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*Full Length Research Paper*

# Characterization of village chicken production systems and challenges across agro-climatic zones in Ethiopia

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**The aims of the study were to characterize the socio-economic features of village chicken producers, types of chicken production systems, flock management practices, family task sharing and production constraints in lowland, midland and highland of Ethiopia. Data were collected at 360 rural households of which 120 were from lowland, 160 midland and 80 highlands. A standardized questionnaire was used to collect the data using person to person interview method. The extensive chicken management system was predominant in all of the three agro-climatic zones. Most of the studied parameters were different (P<0.01) across agro-climatic zones. Based on the whole data set, 77.9% of the households practiced an extensive form of chicken management system. However, the proportion was much higher (90%) in lowlands. From the visited 360 poultry farms, 96% of them had native chicken breeds, 3% had exotic chicken breeds and the remaining 1% had crossbreds. Chicken ownership was pre dominated by rural women than men in all of the three agro-ecological zones. Regarding family task sharing in rural poultry production systems, women were responsible for 47.9 to 77.6% of farm activities. The major production constraints and/or problems were the lack of high performing chicken breeds and disease occurrence during the period in which this study was carried out. Newcastle disease was the most prevalent health problem at 61% of the visited farms and it was highly important in all of the three agro-ecological zones. Our findings will support agro-ecology based interventions for improving village chicken management systems and enhance their economic contributions to the farmers.**

**Key words:** Agro-climatic zone, flock management, production constraint, production system, task sharing, village chicken.

## INTRODUCTION

Ethiopia is one of the sub-Saharan African countries where most of the national economy depends on agriculture (CSA, 2004; Deressa et al., 2008). Poultry production plays a vital role for food security and contributes to the country economy (Gerima et al., 2016). Poultry production is a promising farming activity,

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particularly in the regions where there is a consistent decrease of grazing areas (Kyule et al., 2014). Low technology poultry production demands small investment compared to other livestock species (Lawal et al., 2016). As a result, poultry production is very well practiced by Ethiopian smallholder farmers (Fisseha et al., 2010).

Ethiopia has about 65 million heads of chicken (FAO, 2000; Tadelle, 2003). Village chicken production account for more than 95% of poultry production in this country (Tadelle, 1996, 2003; Mekonnen et al., 2010), whereas the average in sub-Saharan African countries is 78% (Tadelle, 1996, 2003). Village chicken production in Ethiopia contributes with 90 and 92% of the national egg and poultry meat production, respectively (Tadelle, 1996, 2003).

People in Ethiopia consume on average 57 eggs and 2.5 chicken per capita per annum (Alemu, 1985; Mekonnen et al., 2010). Besides its advantage as a source of food and income, village chicken production ensures employment opportunities for rural smallholder farmers and offers socio-cultural advantages (Moges et al., 2010). Despite all these contributions of rural poultry to the smallholder farmers, little attention has been paid to improve the system. The farmers' indigenous knowledge and management practice on village chicken production has not been exploited yet.

Characterization of village chicken production systems in different agro-climatic zones might help to identify important problems hindering the success of the poultry sector in specific agro-ecological areas. A previously conducted study in Zimbabwe has shown a high influence of agro-ecology on various parameters of village chicken production systems (Muchadeyi et al., 2007). Moreover, such agro-ecological based studies have not been studied at a wider scale in Ethiopia (Tadesse and Tesfay, 2013).

Therefore, the major objectives of this study were to characterize the socio-economic features of village chicken producing farmers, chicken management systems, task sharing and production constraints at the national level across major agro-ecological zones of the country. Outputs from this study may support agro-ecology based policies, research strategies, and development programs aiming to improve the production and productivity of village chicken at grassroots level in Ethiopia.

## MATERIALS AND METHODS

### Study sites

In this study, nine districts were selected from four regions in Ethiopia (Oromia, Amhara, Southern Nations, Nationalities and People region [SNNP], Tigray) where village chicken production predominate and have an easy access for transportation. Among the nine districts, the Dodota, Haremaya and Ada districts were selected from Oromia region (3°N to 10.5°N latitude; 34°E to 43°E longitude), the Gonder Zuria and Basonaworna districts were selected from Amhara region (9°21' to 14°0' N latitude; 36°20' to 40°20' E longitude), the Arbaminch Zuria, Abeshge and Malga districts were selected from the SNNP (6°3'31.03" latitude ; 36°43'38.28" longitude) and the North Mekele district was selected from Tigray region (13°14' 06" N latitude; 38°58' 50" E longitude).

The selected districts were categorized into three groups as lowland, midland and highlands based on their traditional form of classification which depends on altitude, temperature and rainfall. Based on this classification, lowlands were represented by the Arbaminch Zuria, Abeshge, and Dodota districts. Midlands were represented by the Ada, Gonder Zuria, Haremay and North Mekele districts, whereas, highlands were represented by the Basonaworna and Malga districts. The lowland areas were characterized by an altitude in the range of 500 to 1,500 m.a.s.l. with an annual rainfall of 200 to 800 mm and a temperature of 20 to 27.5°C, whereas, the midland areas were representing an altitude in the range of 1,500 to 2,300 m.a.s.l. with an annual rainfall of 800 to 1,200 mm and temperature of 17.5 to 20.0°C, which was mainly characterized by mixed crop-livestock farming. On the other hand, highlands were featured by an altitude in the range of 2,300 to 3,200 m.a.s.l. with an annual rainfall of 900 to 1,200 mm and a temperature of 11.5 to 16.0°C. Highland districts were mainly characterized by crop production, but mixed crop-livestock farming system was also common in this area.

### Sampling procedure

A multi-stage sampling procedure was employed to select sampling locations and target households. In each district, four villages were selected and 10 households that had a minimum of five chicken were randomly selected in each village. In total, 360 households: 80 from highlands, 160 midlands, and 120 lowlands were considered. Person to person interview was made to collect qualitative and quantitative data on the studied parameters using a standardized questionnaire. Data collection was supported by the technical staffs of the agricultural and rural development offices in Ethiopia. Agro-climatic data of the selected districts were obtained from the respective agricultural and developmental main offices in Ethiopia.

### Statistical analysis

The data were coded and stored on a database. Cross-tabulation procedure of descriptive statistics such as percentages and frequencies were performed for socio-demographic characteristics of households, livestock composition, chicken breeds composition, and chicken disease data (Table 1, Figures 1 to 3) and chicken management systems and task sharing data (Tables 3 and 4) using the *Statistical Package for Social Sciences* (*SPSS*) (2006). Chi-square test was performed to determine differences in the frequency distribution of the studied variables among the three agro-ecological zones. Rank means were compared using a non-parametric Kruskal Wallis test (NPAR1WAY) of SAS version 9.2 (SAS Institute Inc., 1999) for non-measurement variables (Tables 2, 5 and 6). Alpha level of 0.05 was used to reject the null-hypothesis of no difference among agro-climatic zones on the studied parameters.

## RESULTS AND DISCUSSION

### Socio-economic features of the respondents

From the 360 respondents, 56.3% were males and 43.8% were females (Table 1). The respondents had an

**Table 1.** Socio-demographic characteristics of the households by agro-climatic zone.

| Parameter (%) | Agro-climatic zones | | | Overall mean | Sig[a] |
|---|---|---|---|---|---|
| | Lowlands | Midlands | Highlands | | |
| Sample size (N) | 120 | 160 | 80 | | |
| Sex of the respondent (%) | | | | | *** |
| Male | 75 | 46.3 | 47.5 | 56.3 | - |
| Female | 25 | 53.8 | 52.5 | 43.8 | - |
| Age of the respondent (years) | 40.2 | 36.9 | 37.3 | 38.1 | NS |
| Marital status (%) | | | | | NS |
| Married | 86.7 | 80.6 | 87.5 | 84.9 | - |
| Unmarried | 4.2 | 11.3 | 6.3 | 7.2 | - |
| Widowed | 8.3 | 6.9 | 6.3 | 7.2 | - |
| Divorced | 0.8 | 0.6 | 0 | 0.5 | - |
| Respondent's religion (%) | | | | | *** |
| Orthodox | 28.3 | 46.9 | 62.5 | 45.9 | - |
| Protestant | 31.7 | 0 | 21.3 | 17.6 | - |
| Muslim | 40 | 27.5 | 0 | 22.5 | - |
| Other | 0 | 25.6 | 16.3 | 14 | - |
| Education level (%) | | | | | NS |
| Illiterate | 30.8 | 41.9 | 32.5 | 35.1 | - |
| Read & write | 69.2 | 58.1 | 67.5 | 64.9 | - |
| Mean land size (ha) | 1.9 | 1.4 | 1.7 | 1.7 | NS |
| Family size (n) | 6.2 | 5.8 | 6.1 | 6 | NS |
| Household Head (%) | | | | | *** |
| Father | 77.5 | 58.1 | 78.8 | 71.4 | - |
| Mother | 13.3 | 17.5 | 15 | 15.3 | - |
| First Son | 9.2 | 24.4 | 6.3 | 13.3 | - |
| Engaged activity (%) | | | | | *** |
| Farming activity | 91.7 | 70 | 87.5 | 83.1 | - |
| Off-farming activity | 8.3 | 30 | 12.5 | 16.9 | - |
| Family background (%) | | | | | *** |
| Farmer | 98.3 | 69.3 | 96.3 | 88 | - |
| Other | 1.7 | 30.7 | 3.8 | 12.1 | - |

Sig[a] refers to significance across agro-climatic zones (rows). Chi-Square significant at P <0.05 (*), P<0.01 (**), and P<0.001 (***). [NS] refer to non-significant. ha hectare, N number of households, n number of individual per household.

average age of 38 years, and 84.9% were married. Regarding their religion, 45.9% of the respondents were Orthodox, 22.5% were Muslim, and 17.6% were Protestant. 64.9% of the respondents were literate and 35.1% were illiterate. The average family size was composed of 6 members. The households had on average 1.7 ha of land. In lowlands, farmers had on average 0.46 and 0.20 ha more land than those living in midlands and highlands, respectively. 84.7% of the 360 households were male headed and 15.3% were female headed. In all three agro-climatic zones, most households were led by males. 83.1% of the total households were engaged in farming activities. Only 16.9% were engaged in off-farming activities. Most of the households came from families who had farming background.The socio-economic and demographic features of households can affect the size of production, management and marketing of village chicken (Aklilu et al., 2007; Tadelle and Ogle, 2001; Muchadeyi et al., 2007). The study findings showed that most households of village chicken farmerswere male headed (84.7%), had diverse religious believes which was dominated by Orthodox, mainly engaged in farming activities, and their economy was more dependent on crop production than on livestock. Our finding on the higher percentage of male headed households was in agreement with the value previously reported for Ethiopia (Mekonnen et al., 2010) and other African countries (Mwale and Masika, 2009).

