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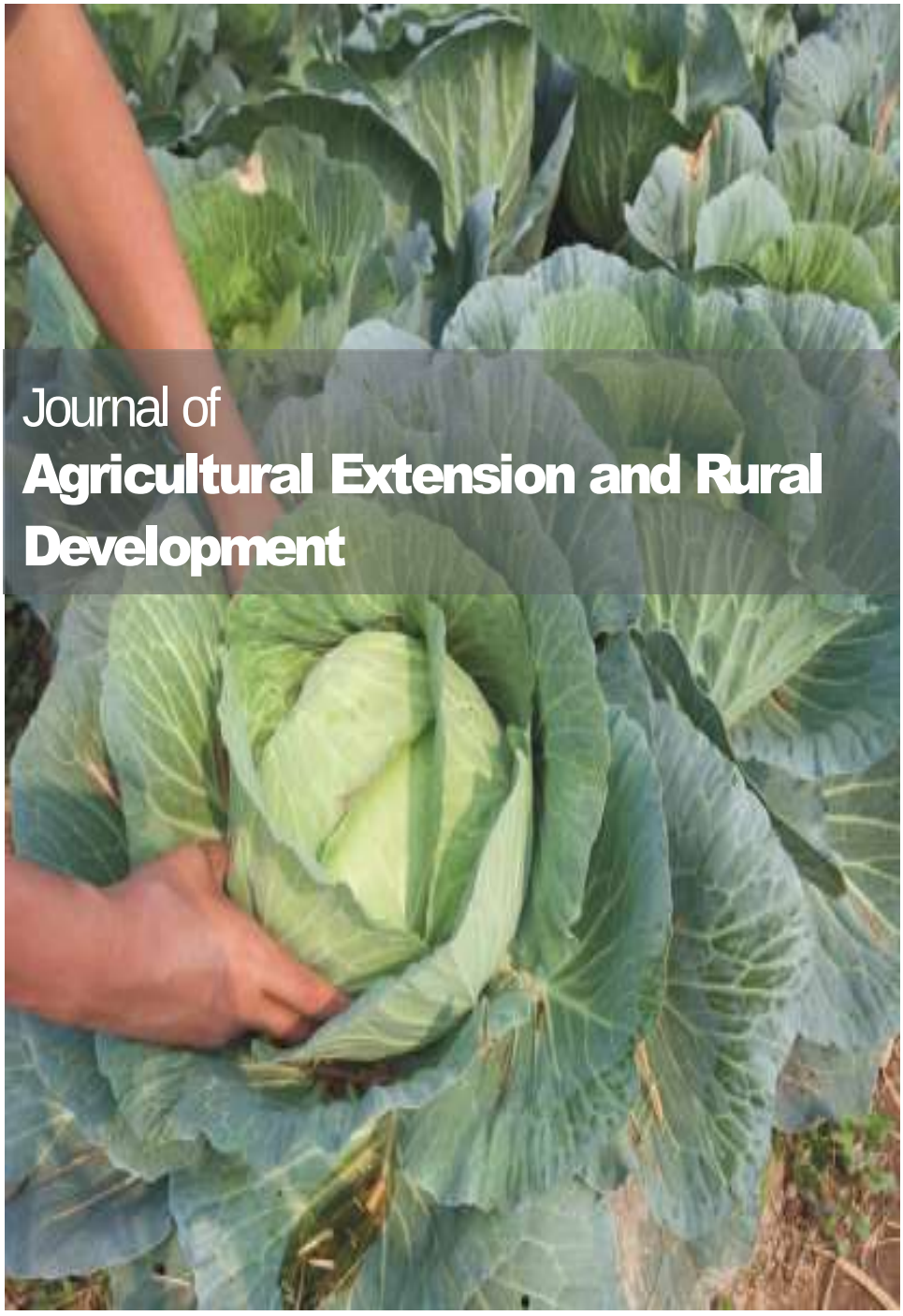

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Review

Determinants and challenges of rural livelihood diversification in Ethiopia: Qualitative review

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The review was made on determinants and challenges of livelihood diversification in Ethiopia. Different published and unpublished documents were collected through different search engines from different databases, Google scholar and Google. After thorough reading, 42 papers were used to review out of 182 papers. There are a lot of pushes and pull factors that affect rural livelihood diversification. Some determinants, which affect rural community were human, financial, social, natural, and physical capitals/assets. Lack of capital, poor infrastructures, lack of access to credit service, lack of access to market and marketing service and farmland scarcity were some of challenges that face rural household to diversify their livelihood. The major limitations of the studies were lack of consistence on terminology of livelihood diversification strategies, generalization during identification of factors affecting livelihood diversification and unable to reason out econometric model results. Therefore, further investigations should be conducted and development practitioners should pay attention to those factors affecting livelihood diversification.

