Wisdom at the source of the Blue Nile

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Wildlife Habitat Loss and Land Cover Change as Conservation Threat in Alatish National Park, Northwestern Ethiopia

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Abstract: *The ecosystem of the Alatish National Park is an Ecotone between the Afromontane Region in Ethiopia and the Sudan-Guinea Savanna Region of Tropical Biome. The biological attribute of the park where the country opt to manage the resource sustainably are thought to be unique. However, the sustainability of its biological resources has faced profound threats. The aim of this study was to identify the threats of habitat loss and evaluate their effect on land cover change in the park. The result showed that fire induced by humans was the major threat of habitat loss. The nomads who intruded into the park from the Sudan side were not easily controlled by the Park scouts. The land cover change analysis revealed that woodland habitat of the Park was altered significantly. The land cover of the Park in 1999 showed that deciduous type of woodland was 46.55%, but it was reduced to 19.8% in 2013. On the contrary, wooded grassland habitat was increased from 35.4% to 64.5% of the land cover in 1999 and 2013, respectively. This indicates that threats of habitat loss remain unsolved after the establishment of Park. Therefore, urgent interventions by the federal government and international conservation foundations should be mandated to support the management effectiveness of the park office. These would enable the park office to control major conservation threats through the Ethio-Sudan Transboundary National Park collaboration and implementation of management strategies.*

Keywords: Fire, lowland, nomad, park office, woodland habitat, wild honey collection

1. Introduction

Biogeographically Alatish is known by its woodland vegetation and diverse fauna composition (Heckel *et al*., 2007; Mengesha and Bekele, 2008; Habtamu and Bekele, 2008; ANPMP, 2009; Tewabe *et al*., 2009 and Kruskop *et al*., 2016). According to White (1983), the flora of the western Ethiopian escarpment including Alatish National Park is considered as undifferentiated woodlands of Ethiopian type and it is linked most closely to the flora of the Sudanian-West African region. The vegetation of the Park could also be considered as a transition zone between the Afromontane region in Ethiopia and the Sudanian region in the Sudan. As a result, the biological attributes of the park are thought to be unique. Demissew *et al*. (2005) also pointed out that the vegetation of western Ethiopia is higher in rank of local endemism compared to most Ethiopian regions.

Alatish has characteristic vegetation consists mainly of deciduous woodland with combretaceous trees, *Acacia* woodland and lowland bamboo (Demissew *et al*., 2005). Other vegetation types like wooded grassland, riverine forest and swamps also occurred. Thus, the Alatish area is classified into major ecosystem components or communities such as Riverine woodland, Seasonal Wetland/flood plains, mixed deciduous Woodland, Acacia, Bamboo and Wooded grassland ecosystems.

Alatish is a trans-boundary Park, adjacent to the Dinder National Park of the Sudan Republic that has huge potential to conserve rich wildlife resources. The Park harbors 20 large mammalian species, including threatened species like Elephant (*Loxodonata africana*), Leopard (*Panthera pardus*), and Lion (*Panthera leo*) (Mengesha and Bekele, 2008). It is also anticipated as a potential site to shelter critically endangered Tora hartebeest (*Alcelaphus buselaphus tora*) which has a historic biogeographic distribution range in Eastern Sudan, Northwestern Ethiopia and Northern Eritrea (Heckel

et al., 2007). In addition to the presence of large mammals, 23 rodent species, 6 species of insectivores (Habtamu and Bekele, 2008), 21 bat species (Kruskop *et al*., 2016), 204 bird species (ANPMP, 2009), 23 fish species (ANPMP, 2009; Tewabe *et al*., 2009), at least 15 reptile species and a few amphibians (Ashagrie, 2015) are reported and inhabiting in the park. Habtamu and Bekele (2008) noted that some endemic rodent species of the Ethiopian highland forest and three shrew species were found in Alatish.

Conservation of Alatish National Park is beyond local interest. Marye *et al*. (2008) and ANPMP (2009) described that Alatish serves as a migratory route for Elephants, which traverse from the Dinder National Park in Sudan. Another regional opportunity of the park is that Alatish is watershed to the Nile Basin in Sudan. From Alatish various rivers like Gelegu, Ayma and Alatish drain into Sudan and these are important tributaries of the Nile. The Park was also demarcated by considering its role in conserving a healthy ecosystem such as preventing environmental risk that will occur due to the expansion of desertification, which may possibly extend to northwestern part of Ethiopia via the neighboring state around the Sahara region (Anonymous, 2006). In combating climate change, Alatish has significant potential in carbon sequestration (Vreugdenhil *et al*., 2012). According to these authors, Alatish National Park has the largest carbon stock estimates (carbon sequestration potential), which is 20,132,576 tons of CO_2 within its vegetation source, among the national parks of Ethiopia.

Under category II protected area management criteria human habitation is not permit in a National Park (IUCN, 1994). In principle Alatish fulfill this criterion compared to the well known National Parks like Simen Mountains National Park, Awash National Park (Belay *et al*., 2012; Zerga, 2015), Abijata-Shalla National Park (Mulualem and Tesfahunegny, 2016) and Yangudi Rasa National Park (Wale *et al*., 2017). Alatish is free from local people settlement and agricultural activities inside the park. Despite this fact, previous studies reported that Alatish had been threatened by anthropogenic effect and its fauna biodiversity was declining (Heckel *et al*., 2007; Marye *et al*., 2008; Mengesha and Bekele, 2008; Menale, 2011; Ivlev *et al*., 2011). Thus, continuous monitoring on population status of wildlife, conservation threats and trends of land cover change are very important to quantify levels of habitat loss, evaluate management effectiveness and design conservation strategy that mitigate conservation challenges of the park. This study was aimed at identifying causes of habitat loss, quantifying land cover changes and providing insight for mitigating conservation threats of the park.

2. Materials and Methods

2.1. Description of the study area

This study was conducted in Alatish National Park (ANP), located in the Quara District of north Gonder Zone, northwestern Ethiopia. It is located between $11^0$47' – $12^0$32'N latitude, and $35^0$15'-$35^0$49'E longitude (Figure 1). Alatish is a flat plain lowland area with an elevation ranging from 528 to 654 meter above sea level with a few scattered mountain cliffs (Abraham *et.al.* 2008). It is far about 1123 km northwest of Addis Ababa and 324 km southwest of Gonder town. As the area had been delineated to be a priority forest conservation area since 1941 during Emperor Haile Selassie's I regime, it was gazetted as a park in 2006. The park has a total area of 2600 km^2. It shares boundaries with Sudan (Dinder National Park) to the West, Benshangul Gumuz National Regional State of Ethiopia the South, and 7 peasant associations of Quara Woreda to the East (Anonymous, 2006).

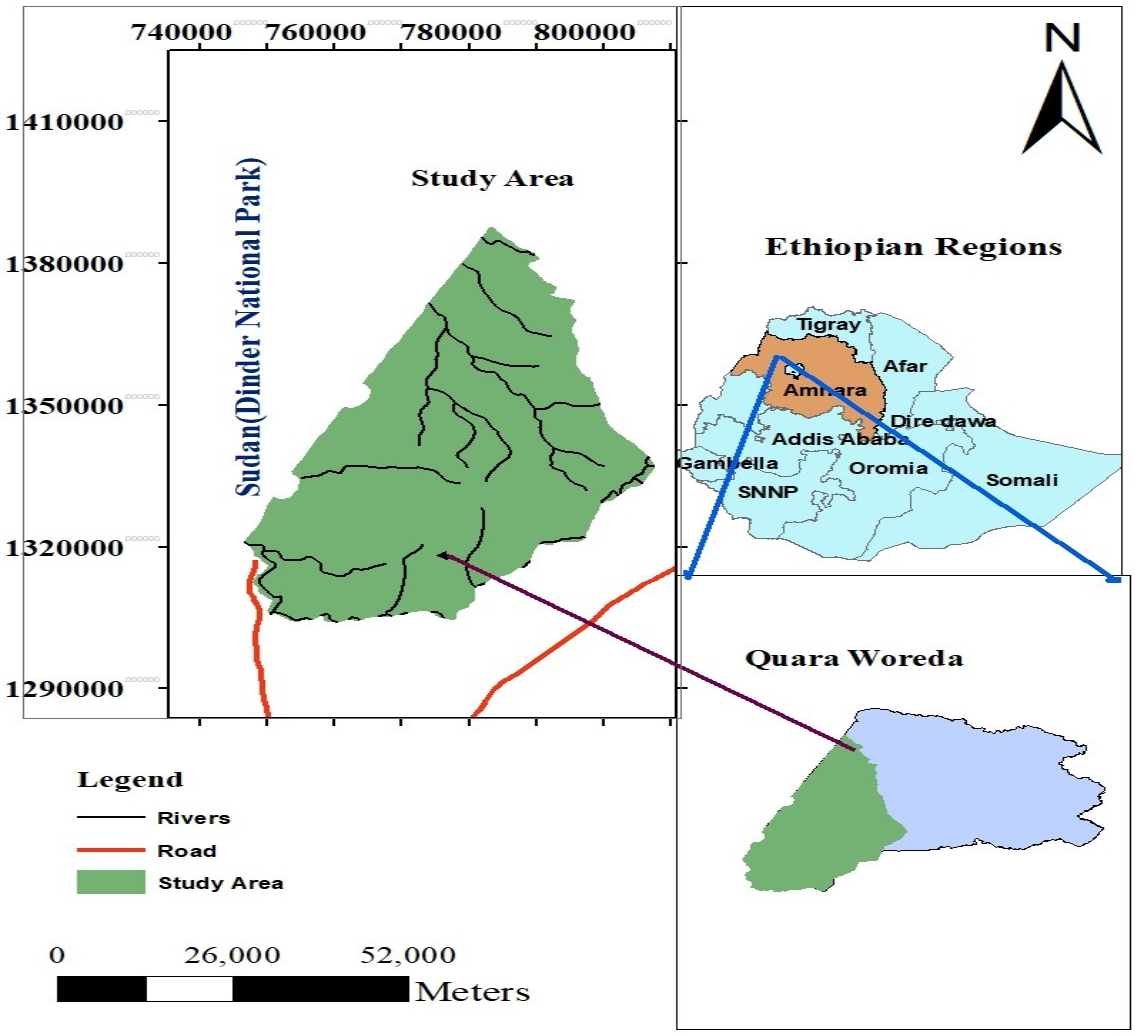

Figure 1. Location map of study area

2.2. Data collection and analysis

2.2.1. *Data collection*

Rapid assessments were conducted in November 2011, May 2012, December 2012 and March 2013 to identify causes of habitat loss. Slow moving vehicle survey was conducted along trials connecting five purposely selected sites of the park. Sites were purposely selected based on their accessibility to vehicle survey and being safe in security issue. Particularly, the survey was carried out from Bermil to Jabra, from Bermil to Amjale and from Amjale to Alga sites, from Bermil to Grara-Mehadid-Drasen sites. All data related to habitat degradation and threats were collected. Pictures and direct observation was used. Informal interview method was applied to the Park scouts and officers to collection data about inaccessible sites.

Ground truth of vegetation cover was sampled in the field to verify image classification. Ground truth information was collected during field survey using GPS on 88 Ground Control Points (GCP) on the study area. These Ground Control Points were collected using stratified sampling technique from each habitat types: Riverine woodland (10 GCP), *Combretum-Terminalia* Woodland (20 GCP), *Acacia* woodland (20 GCP), Wooded grassland (20 GCP), Bamboo woodland (8 GCP) and water body/flood plain (10 GCP). When taking sample GCP, the current land-cover classes and their corresponding GPS points were recorded in the field.

2.2.2. *Data analysis*

To quantify impacts of threats on habitat loss, land cover changes on the different habitat types was estimated using satellite imagery. Thirty meter resolution landsat images accessed from United States Geological Survey (USGS) was applied. Enhanced Thematic Mapper (ETM+) Landsat-7 and Landsat-8 satellite images of November 1999 and November 2013 on path 171 and row 51 and 52 were used. The Ethiopian Mapping Agency (EMA) topo-map with 1:250,000 scale locating on the study area was used for geo-referencing the satellite images. The satellite images were radiometrically and geometrically processed using ERDAS Imagine 10.0 (Ortho-rectification with WGS 1984 UTM Zone 36 N).

Land-cover classification was made by supervised classification method. The GPS points were overlaid on the imagery and used for refinement of the land cover map interpretation. For Land Cover mapping, visual interpretation technique was employed. Based on the ground truth samples, training samples and signature generation (interpretation keys) were developed. In the process of classification, training area was taken on each of the land-cover class, based on the reflectance signature of different features on the false color composite 4-3-2 (FCC) band combinations. Image classification was done using Maximum likelihood classifier technique, and a 3 x 3 pixel moving windows majority filter was employed to smoothen the classification. Accuracy test for the prepared land-cover classification was computed by taking the field collected ground control points from the six land-cover classes through ENVI 4.7. Change detection statistics matrix of land-cover and rate of change were also computed by ENVI 4.7. The rate of land-cover pattern change during the period 1999–2013 was estimated as the difference in the respective land-cover type in hectare divided by duration of years. The prepared supervised land-cover images were exported to ArcGIS 10.0, and LC maps were prepared for the years 1999 and 2013.

3. Results and Discussion

3.1. Threat of habitat loss

It was observed that fire was the conservation threats of the Park. Fire burning severely degraded habitat quality by removing tree coverage of the park to the extent that burnt trees cannot be regenerated. Fire also affected the pattern of seasonal ground cover change. The non-woody vegetation cover of woodland and wooded grassland ecosystem was removed by fire and the clay and sandy soil remain bare in the long dry season (Plate 1). This implies that the conservation threat of the park reported at the early stage of the park establishment (Heckle *et al*., 2007; Habtamu and Bekele, 2008) is still the threat of habitat loss.

Plate 1. Intense fire burn that removed trees and herbaceous land covers (Photo taken by author)

All (thirty) of the interviewees confirmed that fire burn was induced by cattle-raising nomads. During early dry season survey, November to December, fire was most frequently observed along the Ethio-Sudan border and some parts of the Park. However, in the peak dry season March to May fire burn was not observed. In their patrol, the Scouts who were assisting the field surveys around Alga and Jabra sites attested the observed fire burning were due to Fellata pastoralist nomads who are coming across the neighboring country of Sudan. According to informants the cattle-raising nomads encroach seasonal wetlands and river banks during dry season.

The survey conducted in this study after eight years of the park establishment found that the park has still been severely affected by fire. At the early stage of the park establishment fire was reported as the major conservation threat in the park (Heckle *et al*., 2007; Habtamu and Bekele, 2008). The park office manages conservation threats imposed by humans through legal enforcement and community participation. However, the conservation threat linked with fire and cross country intruder nomads was reported after some years' conservation efforts of the park (Minale, 2011). The impact of Fellata pastoralist nomads' in the Park is still a problem.

Commonly in livestock herding, fire has been used as a tool to control ectoparasite load, reptiles and predators attack; and to clear dried tall grass for subsequent improving forage quality (Myers *et al*., 2004). The fresh offshoots that regenerate around seasonal wetlands and riverine habitats after burning during the dry season and in the beginning of the rainy season would provide palatable fodder for herbivores. These strategies seem to be used by the neighboring Sudan nomads who intrude into the park. Since most of the fire incidents were observed in the Sudan border of Alatish Park and the Park Scouts usually caught the Sudanese nomads inside Alatish. Although controlled fire has positive effects in managed areas (Taledo *et al*., 2014), uncontrolled fire that spread fast due to the presence of large dry fuel load resulted in deforestation of the Park.

Fire has been also recorded as threats in most western lowland vegetations of Ethiopia (Jensen and Friis 2001; Gashaw *et al*., 2002a, b; IBC, 2005; Demissew *et al*., 2005). Even in the conservation area, Alatish National Park, controlling the activities of Sudanese nomads in the Park and fires induced by them has not been effective for setting long lasting solution of the conservation area. Since the nomads are armed, the

scouts face challenges when they were trying to educate them and protecting the Park. According to the park staffs, the fail immplementation of legeal enforcement and application of transboundary park/boarder agreement contributes for the impact of fellata/ nomads on the Park.

In the field survey it was observed that conservation threats imposed by local people were managed by the park office through legal enforcement and community participation. According to the community mobilization expert, elders of local people are park committee members. They contribute for conservation of the Park through conservation education and mediating conflict of local people interest with park conservation. None of the interviewees reported impacts of local people in causing fire burn. Nevertheless, signs of wild honey collection and fire induced in to the Park were observed during the field surveys (Plate 2).

Plate 2. Destructive activities of honey collectors. Honey collection practice inside the tree holes by cutting down trees (left); fire induced in the park to collect honey in tree holes (right). (Photo by Author)

3.2. Land cover change

The comparative land cover maps (Figure 2) show change on land cover between 1999 and 2013. As observed on the map, coverage of deciduous woodland was reduced from 1999 to 2013. Complementary to this land cover shrinkage, the coverage of wooded grassland and Acacia woodland was increased from 1999 to 2013.

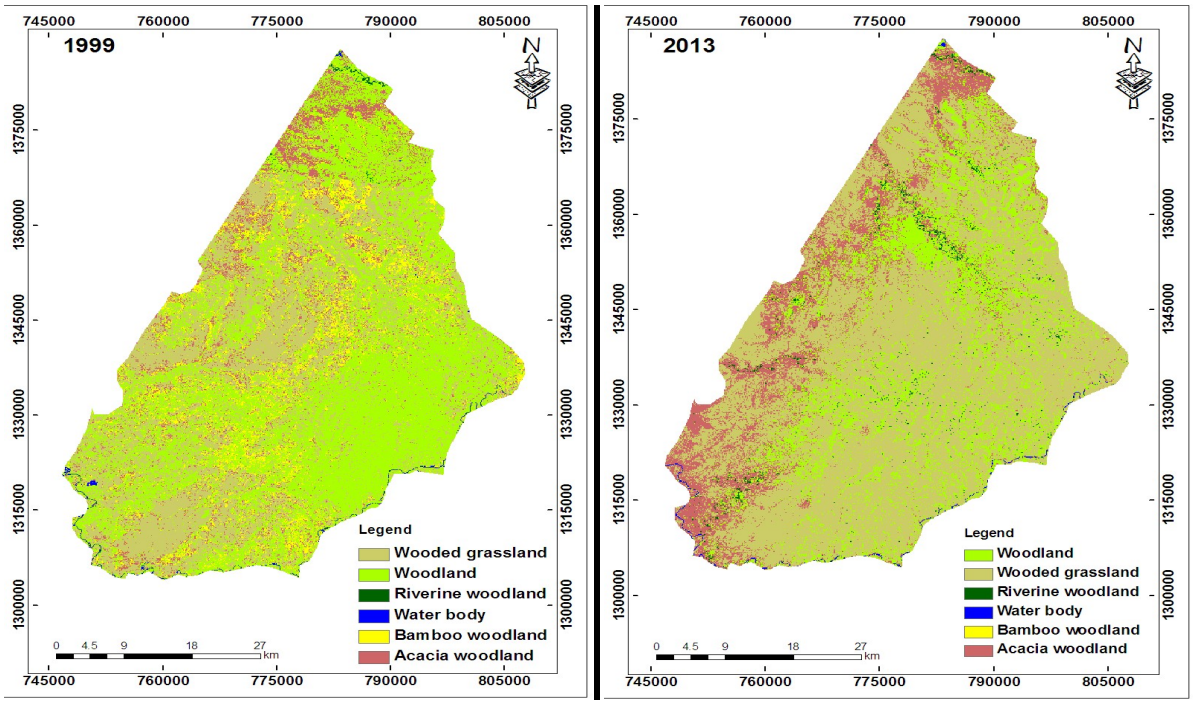

Figure 2. Land cover maps of 1999 (left) and 2013 (right). Source: own survey 2013

The land cover changes matrix between 1999 and 2013 indicated declining trend in coverage of woodland vegetation (Table 1). Mainly the deciduous woodland was changed into wooded grassland and Acacia woodland. Bamboo woodland cover was also largely converted into wooded grassland.

Table 1. Land cover and change matrix between time periods of 1999 to 2013 of Alatish National Park.

		1999 Land Cover (ha)						
		AW	WB/FP	RW	WGL	BW	DW	Class total
2013 Land Cover (ha)	AW	4291.8	111.1	132	12832.9	3497.8	**18551.8**	**39417.5**
	WB/FP	10.6	210.7	357.4	6.52	0.9	94.9	681.0
	RW	24.8	5.7	124.5	1211.3	46.64	1436	2848.9
	WGL	16011	141.8	9.5	71769.6	**18215.0**	**70423.1**	**176570.4**
	BW	2.48	0.3	0.1	12.87	3.8	13.7	33.1
	DW	1967.1	164.2	191.8	11077.5	3879.3	36920.5	54200.4
	Class total	22308	633.8	815.2	96910.7	25643.5	127440.0	
	Class change	18016.3	423.1	690.7	25141.1	25639.7	90519.5	
	Image difference	**17109.4**	47.2	2033.8	**79659.7**	**-25610.4**	**-73239.6**	

Note: AW- Acacia Woodland, WB/FP- Water Body/Flood Plain, RW- Riverine Woodland, WGL- Wooded Grassland, BW- Bamboo Woodland, DW-Deciduous Woodland

Deciduous woodland was the highest land cover (46.55%) in 1999, but this land cover was only 19.8% cover in 2013 (Table 2). The change analysis depicted that the woodland cover was reduced by 26.7% with rate of 5231.4 ha per year. Bamboo woodland is another land cover that reduced through

time. Bamboo woodland which was 9.34% in coverage in 1999 was extremely shrunk below 1% in 2013. However, wooded grassland which was the second highest land cover (35.4%) in 1999 was highly increased with a rate of 5689.98 ha annually. In 2013 wooded grassland covered 64.5% of the total land cover. *Acacia* woodland also showed increasing change of trend with rate of 1222.1 ha per year; from 1999 to 2013 *Acacia* woodland increased by 6.25%. Riverine woodland and seasonal flood plain/wetlands are generally small in their coverage and did not show noticeable changes. Even though, riverine woodland cover is small in total proportion, it seems to be increasing in coverage from 1999 to 2013.