## Crop-livestock production

Village chicken farmers in Ethiopia produce different

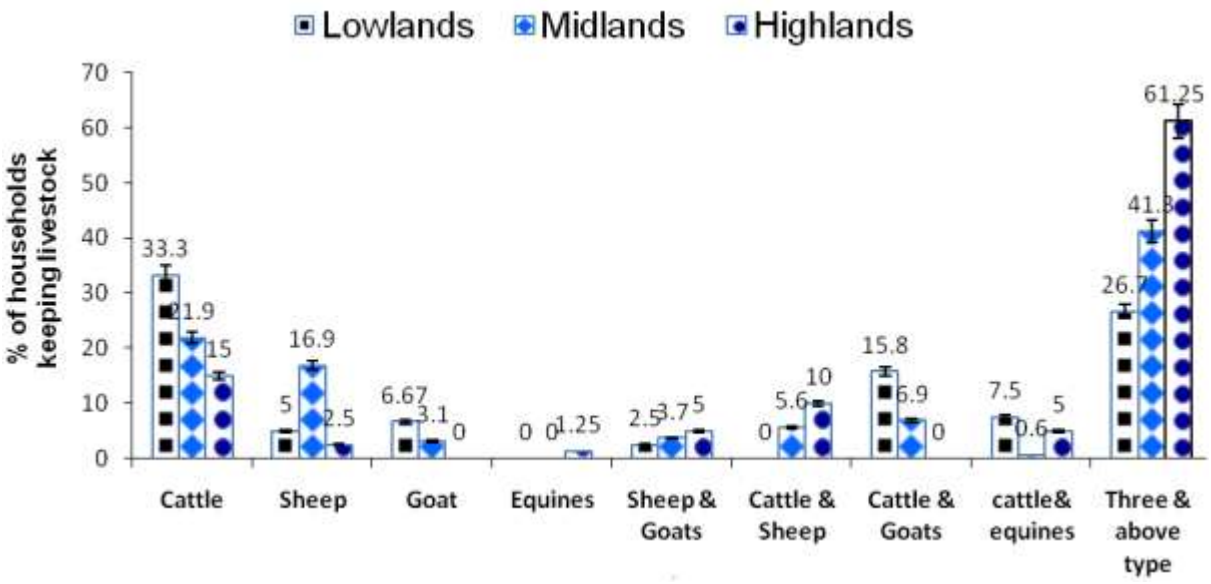


**Figure 1.** Livestock species kept at chicken farmers' level in lowlands, midlands and highlands of Ethiopia

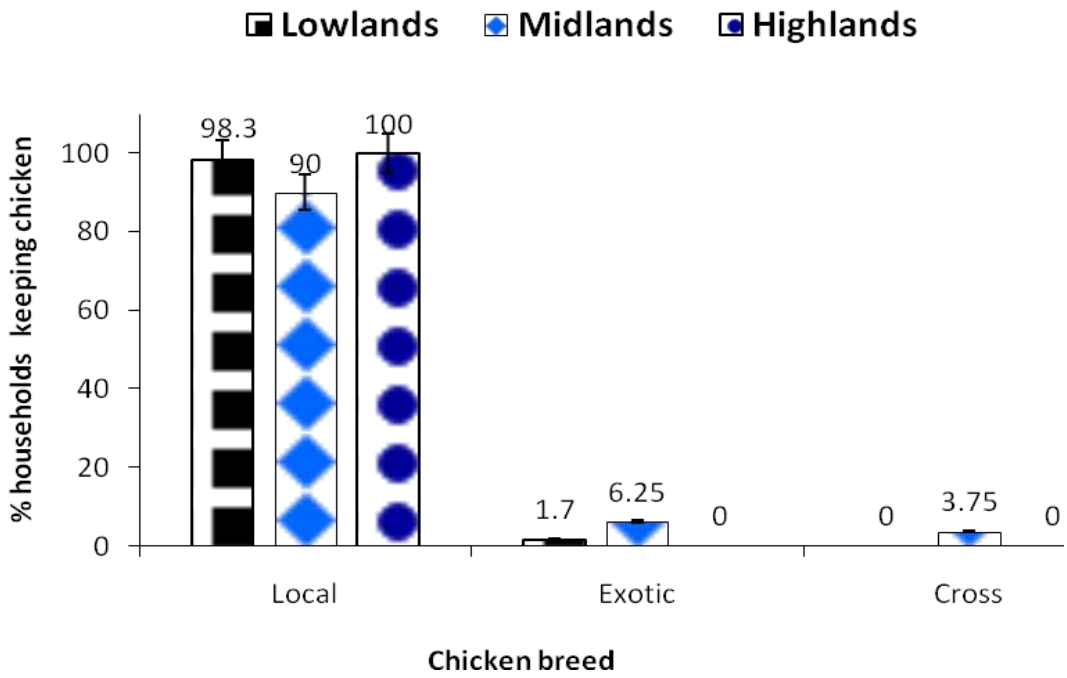


**Figure 2.** Chicken breeds kept in lowlands, midlands and highlands of Ethiopia.

types of crops. They were asked to rank their crops based on size of production from most important (1) to least important (4). In lowlands, the top three important crops were barley, teff and wheat (Table 2). In midlands, crop production was dominated by teff, wheat and barley. The top three predominant crops in highlands were barley, wheat and maize. There was a significant ($P<0.05$) difference in the relative importance of each crop across the studied agro-climatic zones. Only maize production did not differ ($P>0.05$) across the agro-climatic zones. The types of predominant crops were different also within an agro-ecological zone ($P<0.001$).

Based on the whole data set, the top three predominant crops were teff, wheat and barley. Our findings indicated

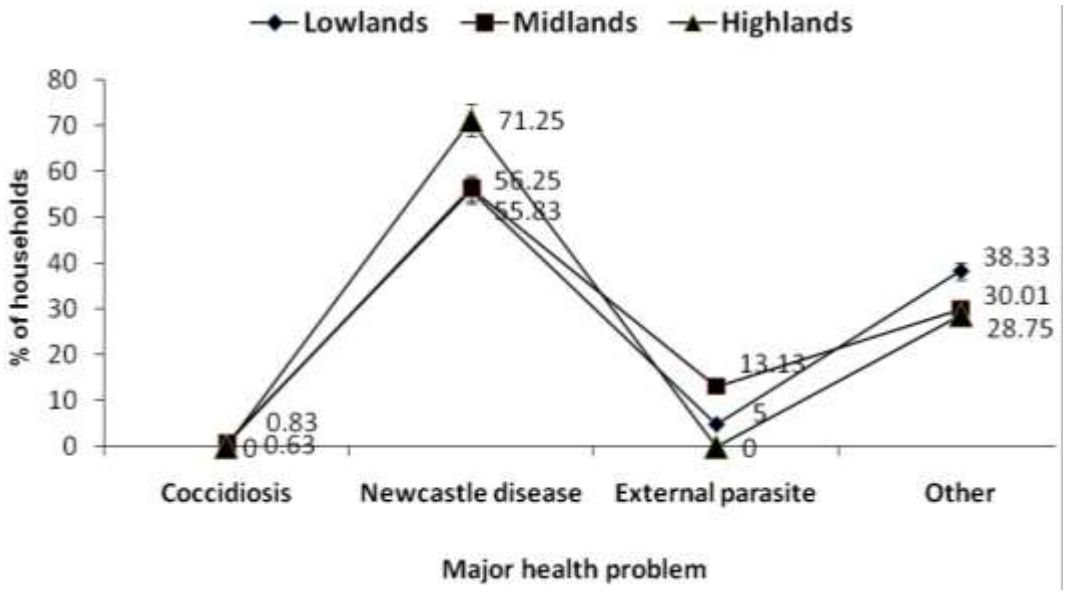


**Figure 3.** Major poultry health problems in lowlands, midlands and highlands of Ethiopia

**Table 2.** Rankmeans and standard deviations attached to the relative importance of different crops (1=most important-up to 4=least important).

| Parameters | Agro-climatic zones | | | Sig[b] |
|---|---|---|---|---|
| | Lowlands | Midlands | Highlands | |
| Number of households | 120 | 160 | 80 | |
| **Crops produced** | | | | |
| Teff | 2.8 (1.27) | 3.0 (1.31) | 4.0 (0.00) | *** |
| Wheat | 3.3 (1.16) | 3.2 (1.08) | 3.3 (0.90) | NS |
| Barely | 3.6 (0.77) | 3.3 (1.01) | 1.7 (1.25) | *** |
| Sorghum | 3.8 (0.53) | 3.3 (1.26) | 4.0 (0.00) | *** |
| Maize | 2.2 (1.31) | 3.4 (0.88) | 3.3 (1.06) | *** |
| Coffee | 3.9 (0.23) | 4.0 (0.00) | 4.0 (0.00) | * |
| Chat | 3.9 (0.30) | 3.9 (0.32) | 3.6 (0.93) | *** |
| Enset | 3.7 (0.69) | 4.0 (0.00) | 3.5 (0.76) | *** |
| Fruit | 3.4 (0.92) | 3.9 (0.35) | 4.0 (0.00) | *** |
| Beans and peas | 4.0 (0.00) | 3.6 (0.75) | 3.6 (0.66) | *** |
| Haricot bean | 3.9 (0.23) | 3.9 (0.07) | 4.0 (0.00) | * |
| Potato | 3.9 (0.18) | 4.0 (0.00) | 3.8 (0.43) | *** |
| Sig[a] | *** | *** | *** | - |

Sig[a] significance of rankmeans within agro-ecology (columns) and Sig[b] significance across agro-climatic zones (rows). Significant at P<0.05 (*) and P<0.001 (***). Rankmeans were compared using Kruskal Wallis test.

that the economy of village chicken farmers in Ethiopia highly (> 90%) depend on crop production. This finding was in agreement with previously reported findings in Zimbabwe (Muchadeyi et al., 2007). The type and quantity of crops produced by village chicken farmers may affect the size and productivity of chicken flocks as cereals especially grains are the main supplementary feeds available for village chicken (Tsadik et al., 2015; Worku et al., 2012). Many types of crops were grown in each agro-climatic zone, however, the type of dominating crops were different among agro-climatic zones. Based on the current findings, in lowlands, the three dominant

crops were barely, teff, and wheat. In midlands, crop production was dominated by teff, wheat, and barley. The three dominate crops in highlands were barley, wheat and maize. There was a significant ($P<0.05$) difference in the relative importance of each crops across agro-climatic zones.

Only maize production did not differ ($P>0.05$) across agro-climatic zones. The types of dominate crops differed also within agro-ecological areas ($P<0.001$). Overall, the three dominant crops were teff, wheat and barley from high to low, respectively. From the 360 interviewed farmers, 88% kept one or more livestock species other than chicken. In the midlands, only 12% of the households had chicken alone. Percentages of village chicken farmers who kept cattle, sheep, goats or equines were 23.4, 8.1, 3.3, and 0.4, respectively. Those chicken farmers who kept cattle in lowlands and midlands were 33.3 and 22%, respectively. However, in highlands, 48.7% of the farmers had combinations of cattle, sheep, and equines (Figure 1). The experience of farmers to keep one or more livestock species besides chicken were previously reported for different African countries (Muchadeyi et al., 2007, Mwale and Masika, 2009; Aboe et al., 2006). In our study, the percentages of village chicken farmers who kept chicken with either of cattle, sheep, goats or equines were 23.4, 8.1, 3.3, and 0.4, respectively. Most of the village chicken farmers in lowlands (33.3%) and midlands (21.9%) kept cattle together with chicken. However, most farmers (48.8%) kept combinations of cattle, sheep, and equines with chicken in highlands. The most frequent livestock compositions at village chicken farmers in Ethiopia were cattle and chicken (23.4%) or cattle, sheep, equines and chicken (20.5%).

## Chicken production systems

In this study, 77.9% of the households practiced an extensive form of chicken management system (Table 3). The remaining 22.1% of the households practiced a semi-extensive form of chicken management system. The extensive management system was predominant in all the three agro-climatic zones, especially, in lowlands and highlands. The low input requirements can be considered as an advantage for extensive chicken management systems. However, this system exposes the birds to predators, harsh climatic conditions, disease challenges, uncontrolled breeding, and inadequate and poor quality feeds (Olwande et al., 2009).

## Culling and replacement

Farmers used different systems to cull unproductive and/or sick chicken. 63.8% of all the visited households sold their unproductive chicken. Selling as a culling strategy was practiced at 47.5% of the households in lowlands, 76.3% in midlands and 67.5% in highlands (Table 3). Many factors can force farmers to cull their chicken. Diseases, low production and lack of feed are some of the major causes of culling (Halima et al., 2007; Muchadeyi et al., 2009). When culling is necessary, farmers cull their chicken in different ways. In this study, selling and home consumption were the dominant methods of culling in all agro-climatic zones. These results are in agreement with previous findings in Ethiopia (Tadelle and Ogle, 2001; Halima et al., 2007).

However, such culling methods can be a risk for human health if sick chicken are used for consumption. Zoonotic diseases can be easily transmitted from chicken to humans (Dale and Corrie, 2013; Mondal, 2015). Flock replacement was made by hatching in 47.6% of the cases. On average, 39.2, 61.3 and 42.5% of the households in lowlands, midlands and highlands used hatching as a method of flock replacement. Buying chicken from local markets was the second method of flock replacement in all agro-climatic zones. Tadelle (2003) reported that 70% of breeding females in Ethiopia originated from hatching at home. Studies in other African countries also reported hatching as the main source of flock replacement under extensive chicken production systems (Kondombo, 2005). Flock replacement by hatching can prevent the introduction of chicken from other places to already existing flocks, reducing the risks of dissemination of diseases; however, it avoids the cleaning up of disease already entered into the flock because it lacks all–in–all–out practice. Such flock replacement method can also prevent gene flow between flocks with different genetic origin.

## Feed, feeding and housing management

Village chickens mainly depend on scavenging for their feeds in many African countries like Ethiopia. Cereals like wheat, barley, maize, and sorghum are the common grains available for supplementation. In the present study, it was noted that village chicken were mainly depended on scavenging for their feeds. Some households provided supplementary feeds to their chicken. Grains were the main (78.7%) supplementary feeds provided for chicken. Additionally, chicken had access for family food leftovers (Table 3). The amount and type of supplementation was dependant on the type and size of crop production in the different agro-climatic zones (Tsadik et al., 2015; Worku et al., 2012).