Key words: Determinants, diversification, livelihood, rural, strategies.

INTRODUCTION

Developing countries like Ethiopia heavily depend on small-scale agriculture with low productive and vulnerable to weather and production-related shocks (Bezabih et al., 2014). In most region of sub-Saharan Africa, there is upsurge of mean temperature and greater variability of rainfall patterns (IPCC, 2007). In Ethiopia subsistence farming, limited arable land and low agricultural productivity compel individuals or households to diversify livelihoods (Lemi, 2009). Farmers' in Sub-Saharan Africa participate in livelihood diversification activities to increase households' income accumulation and to maintain livelihoods facing from increasing climatic and economic risks (Echebiri et al., 2017; Prowse, 2015).

Diversification is norm in which individuals and households diversify assets, incomes, and activities due to push factors to reduce risk and pull factors for 'realization of strategic complementarities between activities' (Barrett et al., 2001). Strategy household livelihood diversification was used to curtail risk and uncertainty (Sharma, 2010). Livelihood diversification is the process of carrying out activities by rural household to survive and improve their standard of living (Weldegebriel

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and Prowse, 2013). Ellis (1998) also defines livelihood diversification as process in which rural communities build various portfolios of activities and social capabilities to survival and improve their standard of living. Diversification of livelihoods is a strategy to cope with economic, environment shock, and an instrument to ease poverty. However, unequal distribution of household resource and asset force them to diversify into a high return sector (to enhance their wellbeing), and low return sector (Gautam and Andersen, 2016). Nevertheless, diversification can have both positive and negative impacts on rural household's livelihoods. Its impact is positive when households are more secure and reduce adverse impact of seasonality (Weldegebriel and Prowse, 2013); but it can result in negative effect when it raise households vulnerability for different risks (Ellis, 1998).

Like other world, rural people in Ethiopia diversify their asset, income and activity due to push and pull factors. They diversify their livelihood through on farm, nonfarm, and off farm income generating activities. On farm income is income generated from crop and livestock on owners farming whether on owner occupied land or leased land (Weldegebriel and Prowse, 2013), and off-farm income is temporary wage or exchange labour on others farms within agricultural sector (Ellis, 1998, 2000). Besides they diversify their livelihood through non-farm income which is income generated from activities in secondary and tertiary sectors (Barrett et al., 2001) or income from non-agricultural activities such as rents, food and drink processing, remittance, etc (Ellis, 2000).

As country level, Asfaw (2018) carried out a review on "determinants of sustainable rural livelihood diversification of small holder farmers in Ethiopia". Nevertheless, Sisay (2013) and Sarah (2015) review on "Rural livelihood diversification" in some Africa countries and sub-Saharan Africa, respectively. Hence, review made on determinants and challenges of rural livelihood diversification in context of country level were few. However, there were many studies conducted in relation to the topic but lacks consistency of livelihood diversification strategies, and there was no single study conducted as country level. So that the review of the paper tried to compile studies conducted in different part of the country to show real image about livelihood diversifications and contribute knowledge on determinants and challenges of rural livelihood diversification strategies. The aims of the review were to: (1) Identify livelihood diversification strategies and (2) Review determinant and challenges of rural livelihood diversification strategies. The result generated through review may be important for development practitioners, researchers and policy makers. The result of review paper may be helpful for development practitioners who work on livelihood improvement of rural people through indicating in what issue they should intervene. For researchers it may give insight on how they should conduct research to fill gap of different studies and to make community beneficiary through generating relevant information by their investigation. Besides it may also be crucial for policy makers to formulate, ratify and implement appropriate policy successfully based on existing situation of rural livelihoods.