Table 2. Proportion of land covers of Alatish National Park during 1999 to 2013 and annual rate of change

Land cover class	1999		2013		Rate of change (ha/year)
	Area (ha)	%	Area (ha)	%	
Acacia woodland	22308.08	8.15	39417.45	14.40	1222.10
Water body/ Flood plain	633.83	0.23	681.01	0.25	3.37
Riverine woodland	815.19	0.30	2848.97	1.04	145.27
Wooded grassland	96910.70	35.40	176570.40	64.50	5689.98
Bamboo woodland	25643.49	9.37	33.07	0.01	-1829.32
Deciduous woodland	127440	46.55	54200.40	19.80	-5231.40
Total	273751.30	100.00	273751.30	100	

The overall patterns of land cover changes in Alatish might be related to variation in fire intensity among land covers, fire resistance nature of plant types and effect of fire on plant regeneration capacity. Gashaw *et al*. (2002a, b) reported that removal of vegetation and seeds are manifested due to the adverse effects of fire in western Ethiopia. Similarly, changes in land cover of this study are observed due to fire effect.

In deciduous woodlands, woody plants are not much dense, rather understory herbaceous plants and grasses as well as grass ground coverage range 30%-60% (White, 1983). According to Gashaw *et al*. (2002a) fire is relatively more intense in sites where grass biomass is huge. Thus, large herbaceous and grass fuel load density in deciduous woodland and wooded grassland might allow intense fire burning to occur annually and remove or minimize tree coverage. Such condition can cause reduction of woodland and increment in wooded grassland coverage in the park. On the other hand, reduction in woodland and increment of wooded grassland coverage might be explained by fire resistance capacity of trees. As Gashaw *et al*. (2002a) suggested trees with thick barks and wide breast height tree diameter might resist fire better than small trees and trees with thin bark. According to these authors moisture content and flammability of tree barks also determine fire resistance ability of tree species. Trees with dry, string, fibrous and rough bark are prone to fire. Most trees in the woodland coverage of Alatish are small to moderate in size with rough and string barks such as *Terminalia sp*., *Combretum sp*., Pterocarpus and Lannea (ANPMP, 2009). When fire burn appears, these woodland plant species burn immediately (Gashaw *et al*., 2002a). However, *Acacia seyal* with smooth barks, and *Balanitus aegypthicus* with thick bark and large stem diameter may protect their cambium from fire. Expansion of *Acacia* woodland might be also related to this fire resistance and regeneration capacity of *Acacia* trees. In addition to fire resistance of trees, Gashaw *et al*. (2002b) noted that significant proportion of large seeds of woody species such as *Combretum* sp. and *Entada africana* probably do not enter the soil but stay in the litter and are exposed to fire. Alternatively, reduction in woody plant coverage may result from the effect of fire that precedes seed dispersal and cause low surface soil seed pool of

some broadleaved herbs and woody species (Gashaw *et al*., 2002b).

Unlike other ecosystems, the fire regime did not affect riverine woodland. This finding agrees with broadly defined Sudanian vegetation zone where fire seems to affect nearly all vegetation types, except closed forest (Jensen and Friis, 2001). Such fire effect was observed in western Ethiopia, from the border region with western Eritrea in the North to the Boma Plateau south west of the town of Maji in the South (Jensen and Friis 2001). Unaffected vegetation cover of the riverine woodland in Alatish might be related to fire resistance potentials of trees due to their thick stem or large diameter and moist bark. Most riverine woodland is dominated by large sized trees like *Ficus sycomorus, Hyphaene thebaica, Acacia sieberiana, Stereospermum kunthianum, Tamarindus indica* and others. In addition, within this woodland, understory grass and herb ground cover is moist, weak and discontinuous. This poor grass and herb layer do not allow frequent and intense fire burn. The main ground layer grasses cover of includes *Bekeropsis uniseta, Eragrostis tremula* and *Sorghum sudanenis.* These grasses have capacity to regenerate immediately after fire burn due to residual moisture content of the soil. Thus, riverine woodland and wetland ecosystems used as feed source for wild animals and cattle in the long dry season when green vegetation of other land covers were rarely found.

4. Conclusion

The habitats of Alatish like other western lowlands of Ethiopia are highly seasonal. The fire induced by illegal nomads and honey collectors mainly caused habitat loss and degradation beyond the seasonal ecological stress. This human disturbance intensifies the aridity of the habitat during dry season. Thus, extreme seasonality of the environment and human induced fire are the major conservation challenges for wildlife conservation in Alatish National Park.

The overall vegetation covers show changes in the reduction of woody vegetation and expansion of open habitat or wooded grassland. Most of the conservation threats in the Park that altered natural habitats were caused by nomad intruders along Ethio-Sudan border. As a result the habitats of wild animals and the animals themselves dwelling in the Park are being threatened. There is a great chance for the local extinction of elephant due to habitat degradation. As a result endangered wildlife species like elephants are being forced to migrate other areas like Dinder National Park in Sudan. Therefore, urgent interventions are needed to manage fire incidences in the park as well to safeguard the wildlife and their habitats. The Federal Government should give due attention for the implementation of the National Park Management in collaboration with local peoples, national stake holders and NGO's as well. Further and detail studies on the fauna and flora of the National Park should be given priority to evaluate the impacts of fire and habitat loss on the population status and diversity of wild animals.

Conflict of interest

The authors declare that there is no conflict of interest in publication of the manuscript on this journal.

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The Role of Saving and Internal Lending Communities in Building Resilience to Shocks for Households: The Case of Meta *Woreda* in East Hararge Zone of Oromia Regional State

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Abstract: *This research was conducted in Meta Woreda, East Hararge Zone of Oromia region to examine the role of Savings and Internal Lending Communities' (SILC) program in building the resilience of communities to shocks. Data were collected through quantitative and qualitative research approaches. Probability Proportional to size and simple random sampling used. The data were analyzed using central tendency, Chi-square, cross tabulation, Independent sample T- test, and partial correlation. The results showed that majority of households had been negatively affected by one or more shocks. Although, different shocks were identified, majority (98%) of respondents agreed that they are highly affected by drought and the impacts identified were loss of asset, malnutrition and displacement. Respondents confirmed that saving, loan and social fund are the three basic services of SILC that helped them to protect impacts of shocks. Independent sample T- test revealed that the difference on the amount of money saved and borrowed between members and non-members was significant at 5% significant level due to lack of awareness (training) and accessibility to saving facilities. The SILC membership increased social capital, improved technical knowledge, created discussion forums, and asset. The survey result depicted that even though SILC is important in building resilience, prevalence of shocks, illiteracy, smaller loan size, and shorter loan periods are bottlenecks which hinder better resilience building. To better improve the resilience of the communities' government as well as non-government organizations need to give attention to SILC by improving the performance of SILC which ultimately improve the livelihood of the community.*

Keywords: Building resilience, Savings and Internal Lending Communities, saving & credit

1. Introduction

Poor rural households are highly exposed to shocks since their livelihoods depend on an increasingly deteriorated natural resource base and on often volatile climatic and market conditions. They are also particularly vulnerable to shocks because they have few assets to fall back on and limited risk management strategies. When shocks occur, people employ a range of coping strategies, which often involve incurring debt or selling assets, leaving individuals and households more vulnerable to future shocks (IFAD, 2015).

Microfinance institutions provide valuable services to the poor in the developing world, however, microfinance is mostly successful in economically dynamic urban or pre-urban areas, where borrowing requirements are high, borrower income streams are regular and diverse, and the cost of reaching clients is low (Hugh and Mark, 2007). In response to these realities, many development agencies have sought to develop community-based financial organizations that could cost-effectively provide financial services to a clientele at the "low demand" end of the spectrum. In recent years, several models of savings-led community finance have emerged that seem to offer better prospects for long term sustainability than the credit-led revolving fund model (World Bank, 2007).

Saving and internal lending communities (SILC) is one which is developed by Catholic Relief Service (CRS). It is a holistic programming approach that offers households a strategy to protect assets, smooth cash flow, and increase income. In comparison to traditional microfinance institutions that face limitations in servingthe financial needs of vulnerable groups such as women, poor farmers, orphans and youth, SILC is able to provide flexible financial solutions to these marginalized groups in a sustainable manner (Vanmeenen, 2010). Understanding the contribution of these types of

microfinance is essential to build their resilience to adverse shocks. The information is also useful to design policy and intervention strategies regarding local level resilience development. Studies on the contribution of microfinance to the reduction of vulnerability and enhancement of resilience are common in other developing countries. Despite recent implementation of SILC model in Ethiopia, adequate studies related to its role or contribution to building resilience of households' are limited. With this background, this research was designed with an overall objective of investigating the role of SILC Microfinance in building resilience of households to shocks.

2. Materials and Methods

2.1. Description of the study area

Meta *Woreda* where the research was conducted is located in East Hararge zone, Oromia Regional State. Meta *Woreda* lies between 9^0 07' and 9^0 32' N latitude and 41^0 29' and 41^0 44' E longitude to the west of Harar town. The *Woreda* is bordered by Goro Gutu & Deder *Woredas* to the West, Kersa *Woreda* to the East, Bedeno & Melkabelo *Woredas* to the South and Somali Regional State to the North, and Dire Dewa Administrative council to the North East.

Figure 1. Location of Meta Woreda Research Site

Source: GIS Shape file, 2016

2.2. Data collection and analysis methods

Primary and secondary data sources were used to undertake this research. Secondary data were collected from reports and working papers. Both published and unpublished documents on microfinance specifically SILC were used. Besides, internet was used as sources of information for secondary data collection. Primary data were collected from randomly selected households of three *Kebeles* through face to face interview and FGD /focus group discussion.

Semi-structured and structured questionnaires were prepared to gather information from the household respondents on major shocks that have affected households, the triggering factors and, socioeconomic impact of shocks, and contribution of SILC to build the resilience of the poor. Five enumerators were used to undertake the survey dataafter ahalf day training was provided to the enumerators on questionnaires. The household survey used structured questionnaires to get perception of the respondents how the SILC have contributed towards resilience building in their households. Both men and women were interviewed. The majority 86 (64%) of the respondents from the total 135 were found to be female while 49 (36%) were male.

2.3. Data analysis

Both descriptive and inferential statistics were used to analyze the data. The data analysis used statistical procedures for social sciences (SPSS 20). Descriptive statistics like, percentages and central tendency measurements were employed to analyze the data. Inferential statistics: partial correlation techniques used to analyze the relationship between SILC membership and Income Generating Activities (IGA) involvement. Chi square test, and cross tabulation are used to analyze linkage between SILC membership withsaving and sex. In addition to this independent t- test were employed to assess the significance of amount of saving and borrowing between members and non-members. Data, collected through FGD and other semi structure interview techniques were simply narrated.

3. Results and Discussion

Shocks are negatively affecting households and have different magnitude of impacts based on the capacity of the household to cope with its impact.

Dercon (2002) divided shocks into two types: common (Covariate) and idiosyncratic. Idiosyncratic risks such as illness or theft affect only a particular individual or household. By contrast, common risks are "aggregate, economy-wide, covariate risks that affect all members of a community or region." This study identified the different types of shocks that are common in the study area. As you see below in the Figure 2 from the total responses 130 (44%) reported that they are highly affected by the drought. In other words, drought shock accounted for 98% compared with each of the listed types of shocks, which the focus group discussants also revealed that triggered famine for continuous years. Likewise, Mulugeta (2009) has confirmed that from the different types of covariate shocks, drought has over many centuries' triggered famines that caused human losses of catastrophic proportions in Ethiopia.

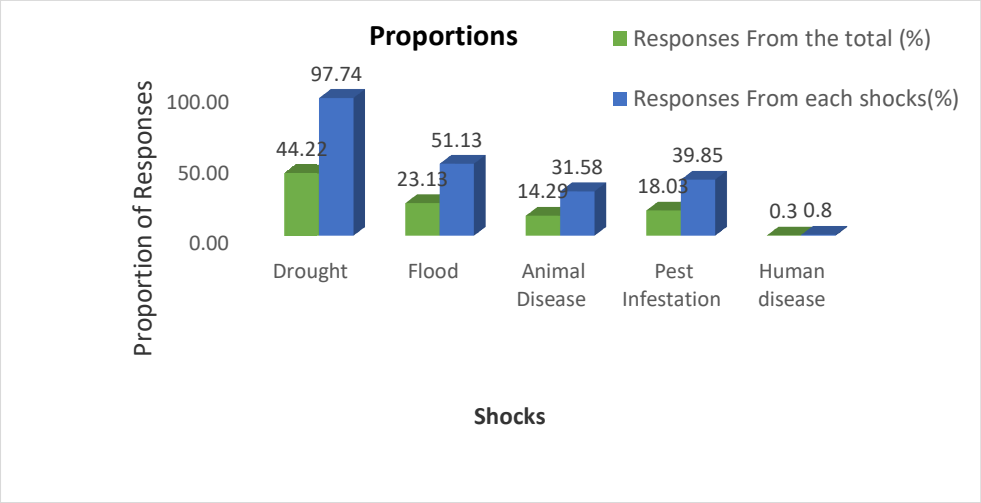

Figure 2. Responses on types of Shocks

The researcher tried to differentiate how severe each of the above identified shocks. Accordingly, 90% of the respondents depicts that drought is the most serious shock as compared to the others and followed by flood (4%). The three most important impacts that respondents identified were loss of asset, malnutrition and displacement. As seen below in the Figure 3 about 134 (40%) of the respondents reported that from the listed impacts of shocks loss of assets is primary. In other words, 99% of the interviewed households replied that loss of assets is the common impact of shocks. The main income sources of majority of households as we see from Table 6 are from sale of agricultural products (livestock and crop products) that are primarily affected by the most prevalent hazard, drought. The impacts of shocks mainly drought is, therefore, loss of assets.

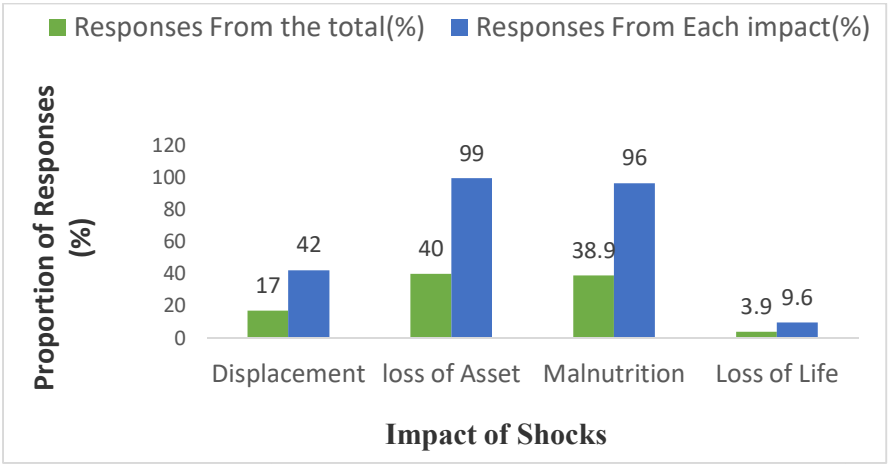

Figure 3. Responses on impact of Shocks

Even though Shocks are causing different impacts on the communities they are exerting different copping mechanism. The investigation of rural livelihood strategies through the sustainable livelihoods lens can provide an important means of learning more about how to strengthen household resilience to cope with shocks (FAO, 2004). The result of analysis showed that the most common coping strategies were sale of productive assets (shoats, livestock, etc.) followed by emergency food aid and daily labor. About 19 % of households responded that sale of productive assets around their house are the prior coping mechanism and 17 % of them reported that emergency food aid and sale of daily labor are coping mechanisms practiced by both members and non-members. Likewise, 12 % respondents witnessed that SILC created easy access to get their saved money in time of crisis. Focus group discussants who are SILC group members assured that they are highly benefited being SILC member in time of crisis as they are accessed their saving and social fund money easily as copping strategy. They said that, "before joining SILC they are using sale of productive asset as a copping but now we use our saved money". As we see from Table 1 SILC group members are better copping capacities than non-members. About 22% respondents in the SILC group witnessed that they use their loan fund as coping mechanism, which helps them to reduce sale of production assets. In other words, 21 % of the non-member respondents are forced to sale their productive assets during the time of crisis as a copping as they have no saved money or easy access of loan.

Table 1. Coping Mechanisms employed between members and non-members

Membership	Sale of productive assets		Loan from MFI		Loan from Neighbor's		Loan from SILC		Food aid from relatives		Emergency food aid		Daily laborer		Migration	
	Yes	No	yes	No	yes	No	yes	No	Yes	No	yes	No	yes	No	Yes	No
Member	53	60	20	27	38	45	70	0	20	48	44	56	56	45	8	20
Non Member	17	5	49	38	32	20	0	65	50	17	26	9	13	20	62	45
Pearson Chi-Square	6.803		3.253		3.179		135.000		9.525		9.525		3.502		7.669	
Df	1		2		1		1		1		1		2		1	
p value	0.262		0.197		0.075		0.0		0.002		0.002		0.174		0.006	

As we see from the Table 2 the degree of freedom is used to analyses the relationship between column and row variables. Significance difference is observed between members and non-members that members use their loan from SILC as a copping as compared to non-members who employ migration, emergency food aid and loan from neighbor. In contrast there is no significance difference between members and non-members in putting aside the sale of productive assets as a copping.

SILC had three mostly used basic services like saving, loan and social fund which abetted communities to recover from the adverse impacts of shocks quickly. Respondents and focus group discussants agreed that access to flexible savings and loans adapted to community needs filled an important service gap in these communities and SILC were different from other local financial institutions in terms of lower interest rates, the sense of ownership of the SILC funds, and the fact that SILC groups encouraged community solidarity and collective action. Likewise, some researches also confirm that access to finance, including both savings and credit, was an important coping strategy for households during the 2007/08 global food price crisis (Compton *et al*., 2010). The result of analysis showed that respondents used various places and systems to save their money to improve their livelihood; purchase food and clothes; pay for school; get prepared for harder times; use as a means to increase their crops and animal production; and pay for special events. Several respondents said that saving money was a way in which they could protect their everyday life. SILC group members overwhelmingly thought that savings was the most attractive component of the SILC groups. They reported that SILC offered them a secure location to save and valuable training on how to manage their finances. Many reported that this was their first experience saving money for their household (Parker *et al.,* 2015). Majority

of households (91%) disclosed that they had saved money in the previous year. Although both save money, members were better in understanding about saving as they have got full package of training on the advantage of saving and they are accessible to facilities as compared to non-members. To give stress on the advantage of SILC one member of the focus group discussant said that "*Little by little saving fills house and little by little wastage empties house".* Rutherford (1999) *discussed that "poor peoplecan save and wantto save, and when they do not save it is because of lack of opportunity rather than lack of capacity".*

As non-members are not get into the benefit of saving and did not take appropriate training from the total respondents, majority (57%) of non-members didn't save money, while all (100%) SILC members save money. The majority of the respondents (100 % of SILC members as compared to 43% of non-members save money, which is still statistically significant as assured by the Chi square test (x^2=27.56, df=1, p<.000).

Cross tabulation was used to see if membership played a role in saving or not. Table 2 clearly showed that members saved more than non-members. This was also tested if the difference between members and non-members in saving was significant or not. The significance value in Table 2 is less than 0.05. So we can conclude that there is significant difference between SILC members and non-members in saving that number of members who saved are more than the non-members.

Table 2. SILC Membership and saving using cross tabulation

	Membership			Pearson Chi-Square		
	Member	Non member	Total	Value	df	Asymp. Sig. (2-sided)
Access to Saving	100.0%	81.5%	91.1%	14.184	1	.000
No Access to Saving	0.0%	18.5%	8.9%			
Total	100.0%	100.0%	100.0%			

The difference between members and non-members is not only limited to the number of households who have saved money but there is also difference on the amount of money saved. The independent sample T- test revealed that the difference on the amount of money saved between members and non-members was significant at 5% confidence level (Table 3). The main reason for such significant difference may be that SILC members are trained on saving, financial education and IGA and have create easy access of loan from their own bank which non-members do not accessed.

Table 3. Independent Samples T-Test of amount of birr saved

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Amount of birr saved	23.839	.000	3.157	121	.002	505.678

The poor have no access to financial services specially loan as they have no or any collateral to take loan. Though, there are different options for loan, SILC creates doorstep, easy loan services and the interest incurred from the loan is profit for members who helped the group capital to grow. Out of the total 135 respondents 77% took loan from different places and the rest 23% did not taken any loan. Cross tabulation was used to see if membership played a role in access to loan or not. SILC members create their "*own bank*" to ease their access of loan. Due to this easy accessibility of loan fund SILC member's average amount of loan was two folds of the non-members that is 1734 birr for members and 1043 for non-member. This was also tested if the difference between members and non-members in loan access was significant or not. The significance value in Table 4 is less than 0.05. So we can conclude that there is significant difference between SILC members and non-members in access to loan that number of members who received loan is more than the non-members.

Table 4. SILC membership and Loan cross tabulation

	Membership			Pearson Chi-Square		
	Member	Non Members	Total	Value	df	Asymp. Sig. (2-sided)

Access to Loan	62	42	104	10.934[a]	1	0.001
No Access to Loan	8	23	31			
Total	70	65	135			

Independent Sample T- Test was run to see whether there is a significance difference between members and non-members in accessing loan. Test assured that significant difference at 5 % confidence level with value less than 0.05 was observed on the amount of money borrowed by members and non-members as seen below in Table 5

Table 5. Independent Sample T-Test of amount of birr borrowed

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Amount borrowed	32.61	.000	2.45	102	.02	690.86

Social funds are separate funds contributed only in the SILC group. Social funds are provided for members as interest free loans and grants who faced emergency problem based on the group bylaw. The majority 5 (83%) of the focus group discussants of the SILC members disclosed that social fund has two main benefits —first that the social funds is loaned with-out an interest, and second that it provides easily and immediately accessible money in times of emergency. These two are the most prevalent benefits because this is the area where the social fund probably helps the most. Before having access to the social fund, respondents had very little resources to obtain money in emergencies which non-members lack.