Due to frequent movement in the field, chicken using considerable energy for physical activity and they are exposed to harsh climatic conditions, disease and predator attack. A previous study conducted by Dana et al. (2010) in Ethiopia showed that 83% of the 225 chicken farmers were practicing scavenging and supplementary feeding management system. According to this author,

**Table 3.** Chicken management systems across agro-climatic zones.

| Parameter (%) | Agro-climatic zones | | | Overall | |
|---|---|---|---|---|---|
| | Lowlands | Midlands | Highlands | mean | Sig[a] |
| Sample size (N) | 120 | 160 | 80 | | |
| **Chicken Management (%)** | | | | | ** |
| Extensive | 90 | 65 | 78.7 | 77.9 | - |
| Semi-extensive | 10 | 35 | 21.3 | 22.1 | - |
| **Since when do you keep chicken? (%)** | | | | | *** |
| < 1 year | 3.3 | 4.3 | 17.5 | 8.4 | - |
| 1-10 years | 33.3 | 51.2 | 28.8 | 37.8 | - |
| > 10 years | 29.1 | 29.5 | 5 | 21.2 | - |
| Since childhood | 26.8 | 1.3 | 43.8 | 23.8 | - |
| I don't know | 7.5 | 13.8 | 5 | 8.8 | - |
| **Chicken ownership (%)** | | | | | ** |
| Boys | 15.8 | 10.6 | 11.3 | 12.6 | - |
| Girls | 2.5 | 5 | 2.5 | 3.3 | - |
| Father | 27.5 | 10 | 32.5 | 23.3 | - |
| Mother | 44.2 | 65 | 45 | 51.4 | - |
| Other | 10 | 9.4 | 8.7 | 9.4 | - |
| **Culling (%)** | | | | | *** |
| Slaughter for home consumption | 16.7 | 19.4 | 18.8 | 18.3 | - |
| Sale | 47.5 | 76.3 | 67.5 | 63.8 | - |
| Other | 35.8 | 4.4 | 13.8 | 18 | - |
| **Replacement (%)** | | | | | ** |
| Purchase | 26.7 | 25.6 | 36.3 | 29.5 | - |
| By Hatching | 39.2 | 61.3 | 42.5 | 47.6 | - |
| Purchase & by Hatching | 30 | 10 | 20 | 20 | - |
| Other | 4.2 | 3.1 | 1.3 | 2.8 | - |
| **Breed selection (%)** | | | | | *** |
| Yes | 20 | 60 | 37.5 | 39.2 | - |
| No | 80 | 40 | 62.5 | 60.8 | - |
| **Type of supplementary feed (%)** | | | | | *** |
| Grain | 94.2 | 69.4 | 72.5 | 78.7 | |
| Grain plus concentrate | 0 | 7.5 | 23.8 | 10.4 | |
| Other | 5.8 | 23.1 | 3.8 | 10.9 | |
| **Where spent chicken in the night? (%)** | | | | | *** |
| In the Family house | 31.7 | 16.9 | 53.8 | 34.1 | - |
| In the kitchen | 30 | 9.4 | 30 | 23.1 | - |
| On the tree | 0.8 | 0 | 1.3 | 0.7 | - |
| In a basket | 7.5 | 8.1 | 2.5 | 6 | - |
| In sheds | 29.2 | 65 | 12.5 | 35.6 | - |
| Other | 0 | 0.6 | 0 | 0.2 | - |
| **How you treat chicken? (%)** | | | | | *** |
| Local medicament | 87.4 | 60.6 | 68.8 | 72.2 | - |
| Advise health technician | 6.7 | 35.6 | 13.8 | 18.7 | - |

Sig[a] refers to significance across agro-climatic zones (rows). Chi-Square significant at P <0.05 (*), P<0.01 (**), and P<0.001 (***). [NS] refer to non-significant. [%] percent.

no farmer was practicing a confined or complete ration system. Regarding housing conditions, this study revealed that almost 35.6% of the households had sheds for their chicken (Table 3). The sheds were small in size and made from locally available materials. 34.1% of the cases showed that chicken spent their nights in the same house with humans (Table 3). So, family housing and sheds were the major housing systems used by farmers to shelter chicken during the night. Similar housing conditions were previously reported in Ethiopia (Tadelle and Ogle, 2001; Halima et al., 2007; Mekonnen et al., 2010) and in other African countries (Gondwe and Wollny, 2007; Olwande et al., 2009). As the system allows close contact of humans with chicken, the risk of exposure to transmittable diseases is very high. For instance, Avian Influenza Virus like H5N1 can be transmitted from chicken to farmers through direct contact (Proenca-Modena et al., 2007; Tiensin et al., 2007).

**Health management**

Diseases were one of the major bottlenecks for village chicken productions in the studied areas. Newcastle disease was most widely distributed among the village chicken in Ethiopia. This was reported in several previous studies which employed different diagnostic methods such as virus isolation, sero-epidemiological investigations and molecular methods to confirm the presence of the disease in Ethiopian village chicken productions (Tadesse et al., 2005; Zeleke et al., 2005; Chaka et al., 2012; Mulisa et al., 2014; Terefe et al., 2015).

In this study survey, almost 56 to 71% of the visited farms were affected by this disease at least once (Figure 3). The disease occurred in all agro-climatic zones during the period studied, particularly affecting chicken in highlands (71.3%). Farmers did not know how to differentiate the disease affecting their chicken in 17.9% of the cases. They knew only symptoms shown by affected chicken. The symptoms most commonly observed in affected village chicken were bloody diarrhea, nasal discharge, sneezing, torticollis, and deaths within few days. Only 18.7% of the visited households contacted veterinarians when their chicken were sick.

Farmers used their own traditional practices to resolve health issues of affected chicken (Table 3). 72.2% of households used local treatments such as lemon, pepper, alcoholic drink, salt and onion for trying to cure affected birds. Unhealthy chicken normally receive a mixture of one or more of the aforementioned traditional treatments with water or feed. Also, some farmers let bleeding from the wings of sick chicken as a means of treatment. Normally the farmers believe that bleeding can give sick chicken relief from their pain and support recovery from the disease (Mengesha et al., 2011).

Farmers smoke leaves of *Eucalyptus* tree in chicken sheds in order to protect the chicken from external parasites. Such indigenous knowledge of farmers is very helpful especially in conditions where there is no access to contact veterinarians and where there is no money to buy medicaments from animal health centers. The rate of village chicken mortality (33.6%) observed in this study was lower than the 60% reported previously (Tadelle, 1996). Reasons for mortality can be poor management practices, bad quality and low quantity of feeds, predations, and diseases. Different types of disease cases were previously reported in Ethiopia (Tadelle and Ogle, 2001; Halima et al., 2007; Mekonnen et al., 2010).

The present study found that Newcastle disease was the major causes of mortality among village chicken in all of the three agro-climatic zones of Ethiopia which is in agreement with previous findings in Ethiopia (Tadelle and Ogle, 2001; Halima et al., 2007; Mekonnen et al., 2010) and in other African countries (Horning et al., 2003; Hassan et al., 2004; Aboe et al., 2006; Henning et al., 2006; Otim et al., 2007; Olwande et al., 2009).

Farmers used some strategies to protect flocks from predators. For instance, they select against white plumage color of chicken, avoiding white plumage which easily expose birds to predators.

**Chicken ownership and task sharing**

Chicken were the wealth of women in 51.4% of the studied cases. The higher chicken ownership of women was observed in all of the three agro-climatic zones (Table 3). Feeding, watering, cleaning, house construction, treating sick chicken, and buying and selling live chicken are common activities in poultry farms. This study described that such activities were accomplished by family members including the mother, father and children (Table 4). Rural women accomplished 47.9 to 77.6% of farm activities, except chicken house construction which was mainly (63%) done by rural men. There was a clear difference in task sharing among the different family members. According to the current findings, chicken ownership and management were dominated by rural women indicating that village chickenare the property of rural women which is in accordance with previously reported findings in Ethiopia (Tadelle and Ogle, 2001; Aklilu et al., 2007; Halima et al., 2007; Mekonnen et al., 2010) and other African countries (Aboe et al., 2006; Olwande et al., 2009).

**Relative advantages of keeping native chicken**

Chicken farmers were asked whether they prefer to keep native chicken breeds than exotic chicken breeds. They were also asked to rank the reasons (1 very important to 5 not important) for preferring native breeds than exotic breeds. Data analysis confirmed that farmers prefer to

**Table 4.** Family task sharing across agro-climatic zones.

| Parameter (%) | Agro-climatic zones | | | Overall | |
|---|---|---|---|---|---|
| | Lowlands | Midlands | Highlands | Mean | Sig[a] |
| Sample size (N) | 120 | 160 | 80 | | |
| **Feeding the chicken (%)** | | | | | NS |
| Mother | 78.3 | 76.9 | 77.5 | 77.6 | - |
| Father | 13.3 | 7.5 | 8.8 | 9.9 | - |
| Other | 8.3 | 15.6 | 13.8 | 12.6 | - |
| **Chicken house construction (%)** | | | | | ** |
| Mother | 12.5 | 22.1 | 2.5 | 12.4 | - |
| Father | 55.8 | 63.1 | 70 | 63 | - |
| Other | 31.7 | 14.7 | 27.5 | 24.6 | - |
| **Preparing basket for hens (%)** | | | | | NS |
| Mother | 70 | 62.5 | 68.8 | 67.1 | - |
| Father | 20 | 26.3 | 12.5 | 19.6 | - |
| Other | 10 | 11.2 | 18.8 | 13.3 | - |
| **Cleaning the chicken House (%)** | | | | | *** |
| Mother | 75.8 | 61.3 | 90 | 75.7 | - |
| Father | 5.8 | 4.4 | 1.3 | 3.8 | - |
| Other | 18.3 | 34.4 | 8.8 | 20.5 | - |
| **Buying chicken (%)** | | | | | NS |
| Mother | 44.2 | 54.4 | 44.8 | 47.9 | - |
| Father | 38.3 | 33.1 | 43 | 38.2 | - |
| Other | 17.5 | 12.5 | 12.3 | 14.1 | - |
| **Selling chicken (%)** | | | | | *** |
| Mother | 53.5 | 59.4 | 56.3 | 56.4 | - |
| Father | 24.8 | 16.9 | 11.3 | 17.7 | |
| Other | 2.7 | 23.7 | 32.5 | 19.6 | - |
| **Treating sick chicken (%)** | | | | | ** |
| Mother | 55.7 | 68.8 | 46.8 | 57.1 | - |
| Father | 31 | 17.5 | 43.3 | 30.6 | - |
| Other | 13.3 | 13.7 | 10 | 12.4 | - |

Sig[a] refers to significance across agro-climatic zones (rows). Chi-Square significant at P <0.05 (*), P<0.01 (**), and P<0.001 (***). [NS] refer to non-significant.

keep high performing exotic chicken breeds instead of native chicken breeds. This finding was noted in all of the three agro-climatic zones. However, native chicken breeds were preferred mainly because they were cheaper for buying a replacement flock and they had lower feed consumption (Table 5).

Indeed the ability of village chicken to survive and produce under an extensive management system makes the choice of birds for smallholder farmer's lever. Due to the lack of improved and locally adapted exotic chicken breeds, 98, 90 and 100% of the total interviewed poultry farmers were keeping native chicken breeds in lowlands, midlands and highlands, respectively. However, exotic chicken breeds were kept only at 0.0% to 6.2% of the households in the studied areas (Figure 2).

Ethiopian farmers tend to prefer exotic chicken breeds than those for native chicken breeds in case they have the opportunity to keep locally adapted exotic chicken breeds. This result could be associated with the high performance of exotic chicken breeds for egg and meat yield. Based on our findings, the farmers mainly preferred exotic chicken breeds or their genetic crosses for their

**Table 5.** Rankmeans and standard deviations attached to relative advantage of keeping native chicken than exotic breeds, farmers' view (1=most important up to 5=least important).

| Parameter (%) | Agro-climatic zones | | | Sig[b] |
|---|---|---|---|---|
| | Lowlands | Midlands | Highlands | |
| Sample size (N) | 120 | 160 | 80 | |
| **Relative advantages** | | | | |
| Egg production and quality | 4.2 (1.53) | 3.7 (1.84) | 4.3 (1.48) | * |
| Meat production and quality | 4.8 (0.74) | 4.8 (0.63) | 4.9 (0.44) | NS |
| Mothering ability | 4.7 (0.97) | 5.0 (0.00) | 4.8 (0.82) | *** |
| Disease resistance | 4.5 (1.23) | 4.8 (0.78) | 4.7 (0.88) | * |
| Adaptation to environment | 4.8 (0.84) | 4.9 (0.31) | 5.0 (0.00) | * |
| Lower market price | 3.5 (1.88) | 4.2 (1.58) | 3.4 (1.95) | *** |
| Lower feed consumption | 3.5 (1.68) | 3.4 (1.92) | 4.0 (1.52) | * |
| Sig[a] | *** | *** | *** | - |

Sig[a] significance of rankmeans within agro-ecology (columns) and Sig[b] significance across agro-climatic zones (rows). Significant at P<0.05 (*), P<0.01 (**), and P<0.001 (***). Rankmeans were compared using Kruskal Wallis test.