METHODOLOGY

Timetable of data, search strategy of published as well as unpublished papers and different search-terms/engines to prevent junk of literature sources were important consideration to review paper. Besides, Google and Google scholar databases like Science direct, Scopus, Pubmed, Index Copernicus, WorldCat and ScinceOpen were used to gather potentially relevant work for the topic. The search engines used to collect published and unpublished works were challenges of rural livelihood diversification in Ethiopia, determinants of rural livelihood diversification strategies in Ethiopia, rural livelihood diversification strategies in Ethiopia, and livelihood diversification strategies. Through all the search, 182 published and unpublished papers were collected. Only 42 published and unpublished papers were considered to review the paper. Decision to include or exclude particular studies was made based on recent, relevance for the review topic and data type, that is, qualitative data. At last, all collected data were analyzed through narration and interpretation qualitatively.

RESULTS AND DISCUSSION

Rural livelihood diversification strategies in Ethiopia

According to Ellis (2000), livelihood activities can be categorized into three namely on farm, nonfarm and off farm. On farm activities are activities, which are directly related with agricultural production focused on both crop production and animal husbandry activities. Nonfarm activities are activities that take place outside the agricultural sector including non-agricultural wage or salary employment and self-employment, rent income, transfers, and remittances. Off-farm activities refer to agricultural activities which take place outside the person's own farm agricultural wage or exchange labor and natural resource extraction (mainly charcoal making).

In Ethiopia, most of the studies conducted identify three rural livelihood diversification strategies: on farm, nonfarm and off farm (Mengistie and Kidane, 2016; Debele and Desta, 2016; Gecho, 2017; Kassie et al., 2017; Teklu et al., 2017; Yona and Mathewos, 2017; Ofolsha and Mansingh, 2015; Dadi, 2016; Asfir, 2016; Addisu, 2017; Yizengaw et al., 2015). Authors mention crop production and livestock rearing as major activities of on farm livelihood activities. Based on the type of jobs, Addisu (2017) classifies livelihood strategies into six such as farming, breeding, fishery, trading, employment, and craftsman. According to Wondimagegnhua et al. (2016), livelihood diversification strategies were on farm (crop and livestock production) and nonfarm.

According to Tenaw (2016) and Mengistu (2016), major livelihood diversification activities were crop and livestock

production, petty trading and remittance. Also making charcoal, daily laborer, contraband trading (Tenaw, 2016), wage and handcraft (Mengistu, 2016) were livelihood diversification activities. However, Tenaw (2016) and Mengistu (2016) lack detail and plain difference among livelihood activities. Nonfarm and off farm livelihood strategies of the agro-pastoralists were livestock trade, causal labor, and remittances (Tilahun et al., 2017).

Off-farm activities were activities, which were done to someone else's farm such as wage labor, natural resource based activities like firewood/grass and charcoal selling (Yizengaw et al., 2015; Ofolsha and Mansingh, 2015; Asfir, 2016; Dadi, 2016; Yona and Mathewos, 2017; Gecho, 2017). Nevertheless, farmers move to other area to work as wage laborer due to fear of negative attitude of the community (Yona and Mathewos, 2017). The off farm activities in which rural communities participate were petty/local trading, remittance, handicrafts, selling wood and wood products (firewood and charcoal) (Mengistie and Kidane, 2016; Debele and Desta, 2016). Some other off farm activities were selling local drinks (*Tela, Areki*); transporting people and goods by using carts; salary from temporary or permanent employment; renting out of the idle or extra oxen; and income from mills (Mengistie and Kidane, 2016), daily laborer and aid (Debele and Desta, 2016). They did not identify nonfarm activities. However, Mengistie and Kidane (2016) and Debele and Desta (2016) did not distinguish off farm and nonfarm activities.