According to Béné et *al.* (2015) resilience interventions are about improving (or at least maintaining) the wellbeing of people in the context of shocks and/or stressors. Thus, analysis of programming designed to strengthen resilience cannot be done without assessing the shocks and stressors (both covariate and idiosyncratic) that affect people's lives. Accordingly, as explained in the above Figure 1 and 2 the researcher analyzed the common shocks experienced, its impacts and coping mechanisms utilized in the research site in detain in Table 1.

In general, SILC brought remarkable benefits for communities. As discussed above and many researches confirmed that the social benefit of SILC over other financial institutions is crucial part that builds social resilience of the communities while the savings and loans create economic resilience. Gash and Odell (2013) also confirm that in their assessment, access to funds in cases of emergencies, the ability to save substantial lump sums, and the availability of credit when it is needed (especially if it is an additional source of funding compared to previous sources) all contribute to resilience at the individual and household levels.

As explained in detail under the literature review part, communities' ability to deal with shocks and stresses is derived from interlinked absorptive, adaptive and transformative capacities. This research also revealed that SILC builds the absorptive and adaptive capacities and slightly the transformative capacity. See below the detail description of the findings.

Absorptive capacity: refers to the ability of social systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters. As explained in the above section 83 % of the focus group discussants in SILC group assured that they easily accessed the social fund interest free to solve their gap related to health care, school fees and expenses associated with emergencies. SILC groups, furthermore, are based on bonds of trust and reciprocity, deepening the bonding social capital of these communities, which is related to the absorptive capacity of resilience.

Adaptive capacity: Adaptive capacities of households and communities are strengthened by improving their ability to make pro-active and informed decisions about alternative livelihood strategies based on an understanding of changing conditions (Levine *et al.*, 2011). As explained Table 1 coping mechanisms used in the above section and explained below Table 6 on its advantages and saving and loan management; SILC has demonstrated benefits over non-members on

better copping, income diversification, asset creation and protection while members are forced to sale their productive assets in time of crisis. This easily access of saving and loan and skill gained helped SILC group members to involve in different income generation which help to diversify their livelihoods and adaptive capacity to shocks. As discussed in the below sections SILC improves, IGA engagement, asset protection and asset creation of members than non-members which helped them to adapt the adverse impacts of shocks quickly.

Transformative capacity: Long-term and sustainable resilience building is not possible without building transformative capacity, which addresses the underlying drivers of risk and vulnerability, and promotes social cohesion through public assets and human capital (TANGO 2015). SILC, by relying exclusively on local assets and capacities, do little to build transformative capacity of the groups through building the social capital and cohesion created as group level as explained above. However, as compared to absorptive and adaptive capacities SILC program needs to focus more in the future on transformative capacity. Organizations, should work with government to develop the transformative capacity of saving group members by improving infrastructures, availing markets and devising appropriate livelihood strategies. Whether households are savings or accessing loan from different sources, it has its own aim on how to spend it the money. As shown in Table 6, respondent's expenditures can be grouped into broad categories of consumption (food, education, clothing, medical and other celebrations) and production (agricultural inputs, animals and other income generation).

Table 6. The purpose of saving and loan between members and non-members

Membership		Food and Perishable expenses		Medical expen-ses	Education (fees/uniform, books)			Purchase of Livestock		Invested in petty trade/IGA		Farming inputs		Purpose-Social obligation ceremonies		Repay debts/loan and taxes		Clothing/blankets/shoes	
		Yes	No	yes	No	yes	No	yes	No	yes	No	yes	No	yes	No	Yes	No	yes	No
Are you member	Member	39	31	24	46	29	41	34	36	59	11	25	45	25	45	18	52	28	42
	Non member	34	30	35	30	24	41	20	45	24	41	28	37	32	33	31	34	33	32
Pearson Chi-Square	Value	0.090		5.241	0.287			4.451		31.925		.766		2.524		7.041		1.578	
	Df	1		1	1			1		1		1		1		1		1	
	Sig	0.764		0.022	0.592			0.035		0.000		0.381		0.112		0.008		0.209	

As we see from the above Table 6 significant difference was observed between members and non-members that non-members expend more money for medical expense and repaying debts/loan/taxes compared to members. On the other hand, there is significant difference between members and non-members that members expend more money for purchasing of livestock and investing in petty trading compared to non-members. There is no significant difference between members and non-members on the purpose of saving and loan for food and perishable expenses, education (fees/uniform, books), land renting/ property purchase, farming inputs, social obligation ceremonies, clothing/blankets/shoes, and transport and water. The main reason can be that frequent awareness is provided to members on how to use the saving and loan budget by different organizations.

The researcher confirmed that SILC model has a tremendous advantage and benefits as compared to non-members. The three Focus group discussants who are non-members of SILC group reported that the savings and loan system is good for the poor people who "have no formal or informal access to finance". Further, one discussant said that one MFI organization are working in the Woreda but their savings and loan systems are complicated and come with high interests. On the other hand, the SILC system is simple and self-operated by the local community, which allows them to be more flexible and understanding in case of adverse situations.

Likewise, 58 % of the SILC members said that SILC supported them to create assets using the lump sum saving which they earned at the end of the year from the share out. In addition to the technical knowledge and asset creation SILC group members confirmed that the SILC supported them to discuss different community issues and also increase social bondage among themselves. SILC members also reported that their participation encouraged community solidarity and collective action. One of the focus group discussants said that, *"unlike the microfinance loans, in SILC we own the loans, the share-out, and the interest"*.

The majority (30%) of respondents selected "sale of agricultural products mainly sorghum and maize" as their income sources out of seven listed income sources. In other words, from the total 135 respondents 53% replied that their source of income is from the sale of agricultural products while the remaining 47% is from other sources of income (Table 7). Likewise, 28% of the respondents replied that their source of income is from petty trade and 18 % of them are from daily laborer. As mentioned above, there is a highly significant difference between members and non-members on the source of income, that is from the seven listed source of income 46% the respondents who are members of saving groups gained their income from petty trade while non-members whose income sources is petty trade were only 10%. In other words, 77% of SILC member respondent's income source is from petty trade while the rest 33% respondent's income is from other sources. Likewise, 32% non-member respondents replied that their source of income depend on daily laborer, outside of their residence as compared to 4 % of member's response.

Table 7. Comparison of members and non-members on sources of income

Membership	Sale of Cereals/ Agriculture products		Labor		Sale of Charcoal		Sale of Fire wood		Petty trade		Remittance from relatives		Sale of Cash crops	
	Yes	No	yes	No	yes	No	yes	No	yes	No	yes	No	yes	No
Member	32	38	4	66	0	70	1	69	54	16	0	70	23	46
Non Member	36	29	37	28	1	64	16	49	12	53	5	60	9	56
Pearson Chi-Square Value	1.261		41.795		1.085		16.463		46.446		5.592		6.992	
df	1		1		1		1		1		1		1	
p value	0.262		.000		0.298		0.000		0.000		0.018		0.008	

As you see from Table 7 there is significance difference between members and non-members that labor, sales of firewood and remittance from relatives as sources of income are high for non-members. There is also significant difference between members and non-members that petty trade and sale of cash crop as sources of income for members are high compared to non-members. There is no significant difference between members and non-members on the sale of Cereals/ Agriculture products and sale of Charcoal as sources of income.

Lack of finance is one of the major bottlenecks that constrained the poor from engaging in meaningful and gainful activities. In response to this, the recent shift in development paradigm focused on the provision of microfinance services to the poor in order to protect them from adversities of shocks. The expectation is that access to microfinance provides better chance of involving in different livelihood and income diversification activities. As the result of this households could increase and diversify their income, ensure food security and recover fast and mitigate adverse impacts of shocks.

A number of people reported that their groups engaged in other income generative activities besides simple saving or lending. As depicted below in Table 8 out of 70 SILC group members, 96% said that their group members engaged in different IGAs as compared to 82% of non-members.

Table 8. IGA Engagement

IGA engagement	SILC Members and non SILC members IGA		SILC members IGA		Non SILC members IGA	
	Frequency	%	Frequency	%	Frequency	%
Engaged	120	88.9	67	95.7	53	81.5
Non-engaged	15	11.1	3	4.3	12	18.5
Total	135	100.0	70	100.0	65	100.0

Partial correlation analysis was also run to check that membership has correlation with the amount of Birr saved and IGA engagement. Hence, the amount of Birr saved has moderately correlated with IGA engagement. Membership has moderately positive correlation with the amount of money saved as shown below in Table 9. Likewise, IGA engagement is also positively correlated with membership but it is not strongly correlated as saving. Partial correlation controlling for membership to IGA engagement is positive but not significant.

Table 9. Partial Correlation on the amount of Birr saved, IGA engagement

Control Variables			Access to Saving	Engagement in IGA	Are you member
-none-[a]	Access to Saving	Correlation	1.000	.221	.324
		Significance (2-tailed)		.010	.000
		df	0	133	133
	Engagement in IGA	Correlation	.221	1.000	.225
		Significance (2-tailed)	.010		.009
		df	133	0	133
	Member	Correlation	.324	.225	1.000
		Significance (2-tailed)	.000	.009	
		df	133	133	0
Members	Access to Saving	Correlation	1.000	**.160**	
		Significance (2-tailed)		**.064**	
		df	0	132	
	Engaged in IGA	Correlation	.160	1.000	
		Significance (2-tailed)	.064		
		df	132	0	

a = Cells contain zero-order (Pearson) correlations

In order to understand how and if family members communicate on the management of the money, respondents were asked to explain their relationship with the household operations. The result of analysis as depicted in Figure 4 showed that majority of SILC members shared the responsibility of deciding how to use the household money. About 77 % of members answered that it was a mutual decision in comparison to 63.5 % of non-members. Majority of the respondents 86 (64%) answered that decision making power increased due to SILC member involvement, which is statistically significant and confirmed by the chi square test (x^2=10.14, df=1, p<.001) Women focus group discussants also assured that, their ability to make decisions is better than non-members. The discussants mentioned that having their own money means more autonomy to do what they want with it than non-members who only expect from their husband.

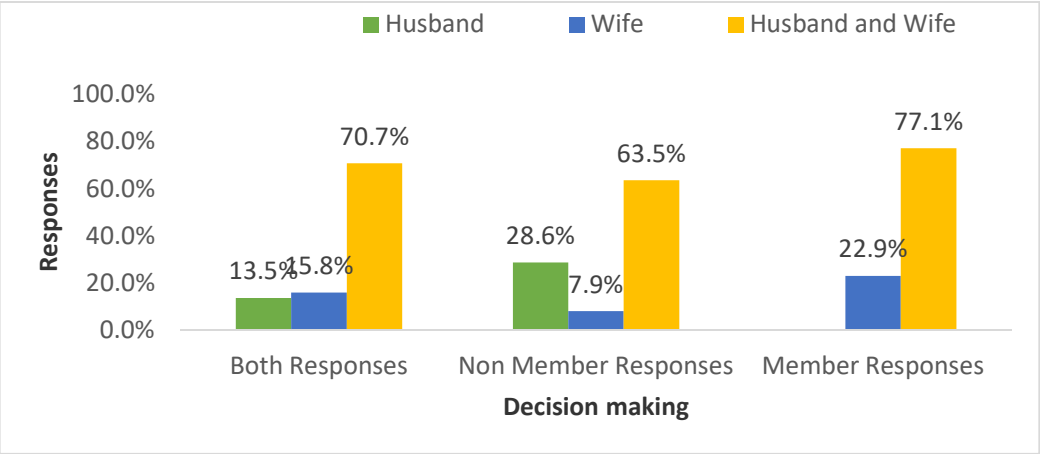

Figure 4. Decision Making

Though SILC has tremendous benefits and contributes in resilience building of members as compared to non-members there are some challenges that hinders SILC not to better build resilience capacities of communities. More than half 37 (53%) of the respondents perceived that there is no challenge in SILC activities while 33 (47 %) of them believed that there are some challenges that hinders the success of SILC activities to better build resilience.

Challenges of SILC activity as mentioned by the respondents is that the amount of money pooled is too small to engage in different income generating activities which highly hinders the adaptive capacity of communities not to diversify their livelihood and to create more assets. Although there is no significant difference more than half of the respondents perceived that there is no challenge to implement SILC.

Tarekegne (2014) also assured that in Ethiopia drought is the most persistent and sever damage as the communities' livelihood is dependent on agriculture. They also spend their saving for coping mechanisms instead of investing on IGAs. From the four challenges of SILC implementation, 24% of respondents replied that prevalence of shock is major challenge followed by "smaller loan sizes" as the amount of money pooled are small from the members and illiteracy of members challenges the group to properly manage their ledger.

Table 10. Challenges for SILC

SILC implementation challenge	Responses		
	No	From all challenges	From each challenges
prevalence of shocks	29	23.60	41.40
illiteracy	21	17.10	30.00
Loan size smaller	26	21.10	37.10
Loan periods are shorter	11	8.90	15.70
No challenge	36	29.30	51.40
Total	123	100.00	175.70

Even though, there are challenges in SILC, there are also good opportunities to better tackle the challenges and be resilient. The opportunities revealed by the respondent are the area is a good cash crop area and they can easily diversify they livelihood if they get credit linkage with financial service providers (FSP). In addition, the raised that the existence of trained and equipped FAS/ PSP who are working with us even after the project is phased out are a good opportunity for us to continue the SILC activities and to become resilient.

As discussed in detail above in Table 10 most predominant challenges that hinder implementation of SILC are prevalence of shocks, small amount of loan size and illiteracy to properly manage their finance. These challenges are also hindered the capacity of communities. Therefore, respondentssuggest that creating credit linkage with FSP helps HHs to become more resilient and to sustain SILC activities. Linkage with FSPs will help communities to engage in different IGAs and to diversify their means of livelihood. The respondents also suggested that as agriculture is their main source of income which is widely affected by the impacts of the drought as discussed above. Thus, plan and prepare ahead by engaging in diversified income sources to overcome these challenges of shocks. Regarding illiteracy, they recommend to access informal education nearby their home, which will help them to easily manage their recordings.

4. Conclusion

The indices of household vulnerability to shocks and the contribution of the informal saving schemes in building resilience such as SILC among others are not well understood. Therefore, this research identified major shocks experienced by the respondent communities and understood the contribution of SILC to the community to prepare, mitigate and bounce back from the adverse impacts of shocks.

The most prevalent shocks respondents experienced were drought and flood; pest infestation, and animal disease. From the listed shocks drought was the most persistent and common in the research area. The researcher has assured that the SILC component has demonstrated proven contribution for SILC group member by helping them cope in drought-related stress situations through building their resilience as

compared to non-members who were forced to sale their productive assets. The social capital inherent in the dynamism of a SILC group provides members with the opportunity to discuss challenges they faced in their day-to-day lives and agree on coping mechanisms to help them to smooth their household cash flows.

Furthermore, SILC groups demonstrated that saving and loan activities increased the capacity of households and communities to face, adapt to and absorb recurring shocks and stresses. SILC activities supported social and economic development and strengthened women's voice in their society by boosting their self-esteem and allowing them to play a bigger role within their community. Though, SILC has tremendous benefits in protecting communities from stress the researcher assured that there were some challenges identified like small loan size, prevalence of shocks and illiteracy.

Respondents are provided some suggestion to solve the identified challenges for the future. From the list of suggestions provided creating credit linkage is the first and followed by involvement in different IGAs. Plan and prepare ahead to mitigate the adverse impacts of shocks were also suggested as a solution. Therefore, to meet the stated objectives and to establish resilience of Households, the researcher recommends proper orientation/ training on drought disaster resilience; which helps them to prepare and plan ahead; linkage with formal FSP to access larger loan that will accelerate involvement of different IGAs and livelihood diversification; and facilitation of linkage of SILC group members with Government adult literacy programs to improve their computing skills. To sum up, collaborative effort among Government, NGOs, and policy makers is crucial to better build resilience of communities.

Conflict of interest

The authors declare that there is no co0nflict of interest to publish the manuscript in the journal.

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Analysis of Gender and Determinants of Market Supply of Onion in Dugda District, East Shoa, Ethiopia

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Abstract: *This article identified factors affecting onion farmers' volume supply in gender perspective in Dugda district, Ethiopia. The main objective of the research was identifying the determinants factor affecting market supply on both male-headed and female-headed farmers separately helps where to focus to increase production and volume of supply. The estimated volume of production of onion was about 1849.1 tons and 1836.0 tons of onions were sold in the study area in 2015/2016. The data used in this study were collected from 157 male and 54 female headed households that were randomly selected from eight kebeles of the district. The survey was conducted to collect the primary data from sample respondents. Complementary, secondary data were collected from various sources. The data were analyzed using descriptive statistics and inferential statics like t-test and chi-square. Multiple linear regressions were estimated to identify determinants of onion volume supply in male-headed household and female-headed household. The findings revealed that quantity produced, onion farming experience, participation in non-farm activities and level of aspiration determined household's market supply of onion in male-headed household. Quantity of onion produced, experience and access to market information determined household's market supply of onion in female-headed household. Therefore, Female-headed farmers should increase their bargaining power through an organized central market information system at the district level, accessibility of appropriate data on buyers by providing their names, addresses and prices.*

Keywords: Determinants, Gender, Female-headed, Male-headed, Market supply, Onion

1. Introduction

The Governments of Ethiopia have a plan to upgrade vegetables marketing and empower women to actively play their part in alleviating poverty and food security. However, vegetable production and marketing needs organized production and market which can minimize wastage, bankruptcy and secure sustainable quality production. Vegetable marketing and production intervention strategies which do incorporate women onion producer would have a positive effect on sustainable production and women empowerment (Saikou, 2014). In line with this, Ethiopia's current Growth and Transformation Plan (GTP) provides room for intensive production, commercialization of vegetables and women empowerment. Therefore, the country's development policy calls for hastening the transformation of the sector as a means for achieving sustainable development and economic growth (MoFED, 2010).

Fifty percent of the population in Ethiopia is women and they are an essential component in the reduction of hunger. Hence, women's empowerment is an important aspect of poverty reduction and one of the means of achieving Millennium Development Goals. Agriculture is one of the major strategies for attaining the Millennium Development Goal. Women's contribution towards agricultural production and marketing cannot be overlooked (Almaz, 2015).

If the existing system identify and take into account factors that determine market supply of onion in gender perspective, problem identification and structured support can mitigate and reduce poverty and improve sustainable production (Almaz, 2015). Despite the fact that researches done on onion (Abay, 2007; Taha, 2007; Tadesse, 2008; Adugna, 2009; Kamrul *et al*., 2009; Mahilet, 2012; Patil *et al*., 2012; Almaz, 2013; Kiruthika, 2013; Asif And Abdus, 2015; Laxmi *et al*., 2017; Khating, 2017; Khating *et al*., 2018), almost all focused on production aspect and overlooked gender disaggregated information. Since, increasing production is not a sufficient condition for benefiting smallholder farmers unless supplied to the market. Moreover, studies on factors affecting

market supply of onion in a gender perspective helps to formulate appropriate policies that improve the livelihood of female-headed and male-headed farmers; to design appropriate policies for the improvement of onion marketing and to empower women farmers. Hence, the objective of this article is, therefore, to identify determinants of female-headed and male-headed farmers' market supply of onion in Dugda district.

2. Methodology

This research was carried out in Dugda, a district which is found in eastern Shewa zone of Oromiya National Regional State. The study area is located at a distance of 130 km from Addis Ababa. Multi-stage sampling technique was used to draw the sampling units of the study. Formal survey was conducted with onion producers. At the first stage, Dugda district was selected purposively due to extensive coverage and production of onions in the district. Melkasa and Adami Tulu Agricultural Research Centers have released improved onion varieties particularly for the study district and improved agricultural inputs utilization as well as conducting wide demonstrations on onion cultivation in Dugda district. Onions were selected as the most important crop to be considered for the purpose of this study due to the fact that it is high-value commodities and are mainly produced in Dugda district and in Ethiopia as a whole. Onions are major vegetable products that are exported as cash crops. In 2015/2016 production season, out of the total area of the district 95,945 ha, total cultivated land was 55,828 ha of which 10,937 ha were covered by onions implying relatively it covered second large area next to tomatoes compared to other vegetables (BoARD, 2015).

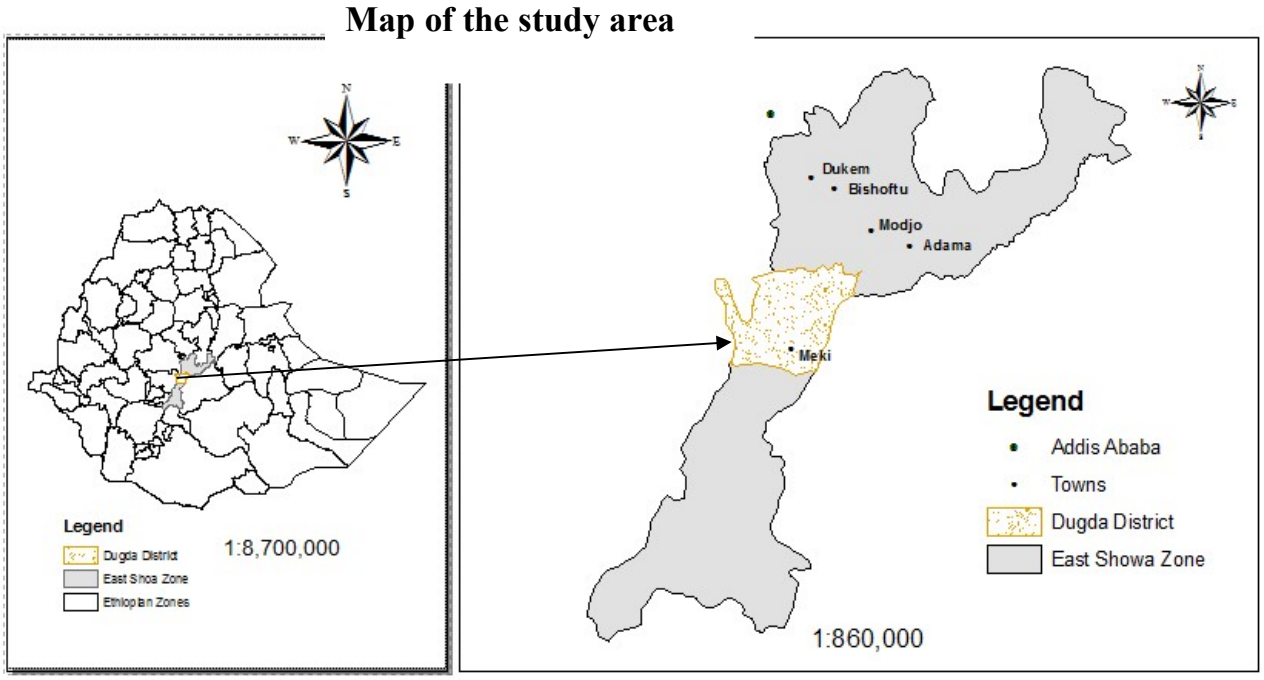

Figure 1. Location of the study area

Dugda district has 39 *kebeles* [1]and out of which 16 *kebeles* are major growers of tomato. In the second stage, eight *kebeles* in the district were selected randomly. The sampling frame of this study was freshly prepared and it was to include producers of onion in the *kebeles* of Dugda district. The third stage of the sampling procedure, respective sampling frame was stratified as male-headed and female-headed households. Finally, the numbers of respondents were determined by using probability proportional to size sampling procedure (John, 2014). A total of 54 female-headed households (FHH) and 157 male-headed households (MHH)

[1] Under Ethiopian government structure, "kebele" is the smallest administrative unit below district and consists of a number of villages (i.e. it is a collection of village). It is part of a district

were selected using simple random sampling methods. Then the predetermined size of the sample farmers from each *kebele* was randomly selected using systematic random sampling technique. To determine the required sample size, this study used a simplified formula developed by Yamane (1967) at 95% confidence level and 10% non-response rate. A pilot survey was carried on 20 non-sampled respondents on actors to check suitability of questionnaire to socio-economic and cultural setups.