**Table 6.** Rankmeans and standard deviations attached to production constraints (5 levels with 1=most important and 5=least important).

| Parameter | Agro-climatic zones | | | Sig[b] |
|---|---|---|---|---|
| | Lowlands | Midlands | Highlands | |
| Number of households | 120 | 160 | 80 | |
| **Constraints / problems** | | | | |
| Disease | 2.5 (1.65) | 3.1 (1.72) | 2.8 (1.65) | * |
| Lack of improved breed | 2.6 (1.71) | 2.2 (1.72) | 2.1 (1.73) | ** |
| High cost of feed | 4.6 (0.95) | 4.5 (1.05) | 4.9 (0.33) | *** |
| Predators | 4.8 (0.80) | 5.0 (0.00) | 4.8 (0.67) | * |
| Poor management skill | 4.4 (1.18) | 4.1 (1.46) | 4.3 (1.32) | NS |
| Sig[a] | *** | *** | *** | - |

Sig[a] significance of rankmeans within agro-ecology (columns) and Sig[b] significance across agro-climatic zones (rows). Significant at P<0.05 (*), P<0.01 (**), and P<0.001 (***). Rankmeans were compared using Kruskal Wallis test.

higher eggs and meat production. Therefore, the keen interest of Ethiopian farmers to have chicken breeds with better fitness and higher production can be achieved through importation and on-station adaptation and evaluation of high yielding exotic chicken breeds and also through a long term selection of the native chicken breeds.

## Production constraints

The success of poultry production and productivity at farm level might be affected by several limitations. This study described the five most important constraints which were reported as the major bottleneck for village chicken productions in Ethiopia (Table 6). All production constraints, except management skills, differed by agro-climatic zones. Even within each agro-climatic zone, the rank order of importance of the different production constraints were not the same.

The most priority constraints were the diseases affecting chicken followed by the lack of locally adapted and well performing chicken breeds in lowlands; whereas, the lack of locally adapted and well performing chicken breeds was the most priority constraint in midlands and highlands. Production constraints such as diseases, unavailability and poor quality of feeds, low management skills, predators attack, lack of modern technologies, and uncontrolled breeding were common findings in extensive chicken production systems (Tadelle, 2003; Kondombo,

2005; Halima, 2007; Mwale and Masika, 2009). Up to date information on the type of the production constraints and their degree of importance is helpful to make necessary innervations at farm level. Farmers' response on lack of locally adapted and well performing chicken breeds as the main production constraint at farm level could be associated with the increasing market prices of chicken and eggs in Ethiopia.

## Conclusions

This study provided a comprehensive overview about village chicken production systems' characterization across agro-climatic zones in Ethiopia. It emphasized the effect of agro-climate on the studied parameters related to village chicken production systems. The study also provided detailed information on chicken farmers' indigenous knowledge and practices across the three agro-climatic zones in the country.

According to the findings of the study, native chicken breeds predominated in the Ethiopian village chicken production systems. The ability of village chicken to survive and produce under extensive form of management system makes them the birds of choice at smallholder farmers' level. Although there are several reasons to choose native chicken breeds instead of exotic chicken breeds in an extensive management system, farmers in Ethiopia take the relative lower feed requirement and lower market price of native chicken breeds as the two top advantages. Many of the farmers' practices did vary among agro-climatic zones. This is likely due to differences in social, religious, economic and climatic factors existing in the different agro-climatic zones. The effect of agro-climate on the studied parameters may imply that there is a need for strategic agro-climate based interventions to improve village chicken production systems in Ethiopia.

Farmers' indigenous knowledge is highly important in an extensive chicken production system. However, training is necessary to upgrade their management skills. This study also showed that the Ethiopian village chicken production systems were characterized by several limitations. The system exposes the birds to predators, harsh climatic conditions, disease challenges, un-controlled breeding, and inadequate and poor quality feeds. The major input shortage in village chicken production was the lack of locally adapted and well performing chicken breeds. Newcastle disease was the major chicken health problem in all of the three agro-climatic zones during the period studied.

Therefore, the future research and development inter-ventions aiming to improve village chicken production systems in Ethiopia should address the main constraints identified at grass roots level. Outputs from this study can support future agro-climate specific interventions aiming to improve management of village chicken production systems and enhance their contribution to the livelihoods of smallholder farmers.

## Conflict of Interests

The authors have not declared any conflict of interests.

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# Assessment of livestock feed resources and feeding systems in Haramaya district, Eastern Ethiopia

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**The study was conducted in east Hararghe zone of Oromia regional state, eastern Ethiopia to assess the major available livestock feed resources. A total of 150 households with experience in livestock keeping practice for at least two years were selected. All respondents indicated that shortage of feed resources, dominance of unpalatable forages and low nutritive values of usable forages were the major feed problems. Overall, 73% of the respondents used cut and carry system as a grazing system and 93% indicated that feeding hay, crop residues and concentrates were the methods used to combat feed shortages. The major feed resources were crop residues, natural pastures and fodder trees/shrubs. Sorghum and maize were the main sources of crop residues, whereas leaves of Cordia Africana, Veranonia amygdalina, Erythrina burana, Combretum molle, Casimiroa edulis and Olea Africana were the major indigenous fodder trees used to supplement livestock species in the dry season. Adequate conservation, improvement and utilization of hay and crop residues as well as the introduction of potential forage production (e.g. planting multipurpose fodders and producing improved forages), and use of animal source as supplement need to be practiced to overcome feed shortage and optimize production. Regulation policies of land use need to be employed in the area to ensure land units for livestock feed production, which will allow the livestock sector contribute to poverty eradication and encourage smallholder farmer to be a food secured household.**

**Key words:** Feed resource, crop residues, fodder tree, forage production.

## INTRODUCTION

Ethiopia is known to be the African country with the richest livestock resources. About 62% of the total land surface in the country is suitable for grazing (Hogg, 1997; Alemayehu, 1998a, b). Livestock industry is an important and integral part of the agricultural sector in Ethiopia. Moreover, livestock farming is vital as a supply of meat and milk, being a source of additional income both for smallholder farmers and livestock owners (Ehui et al., 2002).

In a smallholder livestock production system, animals are dependent on a variety of feed resources that can vary both in quantity and quality. For optimum livestock production, feed resource available should match with the number of animals in a given area. Feed resources as

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reported by Tolera et al. (2012) can be classified as natural pasture, crop residue, improved pasture forage and agro-industrial by-products, of which the first two are the most important contributors. Animals depend mainly on natural pastures for their feed requirements. In Ethiopia, there are extensive areas where keeping of livestock on the natural vegetation is the only possible types of land use (Coppock, 1994).

Natural pastures which provide more than 90% of the livestock feed are generally very poorly managed. Nowadays, the rangelands of Ethiopia are being extensively damaged both in quantity and quality (Belaynesh, 2006). Due to the poor management and overstocking of natural pastures, which are highly overgrazed and result in severe land degradation, loss of valuable species and dominance by unpalatable species (Alemu, 1998).

Fibrous agricultural residues is the most important contributor in livestock feed, especially in the populated countries where crop cultivation of land is prioritized. Tolera et al. (2012) reported that crop residues contribute to about 50% the total livestock feed supply in Ethiopia. Livestock production constraints could vary not only among agro-ecological zones, but also among production systems. For example, different animal species are bred by the urban and peri-urban farmers which are regulated by the demand of products such as milk and availability of the supplemental feeds.

The peri-urban and urban farmers usually purchase basal feeds (grasses and crop residues) from the rural area. However, the supply of feeds to the urban farmers depends on the availability of feed resources in the rural area. Therefore, it is necessary to assess livestock feed resources and constraints that cause feed inadequacy in the rural livestock production systems. Such information will be used to develop policies in order to minimize the problems that could be generated. There is very little information which asses the availability and utilization of feed resources in Haramaya district specially in the three selected peasant associations (PAs) of Haramaya district namely Damota, Tuji Gabisa and Tinike. Feed resource assessment is important to diagnose the problems and suggest intervention measures to be taken by farmers and policy makers.

## MATERIALS AND METHODS

### Description of the study area

The study was conducted in three of the 33 peasant associations existing in Haramaya district of east Hararghe zone, Oromia regional state that surrounds Haramaya University namely Tuji Gabisa, Tinike and Damota. Eastern Hararghe is one of the 18 zonal administrations and comprises 19 districts, out of which four districts are pastoral and the rest 15 are mixed crop-livestock systems (EHOARD, 2013). Haramaya district comprise a total area of 55,000 ha located in latitude 9°9' to 9°32'N, and longitude 41°50' to 42°05'E, between 1600 and 2100 m.a.s.l. high. It is located 15 km to the North of Harar city. According to CSA (2007), the population of Haramaya district is 215,140 (26,129 urban and 189,011 rural) and the district is the most densely populated area from the zone (the estimated density is 335.16 persons per $km^2$). The minimum and maximum temperatures are 5.2 and 24° C, respectively (EHOARD, 2013) and the mean annual rainfall is 492mm ranging from 118 to 866 mm. The area has a bimodal rainfall pattern, with small rains from March to May and main rains from June to September (EHOARD, 2013).

### Sampling techniques

The three PAs of Haramaya district that surrounds Haramaya University were purposively selected as the PAs are in short supply of animal feed resources in the district. Based on the aforementioned criteria, the selected rural peasant associations from Haramaya district were Tuji Gabisa, Tinike and Damota. First, a total of 150 households who had an experience in livestock species keeping practice for not less than two years (with an adequate livestock husbandry skill), 50 from each peasant association, were selected.

### Types of data and methods of data collection

Data were collected both from primary and secondary sources. Secondary sources consisted on data about climate, human population, livestock population and livestock production constraints, and were collected by reviewing different literatures conducted so far in the district. Primary data (household size, land utilization pattern, major feed resource, household herd size; seasonality of feed resources) were collected through a survey during the course of the study. Primary data were collected using semi-structured questionnaire starting from March to April, 2015. The questionnaire was first pre-tested before in the beginning of the survey. A total of 150 individuals, 50 from each peasant association, were selected as respondent to be involved in the survey convey.

### Statistical analysis

Primary data from surveyed households and relevant secondary data were organized, summarized and analyzed using excel spread sheet 2007. Mean and percentage values of different parameters were compared among the PAs.

## RESULTS AND DISCUSSION

### Household characteristics

Among the interviewed households in Damota, Tinike and Tuji Gabisa PAs, 23(46%), 27 (54%) and 40 (80%) were husbands, respectively. The rest of respondents were spouses. Thus, representing the 60% of all interviewed were husbands and 40% were spouses (Table 1). In each PA, the proportion of illiterate respondents was higher than 50% with the highest proportion (66%) in Tuji Gabisa PA. This might be attributed to the age of respondents that participated in the interview program which is on average 44.15 years. It is evident that schools were not well distributed before 40 years in the rural parts of Ethiopia which impedes the literacy rate. The proportions of those who can only read

**Table 1.** Respondent's status, education background, current occupation and occupation five years ago in the different PAs of Haramaya district.

| Variable | Damota PA | | Tinike PA | | Tuji Gabisa PA | | Total | |
|---|---|---|---|---|---|---|---|---|
| | HHC | Percentage (%) | HHC | Percentage (%) | HHC | Percentage (%) | HHC | Percentage (%) |
| **Respondent status** | **N=50** | | **N=50** | | **N=50** | | **N=150** | |
| Husband | 23 | 46 | 27 | 54 | 40 | 80 | 90 | 60 |
| Spouse | 27 | 54 | 23 | 46 | 10 | 20 | 60 | 40 |
| **Education background of respondents** | | | | | | | | |
| Illiterate | 27 | 54 | 27 | 54 | 33 | 66 | 87 | 58 |
| Read only | 17 | 34 | 7 | 14 | 7 | 14 | 31 | 21 |
| Elementary | 0 | 0 | 13 | 26 | 7 | 14 | 20 | 13 |
| Junior secondary | 0 | 0 | 0 | 0 | 3 | 6 | 3 | 2 |
| Secondary | 6 | 12 | 3 | 6 | 0 | 0 | 9 | 6 |
| **Current Occupation** | | | | | | | | |
| Mixed farming | 50 | 100 | 50 | 100 | 50 | 100 | 150 | 100 |
| Livestock rearing only | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Crop production only | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Occupation 5 years ago** | | | | | | | | |
| Mixed farming | 33 | 66 | 43 | 86 | 47 | 94 | 123 | 82 |
| Livestock rearing only | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Crop production only | 17 | 34 | 7 | 14 | 3 | 6 | 27 | 18 |

HHC=household count.

and reached secondary school were highest for Damota PA. However, the proportion of respondents who reached elementary school was highest for Tinike PA. The low level of educational status in the district was similar to other areas in rural Ethiopia (Coppock, 1994; Alemu, 1998). This situation may show an adverse impact on technology transfer and hamper the productivity of the interventions being made in the district. The result is in line with the case reported by Teshome (2007). As far as the major occupation of the households were concerned, all of them (100%) were practicing mixed farming agriculture (that is, crop-livestock system) whereas 18% indicated that they have been practicing solely crop production during the last five years.

