broiler and pullet-producing farms, both NPR and BCR were not statistically different by ownership type. The NPMs of broiler and pullet-producing farmers were 42.78% and 35.21%, respectively. Khan and Afzal (2018) reported that the profitability of broiler farms 'was not significantly different between sole-proprietorship and partnership, but the difference was significant between small and large flock-size farms. The BCR of broiler and pullet-producing farms were reported as 0.93 and 0.92, respectively. These values, being close to one, indicate that farmers derived substantial benefits from their respective poultry businesses. The results revealed that such firms were economically advantageous, but they should focus on improving production efficiency and cost management to boost the BCR above one. Such firms should focus on increasing flocks' size so that they maximize profitability with constant input costs. Smaller flock sizes in poultry farms and high mortality rates of chickens were important variables that determined the profitability and financial losses of farm enterprises (Bao Truong et al., 2021). When the profitability of the three enterprises in terms of NPM was compared, the broiler, layer, and pullet farms ranked first, second, and third, respectively. However, in terms of efficiency, layer, broiler, and pullet farms rank first, second, and third in their order. In order to guarantee ongoing efficiency and success in their businesses, farmers often need technical, marketing, and financial management knowledge and skills.

CONCLUSION

The current study confirmed the instability of small-scale commercial chicken production in the study area, where a large number of poultry farmers freeze their businesses after one or two production cycles due to dynamics in input supply and the high cost of inputs. The profitability of poultry farms was maximized in farms that had a larger flock size, regardless of the type of ownership. In terms of weight and egg productivity, sole-proprietor farms produce higher quality products such as eggs, pullets, and broilers than partnership farms. Majority of the chicken farms are profitable when evaluated in terms of total factor productivity, benefit-cost-ratio, and net-profit-margin. Lack of chicken supplies, high feed costs, lack of finance, high disease prevalence, and seasonal fluctuation of demand for poultry products are the determinants of productivity and profitability of small-scale commercial chicken enterprises in the study areas. To promote small-scale commercial poultry production and sustain its productivity and profitability, there should be an integrated strategy among government authorities, entrepreneurs, producers' associations, large commercial poultry-producing farms, feed milling industries, and financial institutions so that they contribute to better performances. Technological options and different intervention strategies should be studied under different farming systems in order to alleviate the major bottlenecks of the industry and maximize productivity and profitability.

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Authors' contributions

This research was conducted by the contribution of all the authors. Dereje Tsegaye designed, conceptualized, collected, and analyzed the data, and drafted the manuscript. Berhan Tamir validated the methodology and protocol, supervised the data collection, and edited the manuscript. Getachew Gebru validated the methodology, supervised the data collection and analysis, and revised the manuscript. All authors read and approved the final version of the manuscript for publication in the present journal.

Ethical considerations

All the authors in the current research have checked ethical issues like (plagiarism, consent to publish, misconduct, data fabrication and/or falsification, double

publication and/or submission, and redundancy).

Availability of data and materials

The data is available with the corresponding author and it can be available based on requests.

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