The analysis was made with the help of descriptive and econometric tools by using Stata SE-version12 software's were employed. Data analysis employed descriptive statistics (such as percentage and mean comparison), inferential statistics such as t-test and chi-square to describe differences between MHH and FHH farmers. Besides, multiple linear regression econometric model was used to identify determinants of onion quantity supplied. Different studies employed different models in order to identify the factors that determine market supply (Kindie, 2006; Abay, 2007; Rehima, 2007; Bosena, 2008; Adugna 2009; Ayelech, 2011; Almaz, 2012, 2017). The commonly used ones are the well-known multiple linear regression model.

Among the different variables that would explain market supply the most important variables, according to the reviewed literature, include family labor, educational level, extension service, ownership of water pump, production level, irrigable land holding, distance to market, achievement motivation, level of aspiration, participation in non-farm activities, Experience, utilization of credit, participation on social organization and market information were found to be important determinants (Abay, 2007; Kindei, 2007; Rehima, 2007; Bosena, 2008; Ayelech,2011; and Almaz, 2013and 2017).

Following Green (2003), the multiple linear regression model is specified as:

Yi = F(X1, X2, X3,X4, X5, X6, X7, X8, X9, X10, X11,X12,X13,X14)

Where Yi= quantity of onion supplied to market

X1= Family labor	X6= Access to market information	X11= Level of Aspiration
X2= Education level of head of Household	X7= Participation in non- farm activities	X12= Participation in social organization
X3= Utilization of Credit	X8= Experience in onion farming	X13= Distance to the nearest markets
X4= Quantity of production	X9= Irrigable land in onion	X14= Ownership of water pump
X5= Extension contact	X10= Achievement motivation	

Econometric model specification of supply function in matrix notation is the following.

$Yi = \alpha i + BiXi + Ui$

Where:

Yi = onion supplied to the market

β = a vector of estimated coefficient of the explanatory variables

X = a vector of explanatory variables

Ui = disturbance term

Before running the model all the hypothesized explanatory variables will be checked for the existence of multi-collinearity and heteroscedasticity. There are two measures that are often suggested to test the existence of multi-collinearity. Namely: VIF (variance inflation factor), Contingency coefficients.

In order to identify factors influencing onion marketable supply both continuous and discrete variables were hypothesized based on economic theories and the findings of different empirical studies. The dependent and exogenous variables, their definitions, symbols and hypothesized signs are shown in Table 1.

Table 1. Symbol, definition and hypothesized sign of variables

No	Definition	Symbol	Type of variable	Hypothesized
1	Onion quantity supplied (2015/2016) in quintals.	QUANS	Continuous	dependent
2	Education level of household head (1= illiterate, 2=read & write, 3= primary cycle,4= secondary cycle,5= tertiary cycle, 6=preparatory, 7=higher)	EDUCA	Discreet	(+)
3	Family Labor (man equivalent).	LABOR	Continuous	(-)
4	Farm experience of household (years).	EXPER	Continuous	(+)
5	Utilization of credit (1=, if yes; 0=, otherwise)	UTLCR	Dummy	(+)
6	Farmers' participation in social organization in score.	PRTSC	Continuous	(+)
7	Participation in income generating non-farm activities (1=Yes, 0=No)	OFFRM	Dummy	(+)
8	Distance of the respondents' house from input and output market (km).	DSTNT	Continuous	(-)
9	Actors getting extension service(1=yes; 0=no)	EXSINC	Dummy	(+)
10	Awareness of price information (1=Yes, 0=No)	MRTINF	Dummy	(+)
11	Ownership of water pump	H_2OPU	Dummy	(+)
12	Irrigable landholding of the respondents in hectare	IRRGL	Continuous	(+)
13	Quantity produced in quintal	PRODU	Continuous	(+)
14	Achievement motivation (1=low, 2= medium,3=high)	ACHIV	Discrete	(+)
15	The level of aspiration (1=low, 2= medium,3=high)	LEVEL	Discrete	(+)

3. Results and Discussion

As indicated in Table 2 below, the estimated volume of production of onion was about 18490.58quintals, of which 18359.57 quintals of onion were sold (99.29%). Sampled respondents indicated that 99.29% of onion produced was marketed and the remaining percentage of total production was accounted for by spoilage, seed and home consumption. Out of the total onion marketed, 76.7% and 23.3% of onion was marketed by MHH (male-headed households) and FHH (female-headed households), respectively. The average production of onion for FHH and MHH was about 77.8 and 91quintals, respectively (Table 3).

The average age of MHHs was 38.73 years compared to 45.07 years for FHHs. MHH have on the average about 2.75 man-equivalent of family labor while FHH had 2.72 man-equivalents. MHH have on the average about 7 years on onion farming experience while FHH have almost 10 years of experience, which was significant at 1% probability level. This indicates that FHH had higher onion farming experience and lower family labor compared to MHH (Table 3).

Table 2. Production and marketing status of onion

Status of onion by Households	FHH(54)		MHH(157)		All Case(211)	
(in quintal)	Total	Mean	Total	Mean	Total	mean
Production Of Onion	4199.48	77.77	14291.10	91.03	18490.58	87.63
Sold Onion	4168.17	77.19	14191.40	90.39	18359.57	87.01
Consumption Of Onion	2527.00	46.80	6968.00	44.38	9495.00	45.00
Onion Used For Seed	0.00	0.00	2063.00	13.14	939.00	4.45
Spoiled Onion	604.00	11.19	14291.10	91.03	2667.00	12.64

Source: Own survey (2016)

The results depicted at Table 3 show that, there were statically difference between average land owned by FHH (0.55ha) and MHH (0.78ha) and there were statically significant at 10% (t=-1.78*). Of which, the average total land sizes under onion were about 0.09 and 0.10 ha for FHH and MHH, correspondingly. The analysis of field data shows that there is significant difference between FHH and MHH producers in participation in different social organization at 1 % significant level (t=2.93***).

Even though it was not statistically significant (t=-1.15), FHH and MHH sold onion by 2.97 and 3.26 Ethiopian Birr [2]. FHHs traveled shortest distance from the nearest market (7.81km) than the male-headed households (8.26km).

[2] 1$=18.15 Eth Birr

Table 3. Scio-demographic characteristics' of onion producers

Lists of Variables	FHH (N=54)	MHH (N=157)	All cases (N= 211)	t-value
Age of the respondent	45.07	38.73	40.35	3.47***
Family labor	2.72	2.75	2.74	-0.11***
Distance	7.81	8.26	8.15	-0.58
Experience in onion farming	9.59	7.13	7.76	3.50***
Total land holding	0.55	0.78	0.72	-1.78*
Total land covered by onion	0.09	0.10	0.10	-0.37
Production of onion	77.77	91.03	87.63	-0.86
Sold onion in quintal	77.19	90.39	87.01	-0.86
Current price	2.97	3.26	3.18	-1.15
Total income	21790.53	28396.95	26706.21	-1.10
Participation in social org.	2.56	3.39	3.18	-2.93***

Source: Own survey (2016) *** & *significant at 1% and 10%probability level respectively.

The chi-square test indicates that there is a significant difference regarding contact with extension agents at 10% significant level ($\chi 2$ =2.92) between the two groups. Thus, about 57.4% of FHH and 43.9% of MHH had visit from extension agents during 2015/2016 production season. Majority of the MHHs (68.8%) were did not take credit compared to their FHH counterparts. Moreover, 90.7% and 84.1% of FHH and MHH respondents had got market information, respectively. This implies that FHH has more access to market information and Use of credit as compared to MHH in the area. The Chi-square statistics is also evidence for presence of statistical difference between the two groups at less than 1% significance level on access to information.

Table 4. Scio-economic characteristics' of onion producers

Lists of Variables		FHH (N=46)	MHH (N=123)	All cases (N=169)	χ^2-value
Extension	Yes	57.4%	43.9%	47.9	2.92*
	No	42.6%	56.1%	52.6	
Credit	Yes	75.9%	31.2%	57.3	32.85***
	No	24.1%	68.8%	42.7	
Water pump	Yes	46.3	46.3	46.3	0.01
	No	53.7	53.7	53.7	
Market information	Yes	90.7%	84.1%	85.8%	10.17***
	No	9.3%	15.9%	14.2%	
Non-farm	Yes	44.4	53.5	46.4	0.68
	No	46.5	53.5	54	

Source: Own survey (2016) ***& *&significant at 1% and 10%probability respectively.

The result of this study indicated that, FHH respondents were put under three categories of level of aspiration. Based on this, 63.0%, 22.2% and 14.8% were low, medium and high level of aspiration, respectively. Whereas, majority (84.7%) of MHH were rated as high level of aspiration compare with their female counterparts. Achievement motivation was defined as the need in an individual to perform different roles with some degree of excellence. As presented in Table 5, the MHH respondents were put under three categories of achievement motivation. Based on this, 72.2% respondents in FHH were under low achievement motivation. This indicating that the existence of difference between FHH and MHH with respect to level of aspiration and achievement motivation, which is significantly different at 1% probability level.

Table 5. Psychological characteristics onion producers

Lists of Variables		FHH (N=57)	MHH (N=154)	All cases (N=211)	χ^2-value
ACHVE	Low	72.2%	24.8%	37.0%	39.5***
	Medium	20.4%	42.7%	37.0%	
	High	7.4%	32.5%	26.1%	
LEVEL	Low	63.0%	6.4%	20.9%	96.82***
	Medium	22.2%	8.9%	12.3%	
	High	14.8%	84.7%	66.8%	

Source: Own survey (2016) ***=Significant at 1% probability level.

As indicated in Table 6, the majority (53.7%) of FHH are illiterate while only 3.2 percent of MHH are illiterate group. The Chi-square statistics is evidence for presence of statistical difference between the two groups (χ2=128.01, p=0.000).

Table 6: Educational level of the sampled tomato producers

Table 6. Educational level of the sampled tomato producers

Education of HHH	FHH (N=46)	MHH (N=123)	All cases (N=169)	χ^2-value
Illiterate	53.7%	3.2%	16.1%	128.01***
Read & write	24.1%	1.3%	7.1%	
Primary cycle	9.3%	6.4%	7.1%	
Secondary cycle	9.3%	31.8%	26.1%	
Tertiary cycle	3.7%	33.1%	25.6%	
Preparatory	0	17.8%	13.3%	
Higher	0	6.4%	4.7%	

Source: Own survey (2016) ***=Significant at 1% probability level.

The estimates of the multiple linear regression models for male and female headed households are presented in Table 7. The market supply functions were found to be significant as evidenced by significant F-value at 1% level of probability (Table 7)., The adjusted coefficients of multiple determinations indicate that the variation in onion quantity sold per quintal associated with the factors of market supply specified in the models was 99%, in MHH, FHH and pooled data set.

Table 7. Determinants of onion quantity supplied to the market

Variable	Pooled (N=211)		MHH (N=157)		FHH (N=54)	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
EDUCA	0.007	0.3	0.054	1.55	-0.002	-0.06
LABOR	-0.003	-0.17	-0.018	-0.84	-0.019	-0.61
DSTNT	0.003	0.49	0.005	0.77	0.008	1.01
EXPER	0.009	1.47	0.018	1.97**	0.019	1.71*
IRRGL	-0.014	-1.13	-0.001	-0.05	0.084	0.97
PRODU	0.999	2032.3***	0.999	2823.48***	0.999	919.48***
EXSINC	0.064	1.09	0.063	0.82	-0.012	-0.15
UTLCR	0.090	1.71*	0.099	1.52	0.080	0.88
H2OPU	0.024	0.47	0.079	0.89	0.000	0
MRTINF	0.046	0.74	0.025	0.35	0.214	1.89*
OFFRM	0.075	1.34	0.156	1.94**	0.0276	0.3
PRTSC	0.006	0.37	0.010	0.54	-0.018	-0.64
ACHIV	-0.030	-0.73	0.0065	0.12	0.068	1.28
LEVEL	0.078	1.64	0.148	1.86*	-0.013	-0.21
Constant	-0.959	-6.3***	-1.645	-5.23***	-0.924	-5.37
Adjusted R2		99%		99%		99%

Source: Model Output, ***, **, and * significance at 1%, 5%, and 10%, respectively.

The regression coefficient of onion production variable was positively related with quantity supplied and significantly at 1% probability level in both FHH and MHH and confirmed the hypothesis.

The result shows that a one quintal increase in the onion production causes a 0.99 quintal increase in the amount of marketed supply both male and female household heads. Total onion production influenced the amount of marketed supply of onion positively showing that farmers who produce more sell also more, which is consistent with the general expectation. This is in line with Abay (2007) who illustrated an increase of onion production by farming households has augmented marketable supply of the commodities significantly.

The finding in Table 7 above, agrees with the hypothesis is that farming experience has showed positive and significant effect at 5% and 10% significant level for MHH and FHH, respectively. Thus, the result implied that, as farmer's experience increase by one year, onion supplied to the market increased by 1.8×10^{-2} quintals and 1.9×10^{-2} quintals for male headed and female headed households, respectively. This is in line with Abay (2007) and Almaz (2013).

Participation in non-farm activity of the household heads positively affected quantity supplied. On average, if an onion male producer participates in non-farming income generating activities' causes a 0.16 quintal increase in the quantity of onion supply. On average, if an onion female producer gets access to market information the amount of onion supplied to the market increases by 0.21quintal. This suggests that information improves level of sales that affects the marketable surplus.

As confirmed with the hypothesis, level of aspiration is positively associated with male farmers' onion market supply. If an onion male producer has high level of aspiration the amount of onion supplied to the market increases by 0.15 quintal.

4. Conclusion

The findings of this study had important policy, education and research implications; because, determinants of market supply of onion play a substantial role by generating income and improving livelihood of both FHH and MHH farmers. It is important to understand these factors for the benefit of poor men and women farmers. The survey results indicated that the average onion production of female-headed producers were lower than male-headed producers. Their achievement motivation and level of aspiration were less than their male counterparts. These implying FHH had weak desire and ambition to achieve in onion production and marketing supply. Moreover, their need to perform different roles with some degree of excellence in onion production and supply to the market was also lower than their male counterparts. Therefore, training and capacity building, adult education and continuous supervision by concerned bodies are vital to enhance motivation and aspiration. Majority (52.6%) of FHH and MHH had no contact with extension agents. Besides, male-headed producers have less farming experience than female-headed producers. Hence, contact with extension agent and sharing of experience is the important component for improving the whole system. Farmers with longer farming experience have wide knowledge and skill, which enables them to perceive risks and constraints related to effective transfer of new technologies. Development agents should arrange periodic experience-sharing sessions among FHH and MHH producers and provide field visits, conduct training on production skills, and promote field demonstrations and trial.

The results of this study also showed that onion farming experience and quantity of onion produced determined household's market supply of onion for both FHH and MHH. Therefore, supporting the efforts of research centers in improved seed production, multiplication, distribution and farm trial should be strengthened in order to supply producers with yield increasing techniques and management innovations. To achieve the country's Growth and Transformation Plan (GTP), concerned bodies should focus on increasing productivity by providing improved seeds, training on production skills, and technical support to farmers in agronomy practices, and technical aid for farmers in post-harvest handling. Encouraging farmer groups to engage in increasing the production and productivity of onions per unit area of land is important. Finally, it is concluded that, access to market information determined household's market supply of onion in FHH. Thus, Female-headed producers should increase their bargaining power through an organized central market information system at the district level, accessibility of appropriate data on buyers by providing their names, addresses and prices.

Conflicts of interest

The author declares that there is no conflict interest regarding the publication of this paper in the journal.

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Appraisal of mineral content of *desho* grass (*Pennisetum pedicellatum* Trin.) as affected by stage of maturity and agro-ecologies in Ethiopia

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Abstract: *Ash determination of forages may not exactly tell the mineral status of forage crops as livestock feed. Therefore, it is important to determine common minerals to have useful information for livestock nutrition as this helps to mitigate mineral deficiency of farm animals rely on that particular forage. The aim of the research was to determine the mineral content of desho grass harvested in different harvesting dates and altitudes for ruminant livestock production in the highlands of Ethiopia. The samples of desho grass were collected from different harvesting dates and altitudes to see the concentration of common macro and micro minerals. The samples were analyzed for common macro-minerals (Ca, K, P, Mg and Na) and micro minerals (Mn, Fe, Cu and Zn). The results indicated most of the concentration macro minerals were not significant (P>0.05) due to altitude factor except Mg and P which were significant. In terms of harvesting dates, only Mg and Ca were significant (P<0.05) while other minerals were non-significant. The analysis of minerals in the current study indicated that desho grass contains most of required minerals for herbivores which depend on it. However, for high producing animals adequate supplementation of both macro and micro minerals could be advantageous.*

Keywords: Ash, Desho grass, macro minerals, mincro minerals

1. Introduction

Mineral elements are inorganic nutrients derived by plants through their roots which are the contact points with the soil. The mineral elements absorbed by plants are then converted into plant products. The latter are then fed to livestock for conversion into animal products (Payne, 1994; Martin and Robertsa, 2000). These mineral elements are believed to have one or more catalytic functions in the cell (Biswas and Mukherjee, 1995). Minerals are dietary essentials for animals and herbage content of minerals below the requirement of animals adversely affects both intake and digestibility (Crowder, 1985). Grazing and browsing animals usually obtain from feed resources they directly get from the environment. Mineral requirement of animals is influenced by type and level of production, age, level and chemical form of elements and management practices (Little, 1982). The availability of minerals in feed resources depends on various factors such as stage of maturity of plants and method of feeds prepared, soil type and environmental factors in which feeds produced (Khan *et al*., 2005). The interaction of different factors make complex the situation for livestock producers not easily determine the optimum amount of minerals required for their stock (Dost, 2001).

Though there are efforts to understand sources and optimum amount of energy and protein nutrients for livestock nutrition in the tropics have been given more emphasis thus far. However, optimal production and productivity of livestock is only possible if there is an adequate supply of minerals (Khan *et al*., 2004). Forages are important sources of minerals for grazing or forage feed livestock. Hence, the feeding value of a given forage source depends on its chemical composition and nutritional content and palatability. As a result, information of forage constituents of animal feed is central to animal production and productivity. The nutritional value of forage is independently and as a group affected by a variety of factors, including variety, soil, climatic, kind and stage of utilization, management and stage of growth. Nutrients composition of forages also varies from time to time and location to location (De Leeuw, 1979).

Desho grass *(Pennisetum pedicellatum* Trin), belongs to the *Poaceae* family and tribe *Paniceae*.

The species belonging to the genus, Pennisetum, constitute a heterogeneous assemblage ranging from diploids to octoploids with either sexual or apomictic reproductive behavior having annual, biennial or perennial life cycle (Martel *et al*., 1997). The grass provides high yields green herbage ranging between 30-109 t/ha (Ecocrop, 2010) and compares favorably with Sorghum bicolor or other Pennisetum species. It responds well to fertilization and could be combined with fodder legumes either in mixtures or in rotational cropping. In short rotation with maize or groundnuts, it yields better than traditional forage grasses, especially when fertilized, while the roots and stubbles also increase soil fertility. To obtain the highest yield, *desho* grass should be cut 4 months after sowing at 8 cm from ground level (Leta *et al.*, 2013). *Desho* grass is used in temporary pastures or in cut-and carry systems since it provides ample quantities of good quality green forage and stands several cuts a year. The grass is also useful for hay and silage preparation (Ecocrop, 2010).

Desho grass is native to tropical Africa and now widespread within 20°N and 20°S. The grass mainly found on disturbed land, road edges and recent fallows, in areas where annual rainfall ranging between 600 mm and 1500 mm with a rainy season of 4-6 months and average daily - temperatures of about 30- 35°C. *Desho* grass thrives on a wide range of soils (including degraded sandy or ferruginous soils) provided they are well drained. However, the grass is susceptible to water logging and frost but has some drought tolerance (Ecocrop, 2010; FAO, 2010). *Desho* grass is used as a soil stabilizer.

Once planted, *desho* grass maintenance activities such as applying fertilizer, weeding and gap filling, are required to ensure proper establishment and persistency of *desho* grass (Solomon *et al.*, 2010). Fertilizer should be applied throughout the plot one month after planting. It is recommended to use organic compost in the form of animal manure, leaf litter, wood ash, food scraps, and/or any other materials rich in biodegradable matters (Danano, 2007). After this initial treatment, fertilizer is only applied sporadically when *desho* plants are struggling to grow or where replanting has taken place. Weeding and gap filling are continuous activities in *desho* grass production. After 2 to 3 years, maintenance inputs decrease substantially or cease altogether as the grass cover closes up and the plot becomes a sustainable fodder source. Past interventions have shown that *desho* based grazing land management practices are best implemented when communal grazing land is re-distributed into small plots (less than 0.5 ha) that are convenient for individual use, development and management (Danano, 2007).