## Household land holding and ownership

Average land holding for crop land per household for Damota, Tinike and Tuji Gabisa PAs was 0.83 ha (ranging from 0.5 ha to 2 ha), 0.7 ha (ranging from 0.1 ha to 1 ha), and 0.43 ha (ranging from 0.1 ha to 1 ha), respectively (Table 2). Average land devoted for communal grazing area was 0 ha, 0.007 ha, and 0.05 ha for Damota, Tinike and Tuji Gabisa PA, respectively. Fallow land was only practiced in Tinike PA. The overall average land allotted for crop, communal grazing and fallow land was 0.654 ha, 0.019 ha, and 0.003 ha, respectively (Table 2). This result is coincident with a previous study by Estefanos et al. (2014)

**Table 1.** Average land holding and livestock ownership per household in the three PAs of Haramaya district.

| Land use types (ha) | Peasant association (PA) name | | | Overall average for the three PAs |
|---|---|---|---|---|
| | Damota (N=50) | Tinike (N=50) | Tuji Gabisa (N=50) | |
| Crop land | 0.83 | 0.7 | 0.43 | 0.654 |
| Communal grazing area | 0 | 0.007 | 0.05 | 0.019 |
| Kalo (enclosure making) | 0 | 0.009 | 0 | 0.003 |
| **Livestock species (no.)** | | | | |
| Cattle | 3.33 | 2.93 | 2.6 | 2.95 |
| Sheep | 1.87 | 1.53 | 1.6 | 1.67 |
| Goat | 2 | 2.67 | 2.13 | 2.27 |
| Donkey | 0.87 | 0.73 | 0.93 | 0.84 |
| Poultry | 5.33 | 3.8 | 4.13 | 4.42 |

for crop land in Haraghe highlands who reported 0.78 ha for overall average land allotted for crop land. This indicated that land is one of the scarce resources for animal production in the study district. Communal grazing area was exercised in Tinike and Tuji Gabisa PAs with an area of 0.007 ha and 0.05 ha per household, respectively. Kalo (standing hay preservation/enclosure making) was only practiced in Tinike PA with an average of 0.009 ha per household. The criteria they used to make Kalo was its accessibility.

## Livestock holdings and composition

The mean number of cattle holding per household in Damota, Tinike and Tuji Gabisa PA was 3.33, 2.93 and 2.6, respectively with an overall average of 2.95. More poultries were reared in Damota PA than in the other two PAs. Overall mean number of sheep, goat, donkey and poultry was 1.67, 2.27, 0.84 and 4.42, respectively. With regard to livestock composition of the area, poultry were the dominant, followed by cattle, goat, sheep and donkey in that order. Therefore, we can conclude that possession of the farmers were higher for poultry than large ruminants in the study area. The result is also similar with the findings reported by Abdi et al*.* (2013) and Estefanos et al*.* (2014). Any farmer in the study area has no more than 10 cattle, which imply that all the interviewed farmers were smallholders. The low number of large ruminant per household could be attributed to the small size of land holding of the household.

## Livestock feeding systems

In each PA, most of the respondents used cut and carry system (zero grazing) as a type of grazing system with the highest proportion in Tinike PA (80%) as indicated in Table 3. Tethering was only practiced in Tinike and Tuji Gabisa PAs. Tethered grazing was practiced at higher rate in wet season than dry season because most of the lands were more free from crop production in dry season than in wet season, supporting the previous study by Estefanos et al*.* (2014). All the respondents in Damota and Tuji Gabisa PAs practiced haymaking, purchasing concentrates and using crop residues as a means to combat livestock feed shortages.

However, most of the respondents (80%) in Tinike PA practiced hay making, purchasing concentrates and using crop residues as a means to combat livestock feed shortages, whereas the remaining 20% used only concentrates which was purchased from the local market. Therefore, feed conservation practice in the form of hay making was exercised fully in Damota and Tuji Gabisa PAs. These results are coincident with the reports made by Freweini et al. (2014) who showed that hay making is highly practiced in Haramaya than Gursum district. All the respondents in Damota and Tuji Gabisa PAs harvested forages for haymaking after the blooming/flowering stage. Only in Tinike PA, 40% and 60% of the respondents harvested forages for haymaking before flowering and after flowering stage, respectively. Most of the respondents in Damota PA (66%), Tinike PA (86%) and Tuji Gabisa PA (72%) used forage legumes, grasses and both forage legumes and grasses as the types of forages for haymaking, respectively (Table 3). All respondents in each PA used haymaking as the only cattle type of livestock species.

Overall, 73% of the respondents used cut and carry system as a means of grazing system and the 93% feeding hay, crop residues and concentrates were the methods used in order to combat feed shortages. The present result is in line with the finding made by Teshager et al. (2013) who reported that most of the respondents fed their animal with hand feeding/cut and carry system. Similarly, most of the respondents (87%) harvested forages for hay making after flowering of forages, whereas 44% used grasses for haymaking. All respondents indicated that feed shortage from its source, dominance of unpalatable forages and forages with low

**Table 2.** Types of grazing system, methods for combating feed shortage and hay making characteristics in the three PAs of Haramaya district.

| Variable | Damota PA | | Tinike PA | | Tuji Gabisa PA | | Total | |
|---|---|---|---|---|---|---|---|---|
| | N=50 | Percentage | N=50 | Percentage | N=50 | Percentage | N=150 | Percentage |
| **Types of grazing systems** | | | | | | | | |
| Cut and carry system | 33 | 66 | 40 | 80 | 36 | 72 | 109 | 73 |
| Tethering | 0 | 0 | 10 | 20 | 7 | 14 | 17 | 11 |
| Rotational grazing | 17 | 34 | 0 | 0 | 7 | 14 | 24 | 16 |
| **Methods for combating feed shortage** | | | | | | | | |
| Using concentrates only | 0 | 0 | 10 | 20 | 0 | 0 | 10 | 7 |
| Hay making only | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Using crop residues only | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| All of the above | 50 | 100 | 40 | 80 | 50 | 100 | 140 | 93 |
| **Stages of harvesting hay** | | | | | | | | |
| Before blooming | 0 | 0 | 20 | 40 | 0 | 0 | 20 | 13 |
| At blooming | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| After blooming | 50 | 100 | 30 | 60 | 50 | 100 | 130 | 87 |
| **Types of forages used for hay making** | | | | | | | | |
| Grasses | 17 | 34 | 43 | 86 | 7 | 14 | 67 | 44 |
| Legumes | 33 | 66 | 0 | 0 | 7 | 14 | 40 | 27 |
| Both | 0 | 0 | 7 | 14 | 36 | 72 | 43 | 29 |

nutritive values were the major feed problems in the study area in that order. The problem of feed shortage in the district is also reported by Estefanos et al. (2014) who stated that farmers in Tuji Gabisa illegally penetrate into Haramaya University's pasture land to graze their animal due to the critical feed shortage.

Similarly, all the respondents pinpointed that overgrazing, grazing pressure, moisture deficit, shrinkage of grazing lands due to cultivation and environmental degradation were the major likely causes of feed shortages in the study area in that order. Due to the very limited communal grazing area available resulting from the increase of the human population and intensive cropping, some overgrazing or overstocking of pasture exists during almost all of the year. This is in line with the case reported by Estefanos et al. (2014) in the same district. Furthermore, it was the mind of all the respondents that donkeys, goats, sheep and cattle tolerated feed shortages in that order.

## Major livestock feed resources of the study area

Major livestock feed resources of the PAs are shown in Table 4. All the respondents reported that crop residues and natural pasture were their main livestock feed resources. The main sources of crop residues in the study areas were sorghum and maize, as it has been observed in previous reports by Estefanos et al. (2014) and Freweini et al. (2014). Fodder trees (leaves and pods) were only used in Damota and Tuji Gabisa PAs. Leaves of *Cordia africana*, *Veranonia amygdalina*, *Combretum molle* and *Olea africana* are the major indigenous fodder trees used to supplement livestock species in the dry season which is agreed with findings made by Belay, (2013). The use of *Erythrina burana* and *Casimiroa edulis* leaves were also used commonly in eastern

**Table 3.** Percentages of respondents indicating the major feed resources in three PAs of Haramaya district.

| Major feed resources | Damota PA | | Tinike PA | | Tuji Gabisa PA | | Total | |
|---|---|---|---|---|---|---|---|---|
| | N=50 | Percentage | N=50 | Percentage | N=50 | Percentage | N=150 | Percentage |
| Crop residues | 50 | 100 | 50 | 100 | 50 | 100 | 150 | 100 |
| Kalo (enclosure) | 0 | 0 | 27 | 54 | 0 | 0 | 27 | 18 |
| Fodder trees | 50 | 100 | 0 | 0 | 36 | 72 | 86 | 57 |
| Natural pasture | 50 | 100 | 50 | 100 | 50 | 100 | 150 | 100 |
| Agro-industrial byproducts (concentrates) | 20 | 40 | 13 | 26 | 23 | 46 | 56 | 37 |

**Table 4.** Seasonal calendar of livestock feed resources.

| Feed source | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Communal grazing (natural pasture) | x | - | - | - | - | - | - | - | - | x | x | x |
| River side grazing | x | - | - | - | - | - | - | - | x | x | x | x |
| Cut-and carry | x | x | - | x | x | | x | x | x | x | | x |
| Crop residues | - | - | - | - | x | x | x | x | x | - | - | - |
| Browses(pods and leaves) | - | - | - | - | x | x | x | - | - | - | - | - |
| Roots and tubers | x | - | - | - | - | - | - | - | - | x | x | x |
| Concentrates | x | - | - | - | - | - | - | - | - | x | x | x |
| Hay | x | - | - | - | - | - | - | - | - | | x | x |

Haraghe zone as reported by Freweini et al. (2014). No fodder trees except 'chat' were practiced in Tinike PA. However, Kalo (enclosure making) was only practiced in Tinike PA with an average occupied area of 0.009 ha. According to the respondents, *Kalo* is practiced for the purpose of feed preservation for drought times and is made mainly for cattle. Agro-industrial by products was practiced in the three PAs, with the highest proportion found in Tuji Gabisa PA (46.67%). Agro-industrial byproducts are not common due to availability and cost, being wheat bran the only byproduct used as feed. This finding is in line with the previous study of Freweini et al. (2014) who reported that around 92% of the respondents have used wheat bran in Haramaya district. Overall, the major feed resources in the study area were crop residues and natural pastures which agrees with the studies by Tolera et al. (2012) and Estefanos et al. (2014) who reported natural pasture and crop residue to be the major feed resources for highlands of Ethiopia and highlands of Hararghe, respectively.

## Feeding calendar and seasonal availability of feed resources

Information about the seasonal availability of livestock feed resources in the areas of study was obtained from group discussions and observations during the field work. Table 5 above shows the result. It was shown that the pattern of availability of feed resources in the district is influenced by similar factors which are also reported by other researchers for the highland areas (Gryseels, 1988; Ahmed, 2006).

## Conclusions

The increase of human population and small land holdings have resulted in feed shortage and overgrazing. The feed deficit observed in the study area could be one of the contributing factors

affecting livestock productivity. Improved forage production and conservation are not practiced and the availability of agro-industrial byproducts is inadequate in the study area. It is necessary to do a big effort to overcome feed shortage through proper conservation and utilization of hay and crop residues. Therefore, introduction of potential forage production, improvement of the feed resource through different techniques and supplementing the livestock with other feed resources should be practiced to optimize production. There should exist a land use policy regulation in the area which could secure land units for livestock feed production to make the livestock sector contributes to poverty eradication and encourage smallholder farmer food secured household. Chemical compositions for available feed resources are not included due to financial limits. However, it would be necessary if a deeper research is investigated on the chemical composition of available feed resources to get a full picture of the livestock feed resources of the district.