According to McDonald *et al*. (2010), plants and plant products from the main supply of nutrients to animals, and the composition of plants will influence the animal's mineral intake. Thus, the species and stage of maturity of the plant, the type of soil and climate, and the seasonal conditions are important factors. Indeed much knowledge into the mineral element content of the grass *Pennisetum pedicellatum* in their natural environment in the tropics including Ethiopia is not available as the grass is not highly researched. The study was conducted to determine the effects of altitude and stages of maturity on mineral composition of desho grass (P. *pedicellatum* Trin.*) in Ethiopia.*

2. Materials and Methods

2.1. Description of the experimental sites

The agronomic component of this study was conducted in two agro-ecologies (mid altitude and high altitude) using a rain fed system. The mid altitude area was represented by Andassa Livestock Research Center located at 11^0 2900 N and 37^0 2900 E at an altitude of 1730 m above sea level. Farta District Office of Agriculture (2014) provided summary climatic data for the area which receives about 1434 mm of rainfall annually. Mean annual temperature varies from a maximum of 29.5 ^{0}C to a minimum of 8.8 ^{0}C. The soil type is dark clay and seasonally waterlogged with 3.4% organic matter, 0.17% total nitrogen and pH of 6.9. The highland area was represented by Farta district, Tsegure Eyesus Kebele (Kebele is the local administration in Ethiopia) at a site called Melo located near Debre Tabor Town, at $11^0$11' N and 38^0E and at an altitude of 2650 m above sea level. The soils of Melo site are characterized by clay and sand mixture with chemical composition of 2.26% organic matter, 0.11% total nitrogen and pH of 5.47. The mean annual rainfall is about 1570 mm and the mean maximum and minimum annual temperatures were reported to be 21.5 ^{0}C and 9.6 ^{0}C respectively.

2.2. Land preparation and planting

The agronomic characteristics of the grass were studied at Andassa Livestock Research Center, located in West Gojam and in Farta district of South Gondar Zone of the Amhara Regional State. Andassa Livestock Research Center (ALRC) is located at $11^0$29" N and $37^0$29" E at an altitude of 1730 m.a.s.l. The study area receives about 1434 mm of rainfall annually. The mean annual temperature vary from a maximum of 29.5^0C in March to a minimum of 8.8^0C in January. The soil of the center is dominantly dark clay soil, which is water logged in the rainy season and crack during dry period (ALRC, 2014). The highland of Farta district called Melo site, is located near Debre Tabor Town. The area is located at latitude and longitude of $11^0$11' N latitude, 38°E longitude and at an altitude of 2650 meters above sea level. The major soils of the district comprises of 20% black, 30% red, and 50% brown. The mean annual rainfall is 1570 mm and the mean minimum and maximum annual temperature is 9.6 ^{0}C and 21.5 ^{0}C, respectively (FDoA, 2014). The laboratory chemical analysis was conducted at International Livestock Research Institute, Animal Nutrition Laboratory (Addis Ababa). The feeding and digestibility trial was done at sheep research farm of Zenzelma Campus, Bahir Dar University.

A total area of 81 m^2 was selected from each of the mid land and high land locations. These were ploughed in May and harrowed in June 2014. The prepared experimental land was divided in to three blocks each of which comprised three plots (3 x 3 m^2 each). *Desho* grass obtained from Southern Nationals and Nationalities by CASCAPE (Capacity Building for Scaling up of Evidence Based Best Practices in Agricultural Production in Ethiopia) project was planted using vegetative root splits in rows on a well-prepared soil. Soil samples were taken from each plot before planting and analyzed for major elements such as N, P, C, OM, pH, and texture. The spacing between rows and plants were 50 and 10 cm, respectively. Land preparation, planting, weeding and harvesting was made according to the recommendations by Leta *et al*. (2013).

2.3. Mineral analysis

The concentration of Ca, Mg, Fe, Zn, and Mn were determined by atomic absorption spectrophotometry (Perkin-Elmer AAS Analyst 100, USA) while flame photometer was used for K and Na analysis. Phosphorus concentration was determined colorimetrically (AOAC 1990).

2.4. Statistical analysis

All data was analyzed with General Linear Model (GLM) procedure of SAS (2007) for least square analysis of variance. Mean comparisons were done using Duncan's Multiple Range Test (DMRT) for variables whose F-values declared a significant difference. Differences were considered statistically significant at 0.01% and 0.05% significance level. The statistical model for the analysis of data was:

$$Y_{ijk}= \mu +Al+H_i+Al*H+e_{ijk}$$

Where, yijk=all dependent variables (morphological data and chemical composition) collected μ = overall mean

H_i = the effect of i^{th} harvesting days (90, 120 and 150 days)

H_i*Al_j= the interaction of harvesting day and altitude

e_{ijk} = random error

The data were analyzed using the General Linear Model (GLM) of SAS 9.2 (2002). Turkey's honest significant test was employed for separation of treatment means.

3. 3. Results and Discussion

3.1. Mineral composition of desho grass

3.1.1. Calcium (ca) content

The result of Ca content of the *Pennisetum pedicellatum* Trin. grass in the current study was higher than the reports of Heuze *et al*. (2015), Imoro *et al* (2012) for the same species but lower than the reports of Aguiar *et al*. (2006) for pangola grass. The calcium content of desho grass in the current study is higher than the requirement of a 3.7 g/Kg DM for a 20 kg live weight sheep grows 100 g/ day and 2.6.g/ Kg DM for growing 500 kg cattle (Underwood and Suttle, 1999). Forages are generally satisfactory sources of calcium (Ca) for grazing livestock, particularly when they contain leguminous species. Minson (1990) gives the average published values as 14.2 and 10.1 g Ca kg per kg dry matter (DM) for temperate and tropical legumes and 3.7 and 3.8 g Ca kg21 DM for the corresponding grasses. Forage calcium

requirements of grazing animals are influenced by animal type and level of production, age and weight (McDowell, 1985). However, it has been suggested that ruminants with high production of milk or any product may increase up the level of 1.2 to 2.6 g/kg for lactating animals. Generally, Sykes and Field (1972) suggested that levels of 2.5 g/kg are adequate in most circumstances. The minimum calcium and phosphorus requirements generally recommended for the maintenance of domestic livestock under range conditions are 0.32% and 0.17%, respectively and beef cattle require 0.16% to 0.60% calcium and 0.16% to 0.43% phosphorous of dry matter ration, depending on sex, age, and growth condition (NRC, 1970).

Though phosphorus is very critical in dairy diets (Hersom, 2010), calcium and phosphorus have integrated functions in animals and the absorption as well as intake of calcium and phosphorus must be adequate since the absorption of these two important minerals depends on their combined ratio. Variations in the levels of Ca between the present findings and those already reported in the literature could be partly due to mature forage specie, composition of forages and environmental conditions.

3.1.2. Phosphorous (P) content

The mean phosphorous content found in the current study was in agreement with the phosphorous content for Pangola grass (Heuze *et al*. 2015) but higher than reports of Aguiar *et al* (2006) for *Pennisetum pedicellatum* and *Pennisetum gaucum*. Phosphorous content of desho grass was within the range of the general requirement of livestock. The phosphorus status of forages varies widely and is influenced primarily by the phosphorus status of the soil, the stage of maturity of the plant and the climate. On average, phosphorus concentrations increase by 0.03–0.05 g kg21 dry matter (DM) mg21 extractable soil phosphorus (Minson, 1990; Jumba *et al*., 1995). Temperate forages generally contain more phosphorus (P) than tropical forages (3.5 vs. 2.3 g P kg21 DM) and legumes slightly more than grasses (3.2 vs. 2.7 g P kg21 DM) (Minson, 1990), but there are exceptions. Tropical legumes, such as *Stylosanthes,* grow vigorously on soils that provide insufficient phosphorus for other species, but their phosphorus status remains low (often < 1.0 g P kg21 DM). Distribution of phosphorus between leaf and stem is relatively uniform, but there is a marked reduction in whole-plant phosphorus concentrations as the forage matures, particularly during the dry season.

3.1.3. Magnesium (Mg) content

The mean magnesium content of desho grass in the current study was 4.22 g/kg. The result is lower than the reported in Gana (Imoro *et al*., 2012). The magnesium content of herbage plants varies with the species and with the soil and climatic conditions in which the plants are grown. In temperate pastures, leguminous species are usually richer than grasses in magnesium (Mg), as they are in calcium (Thomas *et al*., 1952; Turner *et al*., 1978). The finding is in agreement with the results of Minson (1990) 2.6 and 2.8 g Mg per kg DM reported for temperate and tropical grasses.

3.1.4. Manganese (Mn) content

The function of manganese (Mn) in the animal body is related to manganese deprivation has been shown to impair immunity (Hurley and Keen, 1987) and central nervous system (CNS) function (Hurley, 1981). The available Mn in desho grass was within the recommended dose 16 mg/Kg DM of feed for sheep and cattle. However, the result of manganese in the current study was lower than Zafar *et al*. (2009).

3.1.5. Zinc (Zn) content

The mean zinc concentration of desho grass was 18.34 mg/kg which was lower than most pastures the mean zinc concentration in pastures is 36 mg kg21 dry matter (DM);values vary widely (range 7 to 100 mg kg21 DM), but a high proportion lie between 25 and 50 mg kg2 DM (Minson, 1990). The requirement of Zn for ruminants is with the range of 18–42 mg Zn kg21 DM, which appears adequate. Also, Zn concentration was found adequate for growing ruminants suggested by Zafar *et al*. (2009).

3.1.6. Iron (Fe) content

The mean iron (Fe) concentration of desho grass in the current study was 319.65 mg/kg which is much higher than the recommended adequate level for grazing animals (McDowell, 1985; Khan *et al*., 2005). High Fe of desho grass in the current study is in agreement with earlier reports of other countries (Khan *et al*., 2003; Zafar *et al*., 2009). Most plant materials used in the feeding of farm animals contain large, though variable, concentrations of iron, depending on the plant species, the type of soil on which the plants grow

and the degree of contamination by soil. Experiments with weaned growing–finishing lambs show that 10 mg Fe kg21 DM is inadequate and that their minimum requirements lie between 25 and 40 mg kg21 DM (Lawlor *et al*., 1965).

3.2. Effect of location on mineral concentration of *desho* grass

The effect of altitude on mineral concentration of desho grass is presented in Table 1. The result indicated all of the micro minerals analyzed from desho grass were not significant (P>0.05). From the macro minerals calcium (ca) was not significant (P>0.05) due to altitude however magnesium (Mg) and phosphorous (P) were significantly affected (P<0.05) by differences in environment.

Table 1. Mineral composition of desho grass

	Minerals					
Location	Fe (mg/Kg)	Zn (mg/Kg)	Mn (mg/Kg)	Mg (g/Kg)	Ca (g/Kg)	P (g/Kg)
Mid	386.7[a]	19.1[a]	81.8[a]	5.1[a]	3.9[a]	2.9[b]
High	252.6[a]	17.6[a]	58.5[a]	3.3[b]	3.4[a]	2.3[a]
Mean	319.7	18.3	70.2	4.2	3.7	2.6
SD	186.6	2.4	27.3	1.3	0.8	0.5

SE= standard Error; Means under each row with different superscripts are significantly different (P<0.05).

3.3. Effect of stage of maturity on mineral concentration of *desho* grass

The effect of stage of maturity (early, mid and late) on mineral concentration of desho grass is presented in Table 2. The result indicated all of the micro minerals analyzed from desho grass were not significant (P>0.05) due to differences in stage of maturity. The magnesium and calcium concentrations of desho grass however, were decreased (P<0.05) as the time of harvesting increased. This may be due to the fact that grasses vary in their genetic capacity to take up minerals from the soil and in their mineral requirements for growth. The concentration of minerals in forages is determined largely by its stage of growth. The result of this finding is in agreement with reports on macro-minerals in Napier grass which declined with advancing stage of growth (Minson, 1990; Kariuki *et al*., 1999).

Table 2. Mineral composition of desho grass

	Minerals					
Maturity stage	Fe (mg/Kg)	Zn (mg/Kg)	Mn (mg/Kg)	Mg (g/Kg)	Ca (g/Kg)	P (g/Kg)
Early (90 days)	398.3[a]	19.3[a]	80.2[a]	5.2a	4.4[a]	2.7[a]
Mid (120 days)	282.2[a]	18.5[a]	76.2[a]	3.9[b]	3.7[b]	2.6[a]
Late (150 days)	278.5[a]	17.2[a]	54.0[a]	3.6[b]	3.1[b]	2.5[a]
Mean	319.7	18.3	70.2	4.2	3.7	2.6
SE	186.6	2.4	27.3	1.3	0.8	0.5

SE= standard Error; Means under each row with different superscripts are significantly different (P<0.05).

The results of this study are in agreement with different workers (Underwood, 1981; Little, 1982; Kariuki *et al*., 1999) who stated that mineral concentration in forages decline significantly with maturity, but the rate and extent of this decline varies with time of year, soil type, soil nutrient levels and seasonal conditions. Kariuki *et al*. (1998) also reported that grass harvested at younger stage contains satisfactory levels of calcium (Ca) and phosphorus (P) that can sustain acceptable growth performance of animals (Kariuki *et al*., 1998).

Different workers in Ethiopia on other species grasses (Zinash *et al*., 1995; Diriba, 2000; Adane, 2003) reported that the ash concentration of the grasses declined significantly as cutting interval increased. Moreover, Hassan *et al*. (1990) reported that ash content of grass significantly declined as days of harvesting increased from 2 to 8 weeks. Taye (2004) reported the highest ash content of Napier grass at shortest days of harvesting after planting. Bana grass harvested at 10 weeks of age contained 9.3% ash (Gwayumba *et al*., 2002). Schreuder *et al*. (1993) reported that bana grass harvested at 9, 12, 18 and 22 weeks of age

produced 17.2, 15.5, 15.4 and 15.3 % ash, respectively. Total ash was also influenced by the available plant density per unit area. This implies that the mineral content in the plant tissue decreases and the uptake gradually increases with increment of plant density mainly for dilution of minerals account of higher population of grasses in the higher planting density resulted in inter and intra-specific competition. When mineral nutrients in herbage are marginal in respect of animal requirements, changes in concentrations brought about by climatic, managerial or seasonal influences and plant maturity are significant factors in incidence of deficiency state in livestock which wholly or largely depend on plants (Underwood, 1981).

Taking the common macro minerals, calcium and phosphorus content of grasses was affected by days of harvesting (Kariuki *et al*., 1999). The highest calcium (0.80%) and phosphorus content (0.21%), and the lowest calcium (0.53%) and phosphorus content (0.17%) of Napier grass were obtained at 68 and 114 days of harvesting, respectively (Tessema *et al*., 2002). In contrast, Wirch *et al*. (2000) on similar grass reported that there were no significant differences in calcium and phosphorus content at 30 and 40 days of harvesting interval. Overall the here was significant difference ($P<0.05$) in calcium content (Ca) of *desho* grass harvested at different dates after harvesting and significantly higher percentage composition of calcium was recorded from the grass harvested at 90 and 120 days after planting). On the contrary, phosphorus content (P) of the grass showed variation with change in altitude rather ($P>0.05$) than with variation. Among macro minerals, phosphorous and calcium are the most important nutrients required for normal animal performance. The P content of the *desho* grass planted in the mid altitude was (2.86g/kg) significantly higher than that planted in the high altitude (2.32g/kg), which may be due to the variation in soil characteristics and climatic condition which determine the uptake of soil nutrients by the plants. Deficiencies of minerals in livestock nutrition likely to affect production of pasture based livestock under extensive livestock production systems unless mineral content and overall nutrient content status of such pastures are monitored.

4. Conclusion

Knowing only the ash content of forage grass materials does not provide sufficient information to rely solely upon whereas the amount of the respective minerals present often gives information that is more useful. This study was primarily aimed at giving an insight into the identification of mineral content of *desho* grass harvested in different stages and altitudes. Most of the mineral components were above the requirement of animals as recommended by NRC. The results of this study revealed that the content of minerals in *desho* grass was affected by both location and stage of maturity. Moreover, though the finding of this research indicated that almost all of the minerals were within the range of required levels of livestock. Thus, to have more crucial information on bioavailability of mineral elements, further study on animals fed *desho* grass based diet and the recommended levels of mineral nutrients needed in their diet. As a conclusion, further study should be conducted on multiplications and using different fertilizer types and rates to find the maximum amount of each mineral from the grass for better livestock production in the area.

Conflict of interest

The author declares that there is no conflict interest regarding the publication of this paper in the journal.

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Effect of Fish Offal Meal on Feed Intake, Growth Performances and Carcass Characteristics of Hubbard Classic Broiler Chicken Breeds

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Abstract: *The effect of partial substitution of full-fatted soybean poultry meal by fish offal meal in broiler chicks was investigated. The experiment had four treatment diets: diet-1(control, without animal protein); diet-2 (local fishmeal); diet-3 (fermented fish silage); and diet-4 (local tilapia meal). Treatment diets substituted the full-fatted soybean meal in the control diet at 5% level. Unsexed 180, one day old Hubbard Classic broiler chicks were randomly allocated tothe four treatment diets. Treatments had three replications of 15 birds per pen, in a completely randomized design. The experiment has three phases and lasted for 42 days. Overall, feed intake, body weight changes (BWC) and average daily body weight gain (ADG) were significantly ($p < 0.05$) affected by a diet that diet-1 was lower than fish offal based diets (diets 2, 3, and 4). During the starter period, birds in diet-1 and diet-4 had lower ($p<0.05$) BWC and ADG than diet 2 and 3. During the finisher period, birds in diet-4 had heavier ($p< 0.05$) BWC and ADG than diets 1 and 3. There was significantly ($p< 0.05$) better feed conversion ratio during the finisher period in diet-1 and diet-4 than the rest of the treatments. During the experimental period, higher mortality ($p<0.05$; 11.1%) was recorded in diet-1 than other diets. Diet-1 was lower in most of the carcass parameters studied. To conclude, regardless of fish species differences, incorporation of fish offal meal into plant-sourced protein diet improves the performance of broiler chicken. In addition, the results indicated that fish silage can also be an alternative to fishmeal.*

Keywords: Feed conversion ratio, feed intake, fermented fish silage, local fishmeal

1. Introduction

Chicken population in Ethiopia is estimated about 50.38 million, of which 2.56% are crossbreds and 0.54% exotic breeds (CSA, 2013). Exotic chicken breeds that are selected especially for meat purpose are termed as broilers. Nowadays it is possible to get a 2 kg live weight broiler within 35 to 42 days, with only 3 kg of feed (Klasing, 2007; Choct, 2009). Feed contributes nearly 65-70% of the total running cost in modern chicken production. In relation to this, plant-sourced protein feed is becoming expensive in Ethiopia due to factors like oilseeds export, animal feed export, competition with human food and high processing cost (Gebremedhin *et al.*, 2009; Hassen *et al.*, 2009).Therefore, utilization of unconventional feed sources like fish offal meal in animal ration would benefit poultry production (Ristić *et al.*, 2001; Agunbiade *et al.*, 2004).

Fish production in Ethiopia, in 2001, was estimated to be 15,400 tons (FAO, 2003). An estimated maximum annual fish production level from Lake Tana was estimated to be 15,000 tons. According to Ann and colleagues, about 8 tons of frozen fillets (roughly 20 tons of whole wet fish) was obtained weekly from three sources of fish suppliers from Lake Tana, with considerable seasonal variation (Ann *et al.*, 2007). In two-thirds of the year, this would amount to 680 tons of fish per annum (weight of whole wet fish).

Considering 60% of the fish weight as fish offal, 12 tons and 408 tons of fish offal (FO) can be generated on the weekly and yearly basis, respectively. Only one processing plant, throughout Amhara region, attempts to incorporate fishmeal into animal feed for sale. It collects fish offal once a week from only one of the three landing sites, excluding summer time. The remaining largest portion of the offal has been dumped around the shore contributing its share for environmental pollution. Summer rain, area of processing, processing cost and sanitation are important problems that have been encountered in fish meal processing in the region. Accordingly, alternative preparation of fish meal like Fermented fish silage can be considered to reduce pollution, storage costs, area of processing, initial capital and enables

year-round production with simple technique (Windsor and Barlow, 1981; Sumarsih *et al.*, 2010). Fermented fish silage is believed to have enzymes or bioactive peptides that may enhance growth and disease resistance of animals (Enes Dapkevicius *et al.*, 2007; Garcia *et al.*, 2007).This experiment was conducted to investigate the potential use of fish offal from Lake Tana as a protein supplement in broilers diets.

2. Materials and Methods

2.1. Description of the study area

The experiment was conducted at Zenzelma campus of Bahir Dar University, which is situated 6 km north of the regional capital Bahir Dar, with an elevation of 1912 meters above sea level, between latitude and longitude of 11°37′N and 37°29′E coordinates (Google-Earth, 2013). It is found in Bahir Dar Duria District, West Gojam zone. The average daily minimum and maximum temperatures were 7 °C and 29 °C, respectively. The mean annual rainfall is 1445 mm. Cattle, Goats, Cow's milk, Chicken,and Egg are the main source of income from livestock. Lake Tana is located adjacent to Bahir Dar with an area of 3500 km^2 with a mean depth of 9 meters, and a maximum depth of 14 meters. It is the largest freshwater lake in the country and the third in Nile Basin with a leading (80%) contribution to the Blue Nile River. It contributes about 20-31% of the total fish production potential of the country (Tesfaye, 1998; Wondie, 2010).

2.2. Experimental feed preparation

2.2.1. Experimental feed processing

Fish offal from three fish species such as tilapia (*Oreochromis niloticus*), catfish (*Clarias garipienus*) and *Labeobarbus* was collected from St. George fish cooperative, around Lake Tana, in Bahir Dar city, on January 04, 2014. The fish offal was prepared into three meal types: 1) Local fishmeal - a composition of three fish species (catfish, *Labeobarbus,* and tilapia) offal; 2) Fermented fish silage - a composition of three fish species (catfish, *Labeobarbus* and tilapia) offal and 3) Local tilapia meal made of only offal of tilapia species. Red kidney bean, soybean, corn, wheat bran, limestone, salt and noug seed cake (*Guizotia abyssinica*) were purchased from Bahir Dar area. General premix, Di-Calcium Phosphate, HCL- L-lysine and D-L methionine were purchased from Addis Ababa.