## Conflict of Interests

The authors have not declared any conflict of interests.

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*Full Length Research Paper*

# The husbandry practices of dairy cattle, feed resources, and dairy products processing and marketing in Sinana District of Bale Zone, Oromia Region, Ethiopia

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**The study was conducted to assess the husbandry practices of dairy cattle, feed resources, and dairy products processing and marketing systems. Stratified random sampling was applied to select 213 households from urban, peri-urban and rural areas. Structured questionnaire were used to collect primary information. Descriptive statistics was employed to analyze the collected data. The study found that 2.5(0.11) dairy cattle were owned per household (mean with SE). About 40.4% of the respondents owned crossbred dairy cattle and 92.0% preferred crossbred animals to expand their dairy farm. Extensive production system (mostly open grazing and without appropriate housing) was dominantly (70.0%) practiced. Grazing pasture, crop-residues and improved forages were the common feed resources. Most of the respondents (71.8%) offered the supplementary feeds for lactating cows. As overall, 6.9(38) kg of supplement feed was offered per animal/day. About 44.6% of the respondents gave priority to age for first mating of heifers (P<0.001).Heifers were allowed for mating at 35.3(0.84) months of age. Cows were kept in the production system for 8.3(0.16) years. Women took the higher share in milking and dairy products processing activities. About 81.3%, 65.4 and 50.8% of respondents in urban, rural and peri-urban, respectively owned (P<0.05) either improved or local dairy products processing equipment. About ½ of the respondents processed the raw milk into cottage cheese, butter and cottage yoghurt. There were no formal dairy products marketing and cooperatives. Overall, 85.1% of the respondents would like to start dairy cooperatives. In conclusion, the majority of the respondents preferred to have crossbred dairy cattle thus to improve the dairying practices in the study areas, crossbreeding of local cattle breeds with exotic breed dairy types with better feeding, proper healthcare and housing management systems , conservation of available feed resources, establishing of formal dairy products marketing system and dairy cooperatives are very essential.**

**Key words:** Age of mating, dairy cattle, dairy products processing, feed resources, husbandry practices.

## INTRODUCTION

Due to diverse topographic and climatic conditions, Ethiopia has estimate of 53.99 million cattle population

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where about 6.7 million were dairy cows (CSA, 2013). The country has a huge potential for dairy development. Given the high potential for dairy development and the ongoing policy reforms and technological interventions, success has been realized. Over the last decades, the dairy sector has shown considerable progress. Total milk production grew at an estimated rate of 3% as compared to 1.8% during the period, 1975 to 1992 (Mohamed et al., 2004). The existing high demand for dairy products in Ethiopia is due to rapid population growth (estimated at 3% annually), increased urbanization and income growth. The urban and peri-urban dairying system has evolved in response to ever increasing demand for milk in urban areas, induced by expanding urbanization, rising per capita income and increasing cost of imported milk and milk products (Staal and Shapiro, 1996). With the shift towards a market economy and policy, private entrepreneurs are significantly responding to the increased demand of dairy products through investing on urban and peri-urban dairying and milk processing. Urban and peri-urban dairy production is one of the dairy production systems prevailing in Ethiopia (Geleti et al., 2014). Due to the availability of commercial feeds and veterinary services in urban and peri-urban areas of Ethiopia, it is usual to see high exotic blood level dairy animals and producers in these areas have better understanding of dairy husbandry and management (Land O'Lakes, 2010).So far, few studies were conducted on dairy cattle husbandry practices, feed resources and dairy products processing and marketing in different areas of Sinana district of Bale zone. Investigating the husbandry practices, limitations and constraints can be used as a benchmark for any development intervention. Hence, it is important to investigate the status of the dairy cattle husbandry practices and the overall related situations in the district. Therefore, this study was conducted to assess husbandry practices of dairy cattle, feed resources, and dairy products processing and marketing in Sinana district of Bale zone.

## MATERIALS AND METHODS

### Description of the study area

Sinana district is located in the Northwest part of the Bale Zone of Oromia Regional State, Southeast part of Ethiopia (Figure 1). The total area of the district is about 1168 $km^2$ which ranked the third smallest district (covered 1.67%) in the zone. The altitude of the district is extended from 1650 to 2950 m above sea level with topographic characteristics of plain land (73.5%), hills (3.7%), mountains (9.6%), rugged (12.3%) and gorge (0.9%). The mean annual temperature of the district is 16.5°C whereas the minimum and maximum are 9 and 23°C, respectively. The mean annual rainfall is 1105 mm whereas the minimum and maximum are 1060 and 1150 mm, respectively (SDFED, 2006). The study district has two rainy seasons where the main rainy season extends from July to October whereas, the short rainy season extends from February to April. Crop and livestock productions were interdependent framing systems in the district. The district has two crop growing seasons and is among the first four districts of the zone which has large cattle population (BZFED, 2007).

### Sampling method and sample size

Stratified sampling method was used to select the study areas. The district farmer associations were stratified into urban, peri-urban and rural dairy cattle framings. Then, 63, 120 and 30 household farmers were selected (total 213 households) from peri-urban, rural and urban areas, respectively, based on their involvement on dairying activities.

### Methods of data collection

Group and individual discussions were carried out with key informants and officials to investigate overview information on agricultural system and dairy cattle production sub-sector in particular. The information investigated was used for the preparation of the structured questionnaire for formal survey. Prior to the actual survey, the questionnaire was pre-tested on sample households to evaluate its appropriateness, clarity and time taken for interview. Seven enumerators with a minimum of diploma educational level were employed and trained how to administer the survey questionnaire and collect data. Primary data were collected from the selected households using face to face interview method in a single visit survey. The data collection focused on the socio-economic characteristics of the respondents, family members labour division for daring activities (herding, milking, dairy products processing and marketing), types dairy animals kept in the production system, preferred dairy animals, common feed resources, age of heifers for first mating, milk yield, types of dairy products processed and marketing systems. Secondary data was collected from Sinana district and Bale Zone of agriculture, finance and development bureau.

### Statistical analysis

Descriptive statistics were used to analyze the collected data. Qualitative data was analyzed using frequency distribution. Quantitative data were analyzed using SAS (2002) JMP-5 statistical software packages. Cross-tabulation analysis was used to compare results between the study areas. To locate the significant difference between means and discrete variables, least significant difference (LSD) means comparison and chi-square ($\chi^2$) tests were used, respectively.

## RESULTS AND DISCUSSION

### Socio-economic characteristics of the respondents

About 89.8 and 10.3% of the respondents participated in this study were male and female household farmers, respectively. The overall average family size was found 5.6(0.24) persons per household with a significant difference ($P<0.05$) between the rural and urban areas (Table 1). As indicated in the table, there was no significant difference between the study areas in landholding. Households residing in urban and peri-urban areas had farmland to conduct mixed crop-livestock farming activities. This indicates households participated in the study were either live in rural areas before or they got the farmland in some means. In agreement, household

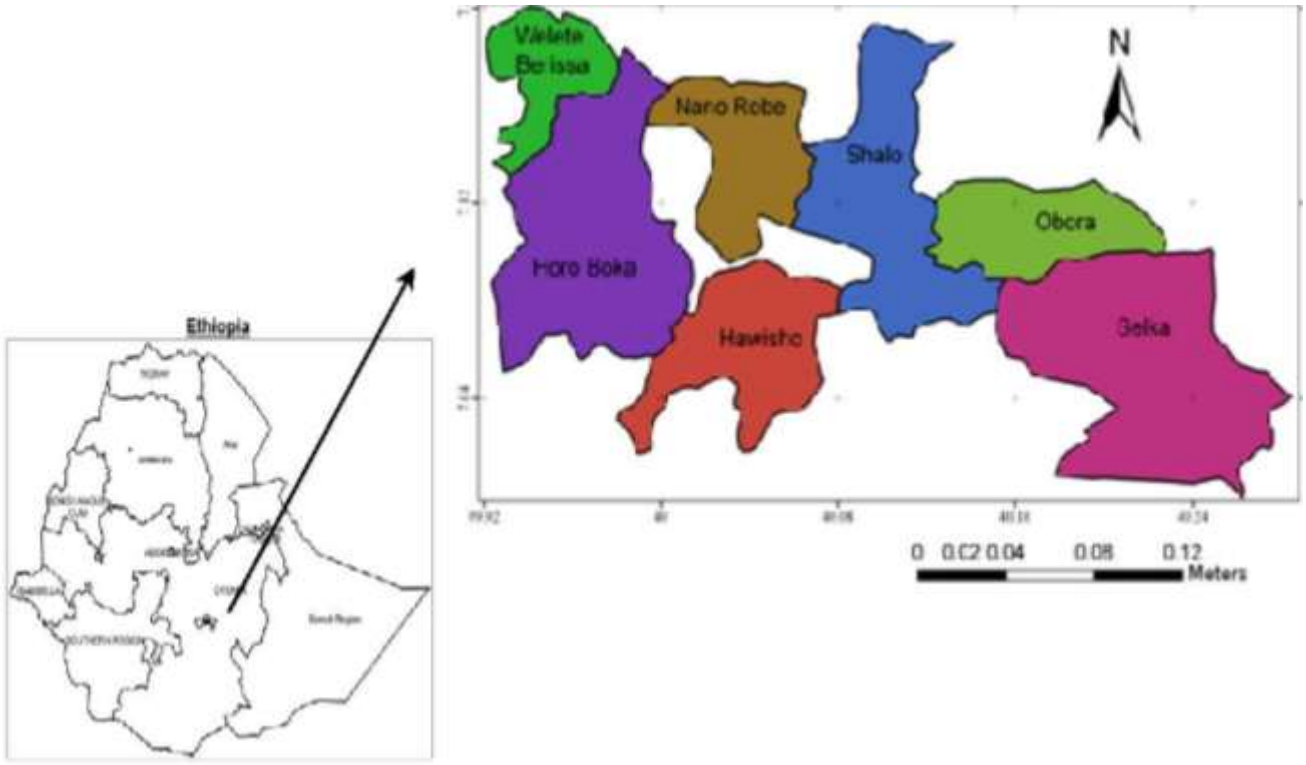


**Figure 1.** Location of the study area.

**Table 1.** Average family size, landholding and number of dairy cattle per household.

| Parameter | Study area | | | | SL |
|---|---|---|---|---|---|
| | Peri-urban | Rural | Urban | Overall | |
| Average family size | 6.0(0.37)$^{ab}$ | 5.1(0.34)$^{b}$ | 6.8(0.57)$^{a}$ | 5.6(0.24) | * |
| Average landholding | 3.6(0.27) | 3.6(0.24) | 4.1(0.55) | 3.7(0.18 ) | NS |
| Average dairy cattle | 3.2(0.21)$^{a}$ | 2.3(0.13)$^{b}$ | 1.8(0.25)$^{b}$ | 2.5(0.11 ) | *** |

*,P≤0.05; ***, P≤0.001; NS, not significant; SL, significant level; Figures outside and inside parenthesis represent mean and standard error, respectively; Means in the row having the same superscript are not significant.

households in rural area of Agarfa district (Bale Zone) own 4.07 ha of land per household (Serekeberhan, 2009). About 25 and 75% of the farmers in peri-urban areas of western part of Ethiopia own land and are engaged in crop-livestock mixed farming (Geleti et al., 2014). In the current study, an average of 15.9(0.61) cattle were owned per household. In comparable, an average of 13.7cattle is owned per household in Burji Woreda of southern Ethiopia (Guyo and Tamir, 2014). In the current study, most (91.1%) of the households kept dairy cattle for family use and income source. As shown in Table 1, households residing in the peri-urban area owned (P<0.001) more number of dairy cattle as compared to rural and urban areas. This could be due to the awareness level of the respondents, suitability of the area for dairying, financial capacity to buy dairy animals and milk demand.

## Family members labour division

The study found that family members shared different duties and responsibilities in the husbandry practices of dairy animals. Accordingly, herding was significantly different (P<0.05) in the study areas. Boys took the higher responsibilities (48.8%) on dairy cattle herding followed by father (16.0%) and girls (12.7%). Cattle are an integral part of the household economy and utilize of family labour (Mottram et al., 2005). Even though women took more responsibilities (82.9%) for milking of dairy cows, there was a significant difference (P<0.001) between the study areas. In the western area of Ethiopia,

**Table 2.** Type of dairy animals kept per household in the study areas.

| Types dairy animal | Study area | | | | SL |
|---|---|---|---|---|---|
| | Peri-Urban (N=63) | Rural (N=120) | Urban (N=30) | Overall (N=213) | |
| Kept only crossbred | 26 (41.3)[b] | 32 (26.7)[c] | 28 (93.3)[a] | 86 (40.4) | *** |
| Kept both local and crossbred | 2 (3.2)[b] | 11 (9.2)[a] | 0 (0.00)[b] | 13 (6.1) | *** |
| Kept only local breed | 33 (52.4)[b] | 75 (62.5)[a] | 2 (6.7)[c] | 110 (51.6) | *** |

***, P≤0.001; SL, significant level; Figures outside and inside parenthesis represent respondent number and percentage, respectively; Figures in the row having the same superscript are not significant.

labour is the key input in peri-urban dairying activities where milking and milk processing are primarily done by women where barn cleaning is mainly carried out by hired labour, women and children (Geleti et al., 2014). In the current study, father in the urban area showed relatively better participation (6.7%) in milking as compared to rural and peri-urban respondents. This might be due to better literacy rate, awareness level and modernization.

There was a significant difference (P<0.001) in participation of household members on milk processing activities. There was a significant difference in the distribution of labour in milk processing among the family members. About 67.7, 92.4 and 76.7% of milk processing duties were left for women in peri-urban, rural and urban areas, respectively. There was a high significant difference (P<0.001) among family members and study areas in participation of dairy products selling where the majority of the activity was done by adult females particularly in rural areas (95%). In the urban and peri-urban areas, there was better participation of family members in selling of dairy products. This could be due the suitable of market opportunities for dairy products selling in the areas.

## Types of dairy cattle kept in the production systems

About 98.6% of the respondents had dairy animals. As shown in Table 2, the types of dairy animals kept were significant (P<0.001) in between the study areas. Households residing in the peri-urban and rural areas owned relatively more (P<0.001) number of local breeds (Arsi-Bale or Boran cattle breed) but in the urban area, more than 93% of the respondents owned (P<0.001) crossbred dairy animals. This could be associated with crossbred can give a better milk yield and the existence of better milk demand in the urban area. Most of households in Ade'a and Lume districts (the central part of Oromia Region, Ethiopia) started their dairying using crossbreds (Melesse et al., 2013). In the western part of Ethiopia, both local and crossbred animals are kept for dairying (Geleti et al., 2014). Distance to the source of technologies has a significant effect on the adoption of dairy technologies (Mwamuye, 2013).

There was a significant difference (P<0.001) in the types of crossbreds of dairy animals kept in the production system across the study areas. Accordingly, 53.6 and 46.4% of respondents residing in urban area kept a crossbred of Arsi-Bale cattle breed with Boran cattle breed and a crossbred of Arsi-Bale cattle breed with the Holstein Friesian cattle breed, respectively. But 85.7% of the respondents residing in the peri-urban area kept a crossbred of Arsi-Bale cattle breed with Jersey dairy cattle breed. About 44.2, 25.6 and 20.9% of respondent residing in the rural area kept a crossbred of Arsi-Bale cattle breed with Jersey cattle breed, Arsi-Bale cattle breed crossed with Holstein Friesian cattle breed and Borna cattle breed crossed with Jersey dairy cattle, respectively. These might be true according to Quddus (2012) who reported that most of farmer semi-urban areas use crossbred cows and rural farmers are reluctant to use improved dairy technologies and higher demand for milk in markets is also an important reason to acquire crossbred dairy cattle.

## Dairy cattle production systems

As indicated in Table 3, there was a significant difference in dairy production systems across the study areas. Extensive dairy production system (mostly practiced open grazing and without appropriate housing) was the dominantly practiced by most farmers 149(70.0%). In peri-urban areas, most practiced extensive dairy production system followed by urban and rural respondents. Producers in urban and peri-urban areas of Ethiopia have better understanding of dairy husbandry and management (Land O'Lakes, 2010). In rural areas of Amhara and Oromia zones of Ethiopia, 20.8% and 25.8% of the households practiced intensive and semi-intensive dairy production systems (limited open grazing, better feed supplementation, healthcare and appropriate housing), respectively. Intensification of smallholder dairy production involves the adoption of improved genetic potential cattle breeds for milk production and other complementary inputs (Dehinenet et al., 2014).

## Preferred dairy cattle breeds

For dairy farm expansion, there was no significance difference in the preference of dairy animal across the

**Table 3.** Dairy production systems in the study areas.

| Production system | Study area | | | | SL |
|---|---|---|---|---|---|
| | Peri-urban (N=63) | Rural (N=120) | Urban (N=30) | Overall (N=213) | |
| Extensive | 59 (93.7)[a] | 64 (53.3)[b] | 26 (86.7)[a] | 149 (70.0) | *** |
| Intensive | 0(0.0)[b] | 25 (20.8)[a] | 0 (0.0)[b] | 25 (11.7) | *** |
| Semi-intensive | 3 (4.7)[c] | 31 (25.8)[a] | 3 (10.3)[b] | 37 (17.4) | *** |

***, P≤0.001; SL, Significant level; Figures outside and inside parenthesis represent respondent number and percentage, respectively; Figures in the row having the same superscript are not significant.

**Table 4.** Reason of preferences dairy animal types in the study areas.

| Preference reason | Study area | | | | SL |
|---|---|---|---|---|---|
| | Peri-urban (N=63) | Rural (N=120) | Urban (N=30) | Overall (N=213) | |
| Availability + better milk yield | 0 (0.0) | 2 (1.7) | 0 (0.0) | 2 (0.9) | NS |
| Availability | 2 (3.2)[b] | 32 (26.7)[a] | 1 (3.3)[b] | 35 (16.4) | *** |
| Easy management | 5 (7.9)[a] | 4 (3.3)[a] | 0 (0.0)[b] | 9 (4.2) | *** |
| Better milk yield | 56(88.9)[b] | 82 (68.3)[c] | 29 (96.7)[a] | 167 (78.4) | *** |

***, P≤0.001; NS, not significant; SL, Significant level; Figures outside and inside parenthesis represent respondent number and percentage, respectively; Figures in the row having the same superscript are not significant.

study areas. Overall, most of the respondents (92.0%) to own crossbreed dairy animals to expand their dairy farm. This could be due to the higher milk productivity of the crossbreeds as compared to local breeds, however, there was a significant difference (P<0.001) in the preference of the types of dairy animals. Overall, 26.8% of the respondents preferred to own pure Jersey dairy cattle breed. With this regard, 29.2% of the respondents residing in peri-urban and 38.1% of the respondents residing in rural areas preferred first to have a Holstein Friesian and Jersey dairy cattle breeds, respectively to expand their dairy farm. However, most of the respondents (56.7% in urban area preferred first to own a crossbred of Boran cattle breed with Jersey or Holstein Friesian breed. Second preferences were Jersey dairy cattle breed in rural (26.7%) and Holstein Friesian dairy cattle in urban (40.0%) and in the peri-urban (7.9%) areas. As shown in Table 4, reasons for preferences of such type of dairy animals were due to for their better milk productivity (78.4%) followed by the availability of these breeds in the study areas (16.4%) and their easiness for management (4.2%). Overall, Arsi-Bale cattle crossbred were the least preferred dairy animals by the respondents for dairy farming expansion.

## Common feed resources

As indicated in Table 5, grazing pasture, crop-residues and improved forages were the common feed resources in the study areas, however, these feed resources very scarce from February to May. The availability of grazing pasture and hay was significantly different (P<0.001) in the study areas but there was insignificance difference in the availability of crop-residues and improved forage. In rural area 87.9% of the respondent utilized improved forages for animal feeding compared to 100% utilization of improved forages in urban and peri-urban areas. This indicates rural farmers have better opportunities for alternative feed resources as compared to farmers residing in urban and peri-urban areas. The other reason might be farmers residing in urban and peri-urban areas might better aware of about the importance of improved forages for their animals. Improved forage crops produce high amount of quality forage for ruminant livestock (Geleti and Tolera, 2012), however, the adoption of improved forages by livestock keepers in rural areas of Ethiopia only is 0.15% (Tesfaye et al., 2010). A small land area and communal grazing lands do not encourage cultivation of forage crops (Benin et al., 2003). Lack of effective extension systems in forage development is also an important factor (Geleti and Tolera, 2012).

In agreement with this study, Seré and Steinfeld (1996) reported that in mixed crop-livestock farming systems higher than 90% livestock feed dry matter comes from rangelands, pastures and annual forages, and less than 10% of the dry matter comes from crop by-products and/or stubble. Serekeberhan (2009) reported that natural pasture of communal grazing land, fallow land, crop-residue and crop aftermath are the most common feed resources in Agarfa district of Bale zone. Similarly, natural pasture is the major and crop-residues the second major feed resources for livestock in Burji Woreda of South Ethiopia (Guyo and Tamir, 2014) where they are adequate from September to half of January but they are inadequate from half of January to half of April.

**Table 5.** Grazing pasture, crop-residue, hay/silage, and improved forages availability.

| Feed type | Availability or scarcity | Study area | | | | SL |
|---|---|---|---|---|---|---|
| | | Peri-urban (N=63) | Rural (N=120) | Urban (N=30) | Overall (N=213) | |
| Grazing pasture | Available | 63(100)[b] | 84 (70.0)[a] | 21 (70.0)[c] | 168 (78.9) | *** |
| | Scarce | 0 (0.0)b | 25 (20.8)[a] | 0 (0.0)[b] | 25 (11.7) | *** |
| Crop residues | Available | 62 (98.4) | 112 (93.3) | 29 (96.7) | 203 (95.3) | NS |
| | Scarce | 0 (0.0) | 1 (0.8) | 0 (0.0) | 1 (0.5) | NS |
| Hay | Available | 27 (42.9)[a] | 30 (25.0)[a] | 8 (26.7)[b] | 65 (30.5) | *** |
| | Scarce | 0 (0.0)[b] | 57 (47.5)[a] | 0 (0.0)[b] | 57 (26.8) | *** |
| Improved forages | Available | 19 (30.2) | 80(66.7 ) | 8 (26.7) | 107 (50.2) | NS |
| | Scarce | 0 (0.0) | 11 (9.2) | 0 (0.0) | 11 (5.2) | NS |

***, P≤0.001; NS, not significant; SL, Significant level; Figures outside and inside parenthesis represent respondent number and percentage, respectively; Figures in the row having the same superscript are not significant.

Crop-residues are becoming increasingly important as sources of roughage feeds for ruminants in Ethiopia but the quantities available for livestock feeding can fall due to costs associated with collection, transport, storage and processing (Geleti and Tolera, 2012). Seasonal availability, other feed alternatives and wastage can also contribute to the loss of crop-residue feed resources.

## Supplementary feeds

Wheat bran and linseed meal were dominantly used as feed supplements in urban and peri-urban areas. Flour mill by-products, oilseed cakes, brewery by-products and molasses are the main constituents of concentrate feeds mainly for peri-urban dairying in Ethiopia while, wheat bran is the most common milling by-product used for commercial oriented livestock feeding in Ethiopia (Geleti and Tolera, 2012). In the current study, irrespective of the study areas, most of the respondents (74.2%) offered (P<0.001) table salt for dairy animals followed by offering of salty soil called *Bole* (11.7%) and table salt plus salty soil (8.9%) as mineral supplements. In agreement, Guyo and Tamir (2014) reported common salt and Bole are used mineral supplements in Burji Woreda of South Ethiopia. Similarly, farmers in the western part of Ethiopia use common salt as a mineral supplement (Geleti et al., 2014). Non-conventional feed resources do play an important role in peri-urban dairy production system (Mekasha et al., 1999). In the current study, overall, 77.9% of the respondents offered the supplement feeds to their dairy animals by mixing them. Only 1.4% offered supplement feeds and mineral supplements solely without mixing with basal diet or other supplement feeds.

There was a significance difference (P<0.05) in feeding supplement feeds for dairy animals. Overall, 71.8% of the respondents (P<0.001) offered the supplement feeds priority to lactating cows followed by offering to bulls (25.4%) and heifers (0.5%). Respondents residing in the peri-urban (88.9%) area significantly gave more priority to the lactating cows compared to rural (65.8%) and urban (60.0%). The quantity of supplement feed offered per dairy animal per day in rural area was higher (P<0.001) as compared to the amount offered in urban and peri-urban areas. A mean of 3.8(0.21), 9.0(0.57) and 4.5(0.23) kg with overall mean of 6.9(38) kg supplement feeds were offered per animal dairy per day in peri-urban, rural and urban areas, respectively. This indicates, farmers were not offering the supplement feeds based on the requirement of the animals.