Local fishmeal and local tilapia meal preparation were following the same procedure. Based on Degebassa *et al.* (2008), about 50 kg of fish offal with 15 liters of water was put in an open barrel, minced, and heated to 95-100 ^{O}C over a period of 18-20 minutes. The cooked material was pressed to separate solids (press cake) from liquids (press liquor) in which oil and water were separated by settling (FAO, 2013). The pressed by-products were spread on a rack for sun drying for five consecutive days (Degebassa *et al.*, 2008). Fermented fish silage was prepared by mincing the wet offal and boiled into a hot bowl at 115-120 ^{O}C for 5-10 minutes. Then, the boiled offal (60%) was put into a clean container with mixtures of malt (15%), molasses (5%), effective microbes (lactic acid bacteria; 5%) and sweet potato (15%) (Tibbetts *et al.*, 1981). The silo (offal and starter) was then mixed and sealed in a plastic container, airtight. It was stirred, at least twice a day for the first two weeks and preserved for one-month duration. Finally, the semi-liquid silo was exposed to the sun for five days for drying (Al-Marzooqi *et al.*, 2010).

Full-fatted soy and red kidney beans were processed in the same way, to remove trypsin inhibitors. The beans were submerged in cold water for 20 hours with occasional stirring and subsequently decanting the water and the mixture was brought to a boiling point at 100ºC for 30 minutes. The soaked beans were allowed to cool, sun-dried and ground.

2.2.2. Laboratory analysis

Representative samples of the experimental diets of local fishmeal, fermented fish silage, local tilapia meal and full-fatted soybean were sent to Bahir Dar University, the then Poly Campus, Food Science,and Technology Laboratory for chemical analysis. The samples were finely ground and sieved through 3 mm sieve with three replications each. The samples were analyzed for moisture, ash, crude protein, fat and carbohydrate (CHO) contents following the standard procedure (AOAC, 2000).

2.2.3. Feed formulation

The treatment rations were isocaloric and isonitrogenous with Metabolisable Energy for starter ranging from 3074 - 3086 and finisher 3198 - 3235 kcal kg^{-1} DM. Average crude protein for starter ranges from 22.03 - 22.45 and finisher 20.08 - 20.18%. Energy was calculated using Wiseman

(Wiseman, 1987): ME (kcal kg-1 DM) = 3951 + 54.40 fat – 88.70 crude fiber – 40.80 ash. The ration was formulated as shown in Table 1.

2.3. Management of experimental birds

The experimental house was cleaned, washed with tap water and disinfected with formic acid. The house was left empty for twenty-four hours before placing the experimental birds. A total of 180, unsexed, one-day-old Hubbard Classic broiler chicks were purchased from Andasa Poultry Farm. Four treatment groups, each with three replications, having 15 birds in each pen (replication) were distributed randomly, with a completely randomized design (CRD). The feeding trial lasted for six weeks (42 days). The total area used by the experimental birds was 9.9m^2. The birds were brooded with electric brooder of 200 Watt bulb for two weeks with 23 hours of light per day. The birds were reared on slatted floor covered with sawdust and teff straw, vaccinated against Newcastle at 1stand 7th day, and Gumboro at 14th day with Thermostable Newcastle and IBD vaccines, respectively. Birds were fed and watered *ad-libitum.* Feed leftover was collected and weighed daily for intake determination. The weight of birds was measured once every week, for seven times starting from one-day-old.

Table 1. Proportion of ingredients used in formulating broiler starter and finisher diets and chemical composition of treatment diets

	Treatment Diets							
	Starter (1-21 days) %				Finisher (22-42 days)%			
Feed components	Diet-1	Diet-2	Diet-3	Diet-4	Diet-1	Diet-2	Diet-3	Diet-4
Corn	30	32	32	32	40	44	44	44
Wheat bran	5	10	3	6	0	0	0	0
Full-fatted soybean	10	5	5	5	10	5	5	5
Full-fatted red kidney bean	24	20	25	23	24.4	22.4	19.4	20.4
Noug seed cake	26	23	25	24	22	20	23	22
Local fishmeal	0	5	0	0	0	5	0	0
Fermented fish silage	0	0	5	0	0	0	5	0
Local tilapia meal	0	0	0	5	0	0	0	5
General Premix[1]	1	1	1	1	1	1	1	1
Limestone	0.25	0.25	0.25	0.25	0.50	0.50	0.50	0.50
Di-calcium phosphate	2.00	2.00	2.00	2.00	1.50	1.50	1.50	1.50
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
L-lysine	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00
DL- Methionine	0.25	0.25	0.25	0.25	0.10	0.10	0.10	0.10
Calculated composition (DM)								
Dry Matter (DM)	90.91	90.93	90.84	90.0	90.50	90.48	90.37	90.44
Ether Extract (%)	4.19	4.17	3.93	4.04	4.39	4.47	4.36	4.44
Crude Protein (%)	22.25	22.03	22.45	22.2	20.18	20.16	20.08	20.12
Methionine (%)	0.60	1.25	1.14	0.56	0.43	1.10	1.25	0.40
Lysine (%)	1.57	3.60	3.80	1.66	0.74	2.75	2.99	5.52
Meth + Cyst	0.49	0.47	0.43	0.50	0.34	0.34	0.30	0.30
Crude Fiber (%)	8.30	7.76	7.73	7.67	7.21	6.52	6.99	6.83
Ca (%)	1.11	1.09	1.10	1.10	1.08	1.07	1.07	1.07
P (%)	1.19	1.10	1.13	1.12	1.01	0.95	0.95	0.95
ME(K. cal/kg)[2]	3074	3086	3086	3085.2	3212	3235.4	3198.2	3209.1

Note: ME= Metabolizable energy, Kcal/kg; Diet-1= control diet; Diet -2= Diet containing 5% Local fishmeal; Diet -3= Diet containing 5% Fermented fish silage; Diet -4= Diet containing 5% Local tilapia meal.[1]General premix inclusion rate in the diet; Vit A, 750,000IU; D3, 450,000IU; Alpha Toco acetate,1,000mg;Vit $_k$ 200mg; vit$_{B1,}$ 100mg,B2,500mg;B6,150 mg;B12, 1mg;Biotin, 5mg; Nicotinic acid,2000mg,Folic acid 50mg;Panthothenic acid,900mg;choline chloride,1000mg; Ca336400.2mg, Iron (Fe) 2000mg, Iodine(I) 120mg, Cobalt (Co) 20mg, Copper (Cu) 500mg, Manganese (Mn) 8000mg, Zinc oxide (Zn) 5000mg, Selenium (Se) 20mg, Citric acid 250 mg. [2]Metabolizable energy (ME) using Wiseman (Wiseman, 1987) formula: ME (kcal/kg) =3951 + 54.40 fat – 88.70 ash.

2.4. Data collection management

Feed intake was determined as the difference between the feed offered and refused collected every 24 hours. Individual birds were weighed weekly per pen base. The body weight change (BWC) of birds was calculated as the difference

between the final and initial body weight. Average daily body weight gain (ADG) was calculated as the ratio of BWC to the number of experimental days. Feed conversion ratio (FCR) was computed as the ratio of daily feed intake to ADG. Mortality was recorded on-time and any abnormality was also monitored. At the end of the experiment, two birds per replication with body weight closer to the mean were starved overnight and weighed at slaughter for carcass evaluation using electronic weighing balance. They were killed by severing the jugular vein. Carcass evaluation was done following the procedures described by Kubena *et al.* (1974).Dressed carcass weight was measured after removing the blood and feather. Dressing percentage was calculated as the proportion of dressed carcass weight to slaughter weight multiplied by 100. Eviscerated carcass weight was determined after removing lower leg (shank), head, kidney, lung, pancreas, crop, proventriculus, small intestine, large intestine, ceca and urogenital tracts from the dressed carcass. The eviscerated percentage was determined as the proportion of the eviscerated weight to slaughter weight multiplied by 100. Fat around the proventriculus, gizzard, against the abdominal wall and the cloacae were collected and weighed. Fat percentage was calculated as the proportion of slaughter weight multiplied by 100. The edible organ parts, heart, gizzardand liver, were also weighed and expressed in percentage, in relation to slaughter weight.

2.5. Statistical analysis

The data collected from the experiment was initially fed to Excel sheet, and after checking the validity of the data it was analyzed with the General Linear Model (GLM) procedures of the Statistical Analysis System (SAS, 9.2) software. Significantly different treatment means were compared using Duncan's multiple range tests.

3. Results

3.1. Chemical composition of feed ingredients

The chemical composition of treatment feeds of fish offal meals (local fishmeal, fermented fish silage,and local tilapia meal) and full-fatted soybean meal determined are presented in Table 2. The ash and crude protein contents were higher in fish offal meals than full-fatted soybean mean. The moisture, carbohydrate and fat contents were lower in fish offal meals than full-fatted soybean. The highest moisture content was observed in the fermented fish silage (7.34%) and full-fatted soybean meal (7.4%), and the least was in the local fishmeal (4.61%).

Table 2. Chemical composition (proximate analysis) of ingredients used in the experimental diet

Sample	Moisture (%)	ASH (%)	CP (%)	FAT (%)	CHO (%)	ME (Kcal/kg)
Fermented fish silage	7.34	21.00	41.37	15.02	15.28	3.908.30
Local tilapia meal	5.79	25.59	44.26	18.52	5.85	3,778.55
Local fishmeal	4.61	27.25	48.85	16.77	2.52	3,741.70
Full-fatted soybean	7.40	4.70	36.60	18.70	32.60	4,324.15

CP = crud protein; ME= Metabolizable energy calculated using Wiseman (Wiseman, 1987) formula: ME (kcal/kg) =3951 + 54.40 fat – 88.70 ash; CHO = carbohydrate content calculated as 100-moisture-ash-CP-fat in percent

3.2. Feed intake

The feed intake (FI) of experimental birds is shown in Table 3. Birds in diet-1 (81.98 g) had significantly lower ($p<0.05$) FI than the fish offal based diets during the finisher and overall experimental period. Birds in diet-3 (119.77 g) had the highest ($p<0.05$) FI during the finisher period. Figure 1 illustrates the linearly increasing trend of overall feed intake of birds during the experimental period.

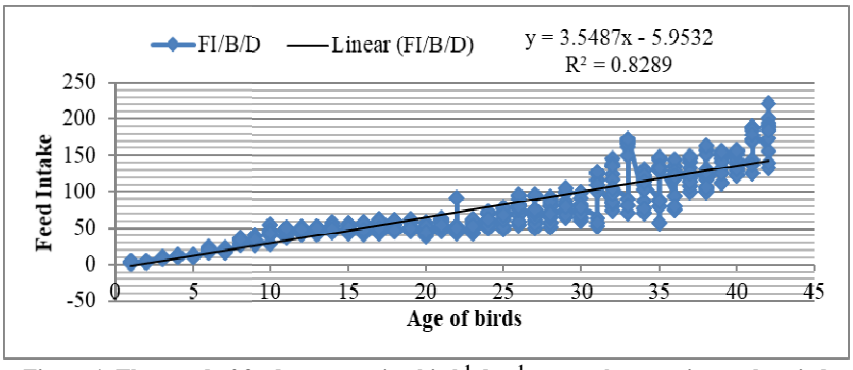

Figure 1. The trend of feed consumption bird^{-1} day^{-1} across the experimental period

3.3. Body weight change

The final body weight (FBW) and ADG are presented in Table 3. During the starter period, birds in diet-3 (417.98 g) had the heaviest ($p<0.05$) FBW followed by those in diet-2 (384.44 g). During the finisher period, birds in diet-1 (1208.56 g) weighed significantly lower ($p<0.05$) than the rest of the treatment groups. During the starter period, ADG was higher ($p<0.05$) in diet-3 (17.78 g), followed by birds in diet-2. During the finisher period, ADG of birds in diet-4 were significantly ($p<0.05$) higher followed by diet-3. For the overall period, birds in diet-1 (41.7 g) obtained the least ADG ($p<0.05$).

3.4. Feed conversion ratio

The feed conversion ratio (FCR) of birds during the experimental period is summarized in Table 3. During the finisher period, FCR was significantly higher ($p<0.05$) for diet-1 and diet-4.For the overall period, FCR was the highest for birds in diet-3 while those indiet-4 had the lowest ($p<0.05$) FCR among the experimental diets.

3.5. Mortality rate and problems

The mortality rate of experimental birds was significantly higher ($p<0.05$) in diet-1 than the fish offal based meal fed birds (Table 3). For dead birds, stretching wings and heads back, reduced feed intake, opening the mouth, increased breathing and closing the eye were observed symptoms on the verge of their death. Deformity of phalanges and leg problem was observed in heavy birds feeding on fish offal based diets.

3.6. Carcass components

The mean weight of carcass components of experimental birds is presented in Table 4. There were significant differences ($p<0.05$) among the treatment diets for all the carcass parameters measured, with the exceptions for the eviscerated, liver and heart ($p>0.05$) weight percentages. Weight at slaughter was lower for diet-1 than fish offal based diets. Birds in diet-3 had the heaviest dressing percentage (91.82 %; $p<0.05$) than birds in diet-1. Fishmeal based diets (diet-2 and diet-4) produced the heaviest ($p<0.05$) abdominal fat accumulation followed by diet-3. Diet-2 was the heaviest ($p<0.05$) in gizzard weight, followed by diet-4. There was no significant difference ($p>0.05$) in all parameters between male and female experimental birds.

Table 3. The mean feed intake, body weight change, feed conversion efficiency and mortality rate of birds fed on different diets

Parameters	Treatment diets				
	Diet-1	Diet-2	Diet-3	Diet-4	P-value
FI (g/b/d)					
Starter	31.75±2.07	36.56±2.41	39.53±2.61	34.56±2.21	0.118
Finisher	81.98±3.93^{c}	114.62±5.54^{ab}	119.77±4.94^{a}	103.99±5.08^{b}	0.001
Entire experiment	56.86±3.15^{b}	75.59±4.61^{a}	79.65±4.54^{a}	69.27±4.15^{a}	0.001
IBW (g/b)	44.52±0.05	44.73±0.06	44.8±0. 058	44.72±0.034	0.708
FBW (g)					
Starter	332.89±6.16^{c}	384.44±6.59^{b}	418.22±6. 74^{a}	335.13±8.73^{c}	0.0001
Finisher	1208.56±7.77^{b}	1499.81±24.43^{a}	1518.75±18.79^{a}	1492.27±19.81^{a}	0.0001
BWC (g/b)					
Starter	288.37±6.16^{c}	339.71±6.59^{b}	373.41±6.74^{a}	290.41±8.73^{c}	0.0001
Finisher	875.67±9.56^{c}	1115.37±23.92^{ab}	1100.53±18.11^{b}	1157.14±20.84^{a}	0.0001
Entire experiment	1164.04±7.77^{b}	1455.08±24.43^{a}	1473.95±18.79^{a}	1447.55±19.81^{a}	0.0001
ADG (g/b)					
Starter	13.73±0.29^{c}	16.18±0.32^{b}	17.78±0.32^{a}	13.83±0.42^{c}	0.0001
Finisher	41.7±0.46^{c}	53.11±0.14^{ab}	52.41±0.86^{b}	55.1±0.99^{a}	0.0001
Entire experiment	27.72±0.19^{b}	34.64±0.58^{a}	35.09±0.45^{a}	34.47±0.47^{a}	0.0001
FCR (Feed: Gain)					
Starter	2.33±0.15	2.26±0.06	2.22±0.01	2.51±0.13	0.287
Finisher	1.97±0.07^{b}	2.16±0.06^{a}	2.29±0.02^{a}	1.89±0.05^{b}	0.002
Entire experiment	2.05±0.04^{bc}	2.19±0.06^{ab}	2.27±0.02^{a}	2.01±0.04^{c}	0.008
Mortality rate	11.11±2.22^{a}	2.22±2.22^{b}	0^{b}	4.44±2.22^{b}	0.017

Diet-1= control diet; Diet -2= Diet containing 5% Local fishmeal; Diet -3= Diet containing 5% Fermented fish silage; Diet -4= Diet containing 5% Local tilapia meal. Means within a row with different superscripts differ significantly ($P < 0.05$); SEM: Standard error of the mean; ADG: Average Daily body weight Gain; BW: Body weight; IBW: Initial BW; FBW: Final BW; BWC: body weight change; FCR: Feed conversion ratio; FI: Feed intake.

Table 4. Carcass components and organ weights of broilers fed different fish offal based protein diets

Parameters	Treatment diets				sex	
	Diet-1	Diet-2	Diet-3	Diet-4	Male	Female
Slaughter wt.(g)	1024.1±9.79^{b}	1383.72±1.62^{a}	1390.7±14.52^{a}	1377.5±9.34^{a}	3020.8±49.16	1267.3±45.92
Dressing %	84.23±0.53^{b}	85.8.8±0.8^{ab}	88.49±1.69^{a}	85.84±0.24^{ab}	86.61±0.87	85.50±0.71
Eviscerated %	67.97±0.87	68.20±0.55	69.67±0.85	69.27±0.90	68.99±0.55	68.57±0.61
Abdominal Fat%	0.76±0.03^{c}	0.98±0.02^{a}	0.91±0.03^{b}	1.01±0.03^{a}	0.93±0.03	0.9±0.03
Liver wt (g)						
Liver %	2.29±0.11	2.18±0.07	2.11±0.09	2.25±0.06	2.20±0.05	2.22±0.06
Heart %	0.57±0.02	0.53±0.01	0.54±0.02	0.55±0.01	0.55±0.01	0.54±0.01
Gizzard %	1.63±0.07^{c}	2.17±0.05^{a}	1.53±0.05^{c}	1.98±0.07^{b}	1.87±0.08	1.78±0.09

Diet-1= control diet; Diet -2= Diet containing 5% Local fishmeal; Diet -3= Diet containing 5% Fermented fish silage; Diet -4= Diet containing 5% Local tilapia meal. Means in the same row with different subscripts are significantly different ($P < 0.05$).

4. Discussion

4.1. Chemical composition of feed ingredients

The higher ash content of fish offal meals than plant protein agrees with literature (Ojewola *et al.*, 2005) that mineral-rich parts in fish offal, as bone, cartilage and scales increased the ash content. The relatively lower crude protein content in fermented fish silage might be due to the lower amount (only 60%) of fish offal input than the other fishmeal diets and the processing methods. Generally, the proximate analysis of this study is in line with previous reports on fish species of crude protein, ether extract and ash contents (Kassahun *et al.*, 2012). But, the ash and fat components of the local fishmeal in this study was higher and protein content was lower than the study by Ojewola *et al.* (2005).This could be due to the difference in selecting the fish offal parts for local fishmeal processing and the method of reducing the fish oil during processing.

4.2. Feed intake

The reduction in feed intake observed in diet-1 might be due to the remnants of anti-nutritional factors (ANFs) after treatment and relatively higher crude fiber in the beans. High fiber from processing is considered as feed intake limiting factor (Obasuyi and Nwokoro, 2006; Rougière and Carré, 2010). The reason for lower FI of diet-4 during the finisher period was probably due to tilapia's higher fat content known to have low digestibility by starter birds. One of the major problems associated with the use of fats in poultry nutrition is the inefficient digestion and absorption in young chickens (Al-Marzooqi and Leeson, 1999). The leading feed intake of diet-3 could be due to, relatively, higher palatability than other diets. Previously, Enes Dapkevicius *et al.* (2007)reported that lactic acid fermentation improves the acceptability of animal feeds.

4.3. Body weight change

The poor growth performance in diet-1 than fish offal based diets could be feed quality difference, which is from the anti-nutrition factors and the reduced non-protein nitrogen content of soybean meal during processing (Ofongo and Ologhobo, 2007; Al-Marzooqi *et al.*, 2009). This finding generally agrees with other observations that an inclusion of animal protein in broiler ration increases performance than plant-sourced protein diets alone (Olomu, 1976; Ojewola *et al.*, 2005). The reason for the highest ADG during the starter period in diet-3 could be due to the fermented fatty acids and amino acids in fish offal became readily absorbable by young birds. Lactic acid fermentation provides fat stability in fish silage and improving acceptability in the animal feed (Enes Dapkevicius *et al.*, 2007). Based on Al-Marzooqi *et al.* (2010), fermented fish silage is recommended to have some soluble proteins rapidly absorbed and promote an early protein synthesis in chickens. But, during the finisher period, diet-4 was significantly better ($p<0.05$) in gain than diet-1 and diet-3. The reason could be the physiological adaptation of grower birds in utilizing crude fat in fishmeal diets. Fishmeal is fairly rich in all amino acids including unidentified growth factors and can rectify amino acid deficiency (Ojewola *et al.*, 2005). This finding was in line with literature that none of the animal protein sources were inferior to the plant-based protein (control) (Mikulec *et al.*, 2004; Ojewola and Annah, 2006). Whereas, other scholars reported that the inclusion of fish silage in diets for

broiler chicks improved growth similar with soybean meal or fishmeal (McNaughton *et al.*, 1978; Johnson *et al.*, 1985).

4.4. Feed conversion ration (FCR)

The poor efficiency of diet-3 among the rest of the diets could be relative; it's better palatability and lowers CP content than the fish meal (diets 2 and 4). Besides, higher ash content among fish offal based diets than diet-1 could be the reason for reducing their feed conversion efficiency. The lower efficiency of the experimental birds than the standard of the same Hubbard classic birds could be the feed quality, housing condition, water intake, temperature stress, cell stress and general management of birds (Moges *et al.*, 2011).