## Age for first mating

Overall, 44.6% of the respondents significantly (P<0.001) allowed heifers for first mating based on age as best criteria followed by based on age plus body weight of the heifer (40.4%) and only based on body weight of the heifer (2.3%), respectively (Table 6). Heifers were allowed for first mating at 38.6(0.83), 33.9(1.16) and 33.6(3.19) months with age overall mean of 35.3(0.84) months age in peri-urban, urban and rural areas, respectively. The age for first mating of heifer was no significant difference in across the study areas. By contrast, age at first calving of indigenous cattle in Agarfa district of Bale zone is 45.49 months (Serekeberhan, 2009). Alberro (1983) reported that the estimated of age at first calving for Ethiopian zebu cattle ranges from 35 to 53 months and for crossbreds it ranges from 29 to 42 months, however, under traditional production system, cattle are delayed age for first calving ranging from 33.4 to 62.5 months. Similarly, Eshete (2002) reported that the average age at first calving of 50.6 month of East African short horn zebu managed under farmer's management level in Ginchi western part of Ethiopia. Proper and better breeding helps in developing good dairy herd and getting good returns (Quddus, 2012).

## Milk production

Overall, respondents in the study area could be kept

**Table 6.** First mating criteria of heifers in the study areas.

| Mating criteria | Study area | | | | SL |
|---|---|---|---|---|---|
| | Peri-urban (N=63) | Rural (N=120) | Urban (N=30) | Overall (N=213) | |
| Age | 29(46.0)[a] | 65(54.2)[a] | 1 (3.3)[b] | 95 (44.6) | *** |
| Age + body weight | 32 (50.8) | 27 (22.5) | 27 (90.0) | 86 (40.4) | NS |
| Body weight | 1 (1.6) | 2 (1.7) | 2 (6.7) | 5 (2.3) | NS |

***, P≤0.001; NS, not significant; SL, significant level; Figures outside and inside parenthesis represent respondent number and percentage, respectively; Figures in the row having the same superscript are not significant.

**Table 7.** Age of a cow kept for milk production (years), milk yield per milking (litres) and milk yield/animal/lactation (litres).

| Description | Study area | | | | SL |
|---|---|---|---|---|---|
| | Peri-urban | Rural | Urban | Overall | |
| Average age of cows kept in the production system | 7.6(0.21)[b] | 8.9(0.23)[a] | 7.6(0.33)[b] | 8.3(0.16 ) | *** |
| Average milk yield/milking | 5.0(0.47) | 4.5(0.39) | 5.18(0.65) | 4.7(0.28) | NS |
| Average milk yield/lactation | 819.0(73.7) | 1021.9(123.9) | 898.8(143.7) | 920.9(65.93) | NS |

***P≤0.001; NS, not significant; SL, significant level; Figures outside and inside parenthesis represent means and standard error, respectively; Figures in the row having the same superscript are not significant.

cows for 8.3(0.16) years in the production system if they were productive (Table 7). In the rural area, cows were kept for more years (P<0.001) in the production system compared to they were kept in urban and peri-urban areas. The average milk yield per cow per day was no significant difference in the study areas. Respondents collected a mean of 4.7 L of milk per cow per day. On average 920.9 L of milk was collected per cow per lactation which was no significant difference in the study areas. By contrast, indigenous cows in Agarfa district of Bale zone give 1.72, 1.04 and 0.54 L of milk yield per daily at early, mid and late lactation stages, respectively (Serekeberhan, 2009). In Ginchi, western part of Ethiopia, the average milk yield per cow per day and per cow per lactation of east Africa short horn zebu cattle kept under farmer's management system give 1.76 and 473.1 L, respectively (Eshete, 2002) which are very much lower than the current findings. Similarly, in the western part of Ethiopia, mean daily milk yield of local cattle breeds being 1.79 and 1.78 L per cow per day at Bako and at Nekemte peri-urban areas, respectively, while, 6.54 and 9.79 L of milk yield per crossbred cow per day at Bako and Nekemte peri-urban areas, respectively (Geleti et al., 2014). These differences were due to breed difference, husbandry systems and the of exotic blood level of the dairy animals.

## Dairy products processing and marketing

In the current study, 95.3% of the respondents had taken training on dairy products processing. About 81.3, 65.4 and 50.8% of respondents residing in urban, rural and peri-urban, respectively owned either improved or local dairy products processing equipment with significant (P<0.05) differences in the study areas. Overall, 52.1% of the respondents mostly processed milk into cottage cheese, butter and cottage yoghurt at home level (Table 8). Respondents residing in urban area processed milk more (P<0.001) into cottage cheese, butter and cottage yoghurt as compared to peri-urban and rural areas. The reason might be, respondents residing in urban area aware better about dairy products processing and value adding effect of processed dairy products. Most of the milk (85%) produced by dairy farmers in Ethiopia is used for household family consumption (Land O'Lakes, 2010) most of the surplus milk produced in the rural area is processed into cottage cheese and butter.

In dairy products marketing, most (48.8%) of respondents made money by selling raw milk around their homestead followed by butter selling (26.3%) at local market. In agreement, there is no formal fluid milk value chains are found in peri-urban areas of western Ethiopia (Geleti et al., 2014). Dairy products market process can be affected by different factors including market outlets, their accessibility and frequency of operation, infrastructure (Andualem, 2004). There is poor trend of dairy and dairy products marketing in Agarfa district of Bale zone and they may be sold informally after household satisfaction (Serekeberhan, 2009).

This study identified that there were no milk collection and processing centres in any of the study areas. Approximately 98.4, 85.8 and 70.0% of the respondent in peri-urban, rural and urban areas, respectively wanted (P<0.001) to start dairy cooperative for milk collection and processing. Regarding to the type of cooperative, 85.1% of the respondents wanted dairy cooperative, 14.4% wanted dairy processing plant and only 0.6% of

**Table 8.** Type of dairy product processing at home level in the study areas.

| Dairy product | Study area | | | | SL |
|---|---|---|---|---|---|
| | Peri-urban (N=63) | Rural (N=120) | Urban (N=30) | Overall (N=213) | |
| Butter | 7 (11.1)[a] | 20 (16.7)[a] | 0 (0.0)[b] | 27 (12.7) | *** |
| Butter and cottage yogurt | 8 (12.7)[a] | 16 (13.3)[a] | 0 (0.0)[b] | 24(11.3) | *** |
| Cottage cheese | 0 (0.0)[b] | 5(4.2)[a] | 0 (0.0)[b] | 5 (2.3) | *** |
| Cottage cheese and butter | 1 (1.5)[b] | 18 (15.0)[a] | 1 (3.3)[b] | 20 (9.4) | *** |
| Cottage cheese, butter and cottage yogurt | 41(65.1)[b] | 43(35.8)[c] | 27(90.0)[a] | 111(52.1) | *** |
| Cottage cheese and cottage yogurt | 0 (0.0)[b] | 5 (4.2)[a] | 0 (0.0)[b] | 5 (2.3) | *** |
| Cottage cheese | 0 (0.0)[b] | 7 (5.8)[a] | 0 (0.0)[b] | 7 (3.3) | *** |

***, P≤0.001; SL, Significant level; Figures outside and inside parenthesis represent respondent number and percentage, respectively; Figures in the row having the same superscript are not significant.

respondents wanted to have both the dairy cooperative and dairy processing plant. In agreement, there is no formal milk collection and processing activities in peri-urban areas of western Ethiopia; milk processing refers to the act of traditionally processing milk into milk products at home (Geleti et al., 2014).

## CONCLUSION AND RECOMMENDATIONS

To expand and sustain the dairy framings, crossbred of Arsi or Boran cattle breed crossbreed with Holstein Friesian and Jersey were the most preferred dairy animals in the study area. Feed resources were inadequate from half of January to half of April. The dairy products production and marketing in the study areas mainly depend on feed resources and availability of dairy product consumers. Feed scarcity and limited access to formal market were the major constraints. There were no dairy cooperatives and dairy product processing plants established in the study areas. Most of the respondents need the establishment of diary cooperatives and dairy products processing plants. Therefore, to improve the husbandry practices of dairying, feed resources conservation, selective dairy cattle crossbreeding with better feeding, healthcare and housing management systems should be practiced. Moreover, implementation appropriate rangeland management systems and conservation of available nature pasture in the form of quality hay with establishing of dairy cooperatives and development of market linkage between dairy products producers and consumers are very essential.

## Conflict of Interests

The authors have not declared any conflict of interests.

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## Abbreviations

**BZFED**, Bale Zone Finance and Economy Development; **CSA**, Central Statistics Agency; **LSD**, least significant difference; **SDFED**, Sinana District Finance and Economy Development Office.

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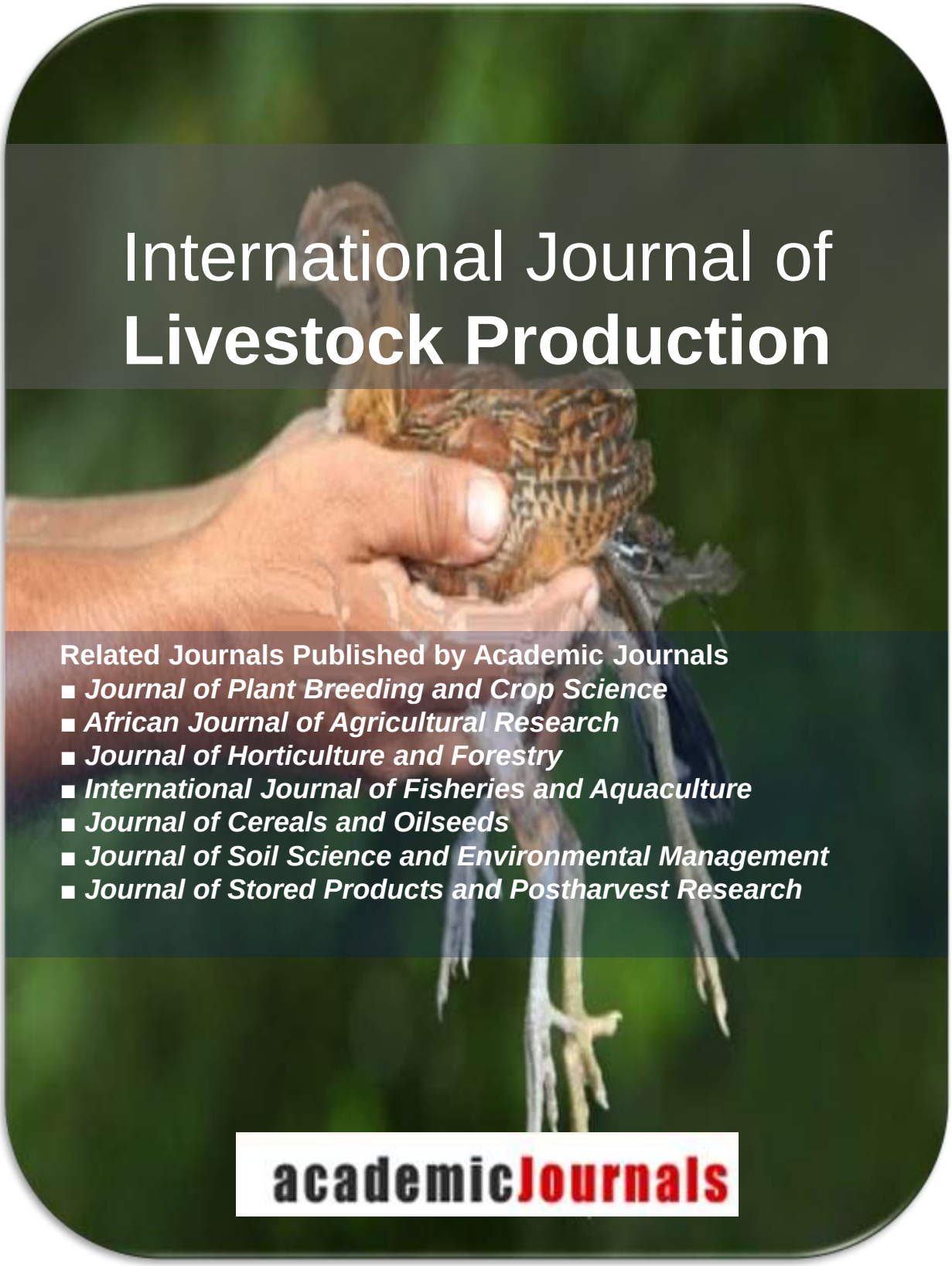

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