4.5. Carcass components

The results obtained showed that higher live weights led to higher dressed weights which agree with other findings (Tesfaye *et al.*, 2012). Lighter birds in diet-1 relatively with the larger surface area were covered with feather as much as the heavier birds do. The carcass weight in Hubbard classic birds in this study was similar to other reports (Gangwar *et al.*, 2010; Girma *et al.*, 2011; Tesfaye *et al.*, 2012). The lower abdominal fat accumulation in diet-3 (0.91) than fishmeal-based diets (diet- 4 (1.01) and diet-2 (0.98)) could be an indication of the efficiency of diet-3 in producing quality lean meat since most carbohydrate (CHO) was replenished during fermentation of fish silage. The lowest fat accumulation in diet-1 birds could be due to feed intake deprivation. Based on Kubena *et al.* (1974) environmental temperature results in higher percentage of abdominal fat The weather fluctuation in the study area might have a contribution to lowering the overall abdominal fat of the experimental birds. The weight of gizzard in fish offal based meals (ranged 1.98- 2.17) was similar to the findings of Ojewola *et al.* (2005) that the fishmeal and crab meal diets ranged between 2.04 – 2.49%.Similar gizzard weights in diet-1 and diet-3 and also diet-2 and diet-4 might be due to the texture of the meals that the former were finer and the later coarser, respectively. An increase in muscular activity in the gizzard occurs breaking down more coarse meal in diets compared to the finer meal (Etuk *et al.*, 2012).

4.6. Mortality rate

The highest mortality rate in diet-1 could probably be due to the disease occurrence during the second week of the trial and the presence of ANFs and toxic effects from plant source ingredients in the diet. A similarcase was previously observed when birds fed on treated beans (Gangwar *et al.*, 2010). The minor incidence of lameness, like improper growth of phalanges and deformed legs observed in fish offal based meals, could be relatively due to their heavy, faster weight gain that limited movement.

5. Conclusion

Finally, from the above results, it can be concluded that fish species difference had no negative effect on the overall performance of the experimental birds except local tilapia meal which was relatively less effective for starter birds implying the potential use of fish-offal for poultry feed. The substitution of full-fatted soybean meal by fish offal meal (at 5%) had no negative effect on the performance of broilers, rather improved plant-sourced protein diet when mixed. Besides, fermented fish silage can be an alternate meal of fishmeal (in diet-2 and diet-4) at 5% inclusion rate for the positive effects of intake and production suitability than fishmeal diets.

Conflict of interest

The authors declare that there is no conflict of interest to publish this manuscript in the journal.

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Impact of Food Security Package Loan on Food Insecure Households' Income and Asset Creation: The Case of West Belesa District, North Gondar Zone, Ethiopia

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Abstract: *Food security package loan has been found to be a critical instrument in order to improve the income of food insecure households. The main purpose of the program was to enhance the food insecure livelihood status through accessing of micro credit. Therefore, the objective of this study was to analyze the impact of Food Security Package Loan (FSPL) of micro credit service on the income and livelihood of food insecure households residing in West Belesa District. The study applied an econometric model of propensity score matching (PSM) to analyze the impact of FSPL on the income and livelihood of households based on data collected from a sample of 254 rural households (157 were food insecure and 97 food secure). The results of the econometric analysis display that FSPL participation significantly affects positively household's on-farm and off-farm income, employment, animal hold, saving and children participation in formal school. However, the food consumption level and types of house owned show no difference. This suggests that the stakeholders (government authorities, NGOs, aid agencies, etc) that deemed micro finance as a means to poverty reduction should take into account the implications of these indicator variables for better promotion of micro finance specifically FSPL and devise an intervention mechanism to further expand its impact towards improving food consumption and household asset building.*

Keywords: Food security package, income, Livelihood, West Belesa District

1. Introduction

Over the past one decade and half, Ethiopia has accomplished significant economic growth and progress. On average annual GDP growth was 10.3% between 2004 and 2012. During 2004 poverty rate of Ethiopian rural population was 38.9% that was down to 29.6% in 2012 (RESET, 2016). Ethiopian economy heavily depends up on the agriculture sector. It remains the largest contributor of an economy with a share of around 80% of the total labor force, 42% of the GDP and 70% of foreign exchange earnings of the country (NPC, 2016). The sector holds the key to creation of demand in other sectors of the economy and remains by far an important indirect contributor to the country's GDP. Hence the capacity of the economy to address poverty, food insecurity and other social-economic problems is highly related with the performance of this sector (EEA, 2013). Since Ethiopian agriculture is rain-fed and nature dependent, the production rate and productivity of the sector is insufficient to cover the consumption needs of food insecure beneficiaries of the country who live in moisture stressed areas. This suggests that persistent poverty and poor chronic status are common manifestation particularly in these areas (Askal, 2010; Meseret, 2012) and chronic food insecurity remains the main features for Ethiopian rural poor (Gilligan *et al*., 2009).

Understanding the importance and the roles of agriculture in the economy, the government of Ethiopia (GoE) has implemented Agricultural Development Led Industrialization (ADLI) policy since 1990s. ADLI adopts rural and agriculture centered development as a long term strategy to achieve rapid and sustained economic growth by making use of technologies that are labor intensive, but land augmenting (such as fertilizer, improved seeds and other agricultural practices). Basing on this overarching policy and strategy, the GoE has also devised several other economic development policies and strategies since 2002, including Rural Development Policy and Strategies, Sustainable Development for Poverty Reduction Program, food security program and establishment micro finance institutions both in urban and rural area. All these policies and strategies are in general designed to bring about rapid and sustained economic growth, guarantee maximum benefits to the majority of the

population via addressing issues of poverty and food insecurity and promote the development of market oriented economy in Ethiopia (MoFED, 2003). Food security program collaborated with micro finance institutions to improve the food insecure households' income as well as their livelihood by financed their business activities.

As part and parcel of Food Security Program (FSP), starting from its inauguration in 2005, Productive Safety Net program (PSNP) includes resettlement, complementary community investment and recently Household Asset Building Program (HABP). As the second phase, according to Julie van and Coll- Black (2012), in 2009, Ethiopia has re-launched the FSP where Household Asset Building Program (HABP) replaced Other Food Security Program (OFSP), the later includes a demand driven extension, support component and improvements in access to financial services. It is argued that food security loan can play a major role in assisting the poor to move out of poverty by providing start–up capital which they have been unable to access historically because financial markets are underdeveloped and could not yet reach majority of the rural poor in most least developing economies (Getaneh, 2004).

However, still there is a debate in the academia and the literature of microfinance role in poverty reduction and food security. Some scholars argue that (despite claims about the role of microcredit in lifting the poor out of poverty, there is little agreement as to whether credit does borrowers more good than harm (Armendarize *et al*., 2010). In line with this, Ghalib (2007) suggests that poverty cannot be eradicated with small amount of money provided by micro finance institutions rather it implicates the poor in the long debt cycle.

Hossain (1988) and Mustafa (1996) found significant positive impacts of micro credit to alleviate poverty and food insecurity. Loan recipients showed higher income, capital accumulation, and value of house structure, children education, household nutrition and employments. On the other hand, Adams and Pischke (1992) found micro credit to be ineffective on the poor income and over all well-being status.

Despite these two opposing ideas, Food security package loan has been designed from 2010-2014 to provide micro credit through ACSI at subsidized interest rate at 10% and the non-subsidize interest rate at 15% to the food insecure beneficiaries to engage in different grave investment opportunities. In order to access micro credit to the food insecure beneficiaries, the program allocated 14 million birr for the district ACSI branch based on the total number of food insecure clients who live in the district (WBAO, 2016). The district ACSI branch has been giving microcredit services to the food insecure households based on the agreement made between ACSI and the district Agricultural Office. The district branch office has been addressing 2936 food insecure and food secured households and disbursed 16.02 million birr with average loan size of 4371.79 to 6777.14 birr minimum and maximum respectively (West Belesa Agricultural Office, 2016). Aiming to answer whether the food security program (FSP) achieved its objective that is expected from the microcredit service delivered to rural households in the study area, this thesis was conducted to analyze the impact of micro credit on food insecure households' income and livelihood change in West Belesa district. It also aimed to identify the timeliness of credit disbursement period and the time when the food insecure households require credit.

2. Research Methodology

2.1. Description of the study area

The study has been conducted in West Belesa District at North Gondar Zone of Amhara National Regional State, Ethiopia. It is among the chronically food insecure Districts in the region where the FSP has been implemented since 2005. The District comprises 30 administrative *kebeles* including Arbaya town. Among which 19 are food insecure *kebeles*. As seen in the map Figure1, the blue colored is food insecure and the green ones are food secure *kebeles* classified based on the exposed to drought and unable to cover annual food consumption level. 19 out of 30 *kebeles* are the food insecure *kebeles.*

West Belesa District is located at about 706 km North of Addis Ababa and about 82 km of Gondar town. It is bordered on the south LiboKemkem, on the west Gondar Zuria, on the East by East Belesa, and on the North by Wogera District. The district is found in the Tekeze lowland sorghum and goat livelihood zone (TSG). Its agro-ecology is predominantly *Kolla* covering 59.8 %, followed by *Woina Dega* 38.7% and *Dega* 1.5%. The

topography is mainly characterized by plateau with a share of 50%, mountains 40%, and hilly 10% of the total land of the District West Belesa District of Agriculture Office (WBDoA, 2016). It is largely covered with small vegetation of bushes and shrubs. The economy of the district is mixed farming largely participated on crop production, followed by livestock rearing which has a special importance among wealthier farmers. Its altitude ranges 1100 to 2350 meter above sea level while the annual temperature ranges between 13^0C and 35^0C. The mean annual rainfall ranges 800-1200 mm. Its population in year 2016 was 192,336, of which 95,156 (49.47%) are males and 16,100 (8.37%) are food insecure ones (Ibid).

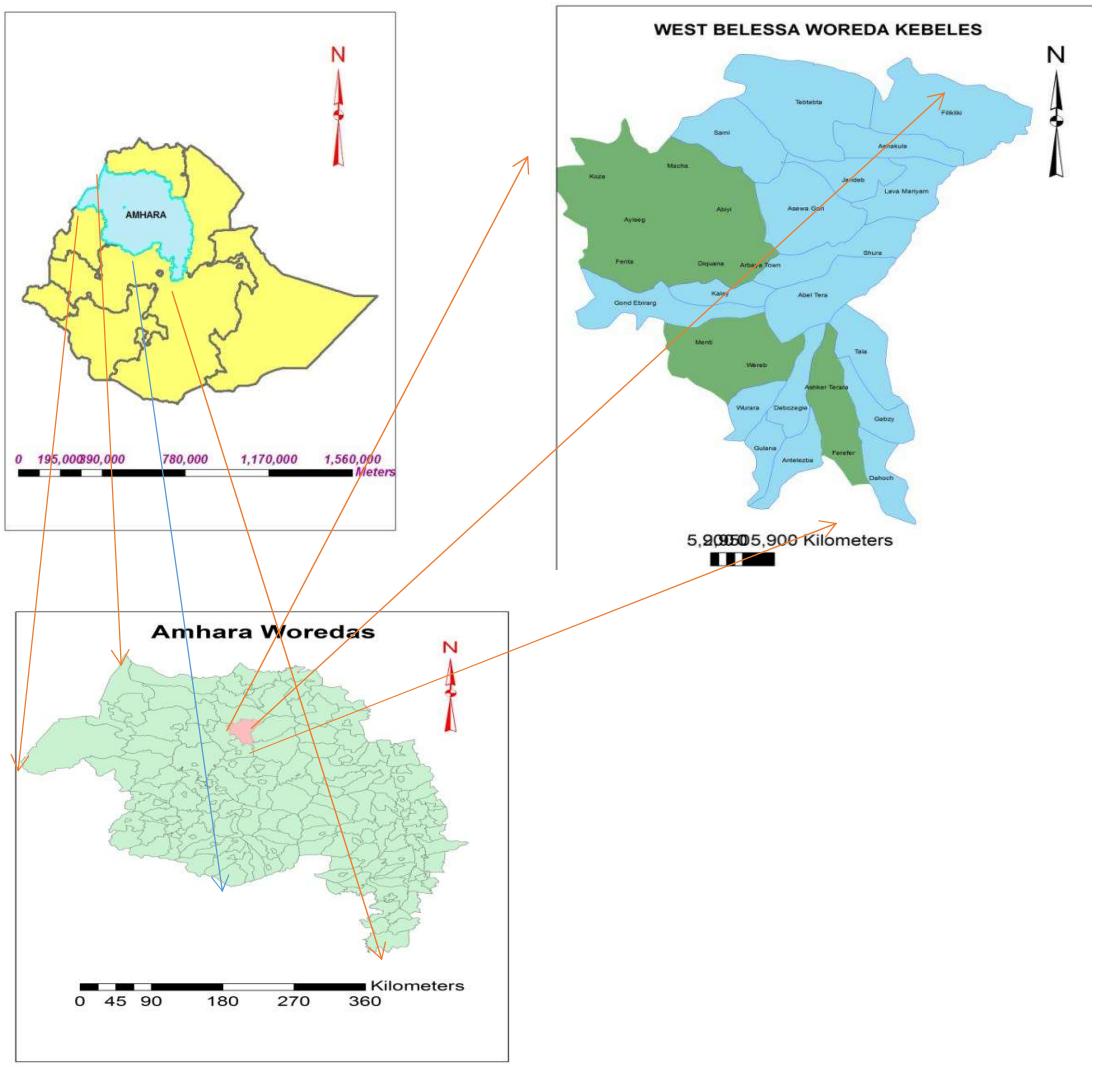

Figure 1. Map of the Study Area

2.2. Sample size and method of sampling design

To determine the size of the sample, this study adopted the following formula developed by Yemane (1967) as he assumed (P = 0.5) that the most variability of the population would be covered.

$$n = \frac{N}{1 + N(e)^2} \quad \text{----------1}$$

Where: n = statistically acceptable sample size
N = Total size of target population
e = level of precision (error level) at 95%, confidence level (0.05).

West Belesa district has thirty *kebeles*. The thirty *kebeles* have clustered in to two based on their food secure status. 19 *kebeles* were food insecure and 11 *kebeles* were food secure *kebeles*. Two *kebeles*

from food insecure/Gulana and Wurarakebeles/ and two *kebeles* from food secure *kebeles*/ Kozi, and Menti kebeles were selected by using random sampling technique from 19 food insecure and 11 food secure *kebeles,* respectively. 2936 food insecure households from food insecure *kebeles* who have been received credit and 3250 food secure households' from food secure *kebeles* who have not been received credits were target for this study to control the spillover effect of credit (WBDAO, 2016).

The sample numbers of population for each *kebele* were determined using probability proportion to size and sample respondents from each *kebele* were selected using systematic random sampling technique. Based on this sampling technique 254 sample households', 157 credit users from food insecure households from food insecure *kebele* and 97 non-credit users from food secure households from food secure *kebele* were selected.

Table 1. Food security status of sampled households and credit use status

Kebeles	Population Size (N)		Sample Size (n)		Actual Respondents
	Food insecure/ credit users/	Food secure/ non-credit users/	Food insecure/credit users/	Food secure/ non-credit users/	
Gulana	450	0	102	0	**102**
Wurara	390	0	55	0	**55**
Koza	0	265	0	63	**63**
Menti	0	185	0	34	**34**
Total	840	450	157	97	254

Source: Own Survey data (2017)

2.3. 2.3 Methods of data analysis

2.3.1. Propensity score matching (PSM)

According to Khandker *et al.* (2010) impact evaluation is the act of studying whether the changes in well-being are indeed due to the intervention and not to other factors. The main aim of FSP package loan was to increase and diversify the income sources of food insecure households. To this effect, there is a need to see whether the intervention of FSP package loan has significant influence on the participant households or not. However, to compare them with and without intervention difference, baseline survey was not conducted prior to the intervention of the FSP in the study area. Therefore, this study uses PSM method because PSM is the appropriate method when such kind of problem arises. Following Caliendo and Kopeinig (2005), there are some steps in implementing PSM. These are: PSM estimation, choosing matching algorithm, checking for overlap (common support), matching quality (effect) estimation and sensitivity analysis.

2.3.2. Propensity score estimation procedure

Propensity score estimation is the first step in PSM technique. When estimating the propensity score, two choices have to be made. The first one concerns the model to be used for the estimation, and the second one the variables to be included in this model. In principle any discrete choice model can be used. Preference for logit or probit models (compared to linear probability models) derives from the well-known shortcomings of the linear probability model, especially the unlike of the functional form when the response variable is highly skewed and predictions that are outside the [0, 1] bounds of probabilities. For the binary treatment case, where estimated the probability of participation versus non-participation, logit and probit models usually yield similar results (Caliendo and Kopeinig, 2005). For this study, logit model was used to estimate propensity score.

Regarding, the choice of variables Smith and Todd (2005) suggested that economic theory, a sound knowledge of previous research and also information about the institutional settings should guide the researcher in building up the model. However, concerning the inclusion (or exclusion) of covariates in the propensity score model. The matching strategy builds on the CIA, requiring that the outcome variable(s) must be independent of treatment conditional on the propensity score. Hence, implementing matching requires choosing a set of variables X that credibly satisfy this condition.

According to Gujarati (2004), in estimating the logit model, the dependent variable is participation which takes a value of 1 if the household participated in a program and 0 otherwise.

The mathematical formulation of logit model is as follows:

$$Pi = \frac{e^{Zi}}{1 + e^{Zi}} - - - - - - - - - 2$$

Where: -

Pi = i^{th} household probability of food in secure who participate in the credit market which takes value 1 otherwise it takes 0

$$Zi = \alpha + \beta Xi + Ui \quad - - - - - - - - - 3$$

Where I= 1,2,3, … N

α = Intercept

β = regression coefficient to be estimated

Xi = Explanatory variables

Ui = a disturbance term

The effect of household's participant in the credit market on a given outcome(Y) is specified as $Yi = y(D = 1) - Y(D = 0) - - - - - - - - - - 4$

Where Ti = a treatment effect (effect due to participation of food insecure HHs in credit),

Yi = is the outcome on the i^{th} household

Di = is whether the i^{Th} household has got the treatment or not

However, Y (Di = 1) and Yi (Di = 0) cannot be observed for the same HHs simultaneously, estimating individual treatment effects Ti is impossible and one has to shift to estimating the average treatment effects of the population than the individual one. The most commonly used average treatment effect estimation is the average treatment effect on the treated (T_{ATT}) which was E (T/D = 1) = E [Y (1) / D = 1] – E [Y (0) / D = 1] specified as follow:

$$TATT = E\left(\frac{T}{D} = 1\right) = E\left[Y\frac{(1)}{D} = 1\right] - E\left[Y\frac{(0)}{D} = 1\right] - - - - - - 5$$

Since the counter factual mean for those being treated, E (Y (0) / D = 1) is not observed, there is a need to choose a proper substitute for it to estimated ATT. Though it might be thought that using the mean outcome of untreated individuals' (y (0)) /D=0) as a substitute to the counter factual mean for these being treated, E (Y (0) / D = 1) is possible, it is not a good idea especially in non-experimental studies. This is because it is likely that components which determine the treatment decision also determine the outcome variables of interest.

In our particular case, variable those determine HHs participation in the credit market affects HHs income and employment generation. Therefore, the outcomes of individuals from treatment and comparison group would differ even in the absence of treatment leading to a self-selection bias. However, by rearranging and subtracting E(y(0) / D 0) from both side of equation 6 T_{ATT} can be specified as

$$E = \left[Y\frac{(1)}{D} = 1\right] - E = \left[Y\frac{(0)}{D} = 0\right] = TATT + E\left[Y\frac{(0)}{D} = 1\right] - E\left[Y\frac{(0)}{D} = 0\right] - - - - - 6$$

In the above both terms in the left hand side are observables and ATT can be identified if no self-selection bias. That is if and only if E (y (0) however this condition can be ensured only in a randomize experiments (i.e. where there is no self-selection bias. Therefore, some identified assumptions must be introduced for non-experimental studies to solve the selection problems.

Basically there are two strong assumptions to selection problems those are

- Conditional independence assumption
- Common support condition

Conditional independence assumption

The CIA is given as $Y0Y1 \perp D/X, \forall X$ ---------- 7

Where ⊥ indicates independence

Xi = a set of observable characteristics

Yo = non participation

Y1 = participants

Given a set of observable covariates (X) which are not a affected by the treatment / in this case food insecure HHs who receive credit/, potential outcomes are increasing of their income, employment engagement, saving of food insecure HHs are independent of treatment assignment / independent of how the borrowers and non-borrowers of food insecure HHs will be selected.

The implication of CIA assumption is that the selection is solely based on the observable characteristics (X) and variables that influence assignment? Participation in credit/ and potential outcomes change of income, own productive assets, smoothing consumption and engagement in different income generating activities are simultaneously observed (Bryson *et al*., 2002; Caliodo and Kopeinig, 2005). Hence after adjusting for observable difference, the mean of outcomes is similar for D = 1 and D = 0. Therefore, E (*Y*0 / *D* = 1, *X*) = *E* (*Y*0 / *D* = 0, *X).*

3. Results and Discussion

3.1. Food insecure household time of credit demand

The food security package loan encompasses a suite of activities which have been designed to enhance the agricultural production, food security and the asset accumulation capacity of the rural households. This program therefore mainly served the food insecure households by providing a subsidized credit for the purpose of purchasing packages, based on the business plan developed. In the first evaluation of food security program, Gilligan *et al*. (2007) noted that except Tigray region access to package loan was low. As seen Table 2, 0, 42.68, 56.69, and 0.64% of the 157 food insecure households was applied to get credit from Micro finance institution (MFI) in the 1st, 2nd, 3rd and 4th quarter respectively and while 96.9, 1.03, 2.03and 0% of the 97 food secure households applied to get credit in the respective quarter. Out of these credit users only 11.46, 73, and 66% of the food insecure households received credit at the 2nd, 3rd and 4th quarter respectively. As indicated in the proposal thesis, credit which were disbursed to the users during the 2nd and 3rd quarters were considered as on time and would contribute income increasing of the food insecure households according the interviewer response. This may be due to the fact that all the inputs for different income generating activities (such as, crop products, livestock to start either petty trade or rearing and fatting) at rural community level are available relatively at cheaper prices during these quarters whereas during 4th quarter all inputs for different income generating activities at rural community level is scarce and hence relatively expensive during this quarter and partly would affect negatively the credit users' annual income according the interviewer response. However, 42.04% of the food insecure households have received their credits lately and would affect their annual income negatively according the interviewer response. As illustrated in the chi-square test statistic, there is statistically significance difference at 1% level of significance between the Food insecure and the food secure households in terms of applying and receiving their package loan. 42.04% of the food insecure households receive credit lately whereas the food secure get credit on time mean on this thesis starting from quarter 1 up to quarter 3 considered on time disbursed of credit.

Table 2. Food insecure household period of credit request and received by quarter

Variable	Attribute	Food insecure HHs		Food secure HHs		Total		Chi-square
		N	%	N	%	N	%	
Request Quarter	1st quarter	0	0.00	94	96.91	94	37.01	241.53***
	2nd quarter	67	42.68	1	1.03	68	26.77	

	3rd quarter	89	56.69	2	2.06	91	35.83	
	4th quarter	1	0.64	0	0.00	1	0.39	
	Total	157	100.00	97	100.00	254	100.00	
Received Quarter	1st quarter	0	0.00	94	100.00	97	38.19	254***
	2nd quarter	18	11.46	1	1.03	19	8.12	
	3rd quarter	73	46.50	2	2.06	74	30.80	
	received lately	66	42.04	0	0.00	66	25.98	
	Total	157	100.00	97	100.00	254	100.00	

Source: Own Survey data, (2017)

*, **, *** Statistical significance level at 10, 5 1% respectively

3.2. Results of econometric analysis

According to Rosenbaum and Rubin (1993), PSM is the conditional probability of assignment to a particular treatment given a vector of observed covariate. In this study PSM was used to estimate the impact of food security package loan on the food insecure households' annual income in the study area. In addition, PSM helps control pre-intervention difference on the covariates. Logistic regression model was applied to estimate propensity scores for matching program Food insecure households with Food secure households. In the estimation process, households were pooled in such a way that the dependent variable takes a value 1 if the household is participant and 0 otherwise.

Table 3. Definitions of explanatory variables and expected sign

Variables	Definitions of variables	Expected sign
HH Part	=1 if a household participated in FSPL	+
Age	Age of household head measure in year	-
Sex	= 1 if the household head is male	+
Edu	Education level the household head measured in year	+
Mohh	Marital status of household head with three categories, taking unmarried/single as base category	
	Married =1 if the household head is married	+
	Divorced =2 if the household head is divorced	–
HHAE	Household's labor force of adult equivalent	+
Agriexn	Agricultural extension contact	+
Own land	Cultivated own land	
Busskills	Participation of on off farm = 2, on farm = 1 and both = 3	+

Source: Own description of variables (2017)

VIF for continues variables and contingency coefficient for dummy variables were calculated in order to detect the presence of strong multi-collinearity problem among the covariates. As shown in table 4 except own land and labor force the other covariates had no serious problem of multicollinearity. Consequently, own land and labor force was dropped from the estimated model to avoid biased estimation. In addition, robust standard errors were estimated using Breusch-Pagan test to detect hetroscedasticity on dummy variables.

After checking multicollinearity and heteroscedasticity assumptions of regression model, the propensity score or the likelihood of participation for a given household is estimated using logit model where the dependent variable is program participation and taking six pre-intervention covariates as independent variables. It was found that the estimated model appears to perform well for our intended matching exercise.

As shown in Table 4, 3 out of 8 covariates significantly affect the program participation decision of households in the study area. The interest of the matching procedure is to get participant households from non-participants with similar probability of participation given the explanatory variables. If the number of explanatory variables affecting the participation decision is limited, it created a good opportunity for matching and it makes the matching procedure less difficult since matching algorism is implemented to eliminate significant differences of explanatory variables between Food security package loan

participant HHs and Food security package loan participant HHs.

Table 4. Logistic regression model estimation of household participation decision

Covariates	Coff.	Std. Err.	T-value	P-Value
Age	0.010672	0.011323	0.94	0.346
Sex				
Male	-0.01498	0.428724	-0.03	0.972
Edu	-0.04023	0.07194	-0.56	0.576
Msohh				
Married	-0.27222	0.658687	-0.41	0.679
Divorced	-0.92528	0.675476	-1.37	0.171
HHAE	-0.29089**	0.127915	-2.27	0.023
Agriexn	0.178278	0.365503	0.49	0.626
Own land	0.570152**	0.23023	2.48	0.013
Busskills	0.843868***	0.164754	5.12	0.000
_cons	-1.13393	0.823166	-1.38	0.168

Source: Own Survey data (2017)

*, **, *** Statistical significance level at 10, 5 1% respectively

The test statistics in Table 4 indicates the participation of food security package loan was strongly influenced by own land holding, labor force and business skills, which have positive and significance influence on the participation decision of a given household. This may be the fact that people with large number of own land may need additional capital besides their own financial capital to run business through accessing other associated factor inputs for exploiting the larger sized land or participate in income generating activities. This in turn facilitates the participation decision of households.

3.3. The common support condition

The other required criterion to match the treated with untreated households is to find out the common support region. There are two approaches to map a common support region for the propensity score distribution; these are minima & maxima, and trimming approaches (Caliendo and Kopeinig, 2005). Leuven and Sianesi (2003) however recommend the use of both the common and "trimming" approaches at the same time for the identification (imposition) of a common support. Even though recommended to use both approaches together, in evaluation studies using PSM, the approach that yields good match is preferred.

After defining the common support region, those observations in the common support region have been matched with the other group and others which were not in the common support region were out of further consideration. The estimated propensity scores in Table 5 vary between 0.17 and 0.95 (mean = 0.67) for food security package loan participant households and between 0.21 and 0.92 (mean = 0.53) for non-participant (control) households. Based on the minima and maxima criteria, the common support region would then lay between 0.21 and 0.92. In other words, households with estimated propensity scores less than 0.21 and greater than 0.92 would not be considered for the matching exercise.

Table 5. Distribution of estimated propensity scores

Group	Observation	Mean	Std. Dev.	Min	Max
Food insecure HHs	157	.6739897	.1761324	.1712023	.9544923
Food secured HHs	97	.5276662	.1684542	.2130317	.926299
Total households	254	.6181102	.1870027	.1712023	.9544923

Source: Own survey data (2017)

*, **, *** Statistical significance level at 10, 5 1% respectively

In a similarly manner, Figure2 shows the distribution of the propensity score for total households, food security package loan participant and non-participant households. In case of treatment households, most of them were found in the left and middle part of the distribution. On the other hand, most of the control households were partly found in the center and partly in the right side of the distribution. Since most of the participant and non-participants' households are located in the middle of the distribution, it makes the matching procedure simple.

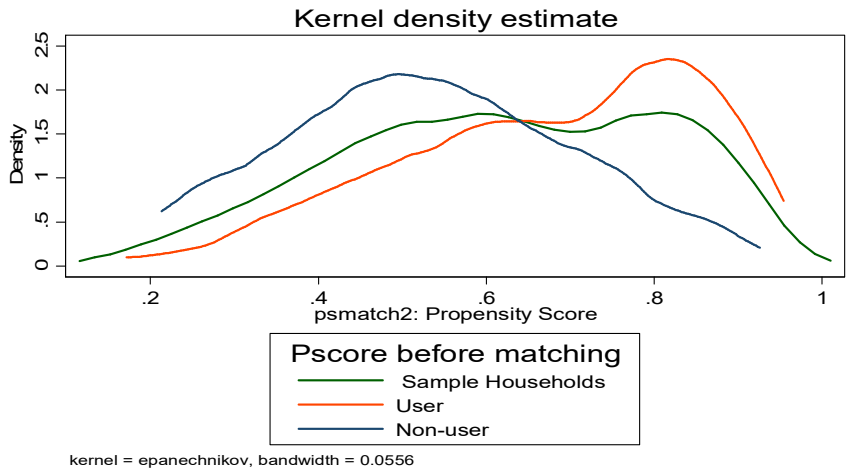

Figure 2. Kernel density of propensity score

As shown in Figure 2, most of the observations lay in the right middle part of the graph with the mean propensity score value of 0.61. 2 out of 157 observations below the maxima criteria are out of the common support region and hence he/she is disregarded from further consideration. The density of distribution of the propensity scores for non-participants of the project on the other hand shows that observations with the probability above the minima criterion fail to lie on the common support region. Accordingly, none of the observations from the non-participants ignored from further consideration.

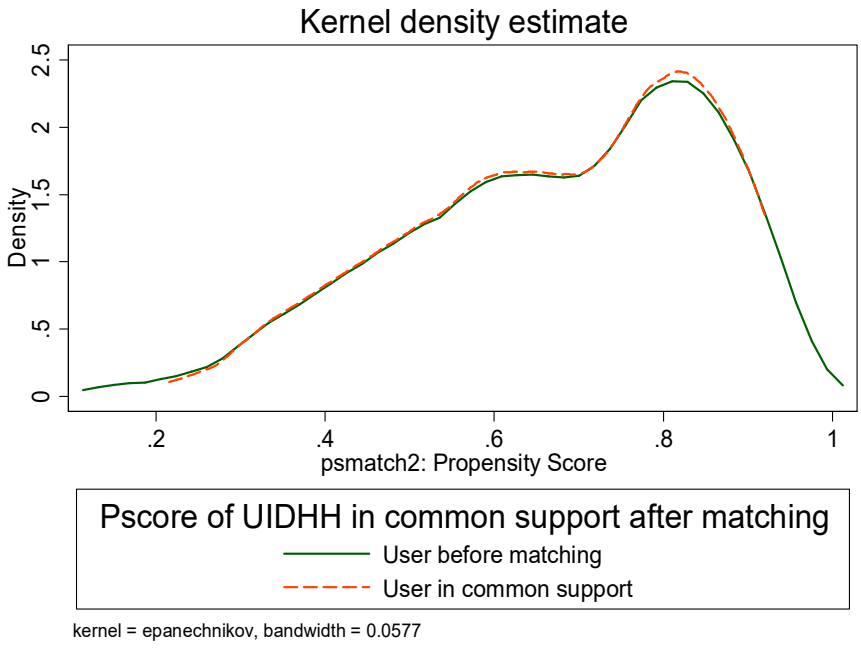

Figure 3. Kernel density estimate of p/scores of participants with and without common support

Figure 3 shows the distribution of treated households with respect to the estimated propensity scores, where the largest and dotted lines graph indicates the treatment households in the common support region, the line graph on the dot indicates the treated households after matching.

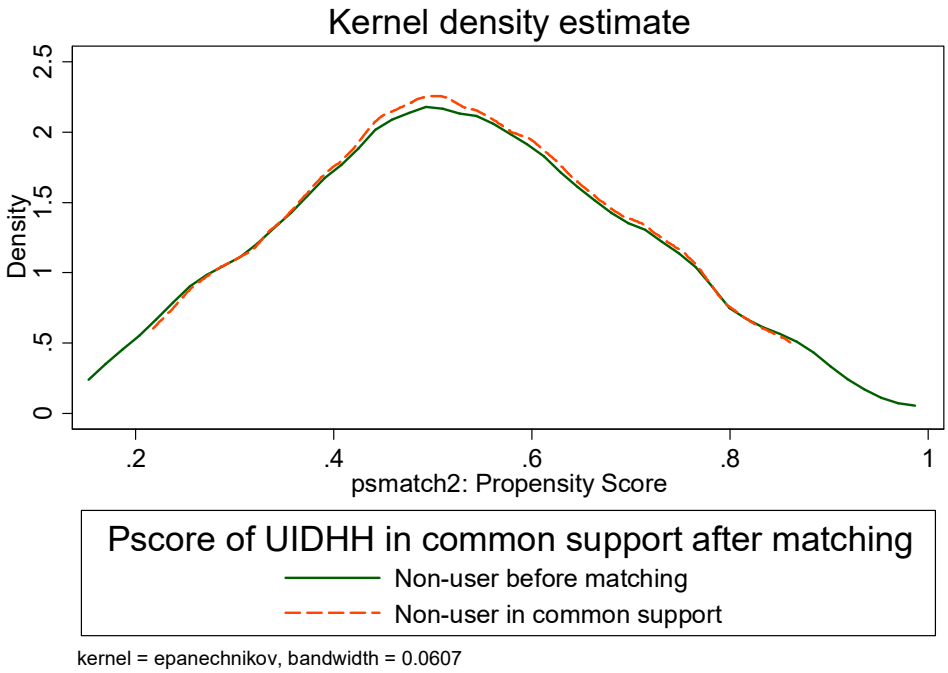

Figure 4. Kernel density estimate of propensity scores of non-participants' households with and without common support

Figure 4 shows the distribution of control households with respect to the estimated propensity scores after matching, when the largest and dotted lines graph indicates the control households in the common support region, the line graph on the dot indicates the control households after matching.

3.4. Matching of participant and non-participant households

Estimators of PSM have different match quality but the choice of matching estimator is decided based on the balancing qualities of the estimators. The final choice of a matching estimator was guided by different criteria such as equal means test referred to as the balancing test (Dehejia and Wahba, 2002), pseudo-R^2 and matched sample size. Specifically, a matching estimator which balances all explanatory variables (i.e., results in insignificant mean differences between the two groups), bears a low R^2 value and also results in large matched sample size is preferable.

Here balancing test means is a test conducted to know whether there is a statistical significant difference in the mean values of covariates before and after matching. The preferred estimators are the higher the number of covariates with equal mean after matching. Keeping other selection criterion, the balancing test indicates the quality of the matching algorithm implemented.

3.5. Selection of best algorithm

Table 6. Performance of matching estimators under the three criteria

Matching Estimator	Performance criteria		
	Balancing test*	Pseudo R2	Matched sample size
Radius Caliper matching			

With 0.01 band width	6	0.1169	135
With 0.1 band width	6	0.1169	173
With 0.25 band width	6	0.1169	180
With 0.5 band width	6	0.1169	192
Kernel Matching			
With 0.01 band width	**6**	**0.1169**	**214**
With 0.1 band width	6	0.1169	**252**
With 0.25 band width	6	0.1169	**252**
With 0.5 band width	6	0.1169	**252**
Neighbor matching			
1 neighbor	6	0.1169	194
2 neighbor	6	0.1169	**252**
3 neighbor	6	0.1169	**252**
4 neighbor	6	0.1169	**252**

Source: own survey data (2017).

* indicates the number of explanatory variables with no statistically significant mean differences between the matched groups of program and non-program households.

According to the criteria outlined above, kernel type with band width 0.01, 0.1, 0.25 and 0.5 have given similar results except large sample size compare to others. As compared to other alternative matching estimators indicated in Table 6 they have relatively similar or low pseudo R^2 with best balancing test (all explanatory variables insignificant) and large matched sample size. Therefore, matched samples by kernel either with band width of 0.01 satisfies the property of balanced matching for all of the covariates. Accordingly, the kernel matching algorism with band width of 0.01 has been used for this research to compare PSNP participants and non-participants with respect to the impact indicators.

Table 7. Balancing test of matched sample

Variable	Mean						T-test	
	Food insecure	Food secure HHs	T-test	Food insecure	Food secure HHs	%bias	T	p>t
_pscore	0.67399	0.53	0.4	0.67399	0.67308	0.5	0.05	0.963
Age	45.9682	44.85	0.94	45.968	45.478	3.4	0.31	0.757
1.sex	0.7579	0.67	-0.03	0.75796	0.84076	-18.3	-1.84	0.067
Edu	0.8472	0.83	-0.56	0.84713	2.3057	-68	-3.65	0
HHAE	2.1940	2.39	-2.27**	2.194	2.1287	5	0.43	0.668
1.msohh	1.1019	1.21	-0.41	0.74522	0.72611	4.2	0.38	0.702
2.msohh			-1.37	0.17834	0.0828	23.1	2.53	0.012
Agriexn	0.8598	0.79	0.49	0.85987	0.77707	21.9	1.91	0.057
Ownland	1.0299	0.92	2.48**	1.0299	1.0502	-2.5	-0.22	0.825
Busskills	2.1273	1.53	5.12***	2.1274	2.0637	6.9	0.57	0.568

Source: Own Survey Data (2017)

*, **, *** Statistical significance level at 10, 5 1% respectively

As shown in Table 7 the balancing tests of covariates, before and after matching; participant and non-participant households were significantly different in terms of certain pre-intervention characteristics. However, these differences were removed after the matching was conducted.

3.6. Impact of food security package loan on income and livelihood of food insecure households

Table 8. Impact of food security package loan on income of food insecure households

Outcome variables	Food insecure HHs	Food secure HHs	Difference	S.E.	T-stat
On farm income	150228.0161	6385.22639	8842.78974***	845.117489	10.46
Off farm income	3320.6129	1534.24162	1786.37128***	613.313856	2.91
Animal holding TLU	2.89	1.94	0.95***	0.23	4.11
Farm Land rent (ha)	0.21	0.11	0.10**	0.04	2.75
Saving (birr)	348.65	157.35	191.29***	47.94	3.99
HH House	0.35	0.36	-0.01	0.06	-0.11
Sending children (Number)	1.32	0.99	0.33**	0.16	2.00

Source: Own Survey data (2017)

*, **, *** Statistical significance level at 10, 5 1% respectively

The food insecure household experience is mixed farming of crop production and animal rearing to generate their annual income. When they gained credit they allocated to purchase of animals for rearing and fattening purpose and trading. Annual income status improvement of food security package loan users can be explained by using variables like on-farm income, off-farm income, expenditure on food consumption and non-food consumption, livestock holding in (TLU), in rented farming land (Ha), engagement in income generating activities, saving part of their income, types of their house standard and number of children attending formal education.

The statistical evidence presented in Table 8 revealed that there is a significant difference on Food insecure HHs and Food secure HHs in the on-farm income, off -farm income, Animal holding (TLU), Saving in birr, engagement in business activities, land rented in ha and sending of the children to formal education. The analysis has proved that, Food insecure HHs were better-off than the Food secure HHs in on-farm and off-farm income by running of on-farm and off-farm packages by about 8842.78 and 1786.78 birr respectively. This is due to the fact that Food insecure HHs was more exposed to participate in business activities thinking to repay their credits. The results also show Food insecure farm households cultivated in rented land has increased by 0.1 ha. Improvement in income has direct effect on saving of money on financial institutions as a result the saving amount of money of the Food insecure HHs were higher than Food secure HHs by an average amount of birr 191.29 during the study period. The animal holding (TLU) of the Food insecure HHs were greater than their counterparts by 0.95 TLU. This is because most Food insecure HHs participated in the on-farm activities particularly rearing and fattening of livestock to increase and diversify their income. In case of sending their children to formal education they have also shown an improvement by 0.33 in number over their counterparts. This is may be the fact that they are more exposed to business activities and social services that forced them to learn their children to formal education.

3.7. The sensitivity analysis of food security package loan

Table 9. Result of sensitivity analysis using Rosenbaum bounding approach

No.	Outcomes	e^y=1	e^y=1.25	e^y=1.5	e^y=1.75	e^y=2
1	On farm income	P<0.000	P<0.000	0.000	0.000	0.000
2	Off farm income	P<0.000	P<0.000	0.000	0.000	0.000
3	Animal holding in TLU	P<0.000	P<0.000	0.000	0.000	0.000
4	Saving money in birr	P<0.000	P<0.000	0.000	0.000	1.1e-16
5	Rented land in ha	P<0.000	P<0.2.2e-16	7.0e-14	3.7e-12	7.5e-11

6	Child education	P<0.000	P<0.000	0.000	0.000	0.000

Source: Own Survey data (2017)

e^y (Gamma) =log odds of differential due to unobserved factors where Wilcoxon significance level for each significant outcome variable is calculated.

Table 9 presents the critical level of e^y (first row), at which the causal inference of significant food security package loan impact has to be questioned. As noted by Hujer *et al.* (2004), sensitivity analysis for insignificant effects is not meaningful and is therefore not considered here. Given that the estimated food security package loan effect is positive for the significant outcomes, the lower bounds under the assumption that the true treatment effect has been under estimated were less interesting (Becker and Caliendo, 2007) and therefore not reported in this study. Rosenbaum bounds were calculated for food security package loan impacts that are positive and significantly different from zero. The first column of the table shows those outcome variables which bears statistical difference between treated and control households in our impact estimate above. The rest of the values which corresponds to each row of the significant outcome variables are p critical values (or the upper bound of Wilcoxon significance level -Sig+) at different critical value e^y. Results show that the inference for the impact of the food security package loan interventions is not changing though the participants and non-participant households have been allowed to differ in their odds of being treated up to 100% (e^y= 2**)** in terms of unobserved covariates**.** That means for all outcome variables estimated, at various level of critical value of e^y, the p- critical values are significant which further indicate that we have considered important covariates that affected both participation and outcome variables. We couldn't get the critical value e^y where the estimated ATT is questioned, which is similar value compared to the value set in different literatures which is usually 2 (100%).Thus, we can conclude that our impact estimates (ATT) are insensitive to unobserved selection bias and are a pure impact of food security package loan interventions programs.

4. Conclusion

This study tried to analyze the timeliness of food security package loan disbursement period to food insecure households and its effect on their annual income generating. To determine whether the food insecure households access credit timely or not, the study set an indicator that show timeliness of credit disbursement. Accordingly, credit is timely disbursed if and only if the food insecure households' gained their credit request as requested in the 2nd and 3rd quarter otherwise it is lately disbursed and affect their annual income negatively.

Based on the survey results, 99.34% of the credit users requested their credit on 2nd and 3rd quarter. Even though 99.34% of food insecure household request in 2nd and 3rd quarter only 57.96% of them accessed their credit on time. The rest 42.04% were accessed lately and affects their annual income generating due to increase cost of inputs in the 4th quarter.

Another objective of this study was to analyze the impact of credit on food insecure annual income sources. Concerning the econometric results, seven explanatory variables had hypothesized to analyze the impact of food security package loan on households' income. The logit regression model showed that the six variables have significant effects on incomes of households. All of the variables significantly improve households' income. These variables are on- farm and off-farm annual income, animal holding, saving, and rented farming land and sending children to formal education.

To access the food security package loan timely implementer bodies and stakeholder should identify the demand of beneficiary and work closely accordingly. In addition to Non- Governmental and Governmental Credit providers, private company should initiate to provide credit to rural area to fill the gap of financial demand of rural areas.

In general, the model output shows that the food security package loan has positive impact on food insecure households' income and livelihood. Therefore, the program should have to be given emphasis for further integration of concerned government bodies, food security offices and private sectors.

Conflict of interest

The authors declare that there is no conflict of interest to publish the manuscript in the journal.

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