Non-farm activities include petty trade, handicraft (weaving, spinning, carpentry, house mudding, poet making) (Yizengaw et al., 2015; Ofolsha and Mansingh, 2015; Asfir, 2016; Dadi, 2016; Yona and Mathewos, 2017; Gecho, 2017) and remittance (Yizengaw et al., 2015; Dadi, 2016; Yona and Mathewos, 2017; Gecho, 2017). Selling of local drinks (*Tella* and *Areke*) (Yizengaw et al., 2015; Dadi, 2016; Ofolsha and Mansingh, 2015; Gecho, 2017) and rent of pack animal like donkey for transportation (Gecho, 2017; Yona and Mathewos, 2017) were nonfarm activities. Nonfarm livelihood activities in which farmers engage were renting (hiring) of oxen and land (Yona and Mathewos, 2017) and wage labor (Ofolsha and Mansingh, 2015; Dadi, 2016; Asfir, 2016). In addition, selling of unskilled labor force and prostitution (Ofolsha and Mansingh, 2015), mining (Asfir, 2016), trading of small ruminants and cattle (Yizengaw et al., 2015) were nonfarm livelihood sources for smallholder farmers. According to Yishak et al. (2016), non-farm livelihood activities were daily labor, local brewery, formal and non-farm employment, firewood and charcoal sale, food preparation and sale, carpentry, transportation of produces, sand extraction and sale. But Yishak et al. (2016) merge off farm and nonfarm activities. The major limitations of the studies conducted in rural livelihood diversification strategies in Ethiopia were unable to distinguish nonfarm and off activities and generalization of livelihood activities rather than classifying them based on livelihood diversification strategies.

Determinants of rural livelihood diversifications in Ethiopia

In Ethiopia, different determinants of rural livelihood diversification strategies were identified. Those determinants were classified into five types of livelihood assets/capitals, namely, human, financial, social, natural, and physical capital. Various scholars distinguish different determinant factors, which influence livelihood diversification strategies based on their inferential statistics results. Nevertheless, some of the scholars did not reason out why different determinants affect farmer's livelihood diversification. Therefore, the review paper discusses diverse determinants as human, financial, social, natural, and physical capital.

Natural capital

Natural capital is a natural assets stocks (land, soil, water, air, genetic resources, etc.) and environmental services (hydrological cycle, pollution sinks, etc.) from which livelihoods are derived (Scoones, 2000). Natural capital that determine livelihood diversification strategies was farmland, area of the study (agro-ecology) and nature of settlement of the household head.

Land size

Farmland size had negative impact on livelihood diversification strategies (Tamerat, 2016; Ofolsha and Mansingh, 2015; Idris, 2014; Degefa, 2005; Gecho, 2017; Anshiso and Shiferaw, 2016; Aababbo and Sawore, 2016; Mentamo and Geda, 2016; Yizengaw et al., 2015). Hence, the probability of engaging in various livelihood strategies decreases when land holding size of household increases because farmers with larger farm land size were encouraged to involve more on farming activities (Tamerat, 2016; Gecho, 2017; Aababbo and Sawore, 2016). In addition, the farm households having more land size were forced to follow agricultural ex-tensification rather than diversification (Anshiso and Shiferaw, 2016; Yizengaw et al., 2015).

According to Ofolsha and Mansingh (2015), female-headed households (FHH) having large land size have probability of increasing product through farming to improve their livelihood, consequently they reduce livelihood diversification strategies. Similarly, studies conducted by Idris (2014) and Tolossa (2005) revealed that farmers having large plot of land have less livelihood diversifier. However, finding of Kebede et al. (2014) indicated that farmland size had positive effect on livelihood diversification since households with better holding have additional income in casual laborer works to smoothen their farm operations.

Area of the study (agro-ecology) has direct relationship

with livelihood diversification. Drier and fragile environment push household to low return and high-risk activities (Ofolsha and Mansingh, 2015). According to the Asfir (2016), households' nature of settlement influenced livelihood diversification strategy positively since farmers' land fragmentation and small size of holding; force them to diversify their livelihood.

Human capital

Human capital is skills, knowledge, ability to work and good health important for the successful pursuit of livelihood strategies (Scoones, 2000). Alternatively, human assets are the human skills, knowledge, levels of education, and capacity to contribute to improve their livelihood (Davidson et al., 2014). The major human capital determinants of livelihood diversification were sex, age, family size, educational level, agricultural extension visits and access to training.

Sex

Sex of the sample respondents had positively affected farmer's livelihood diversification strategies. Male sample respondents had better livelihood diversification option than female. This implies that female farmers were less likely to diversify livelihood than male-headed households. The authors explained those female head households had more responsibility in the house and traveling for searching nonfarm and off activity from urban area was culturally unacceptable (Demissie and Legesse, 2013; Debele and Desta, 2016; Gecho, 2017; Aababbo and Sawore, 2016). Opposing this result, Yizengaw et al. (2015) revealed that sex of sample respondents had negatively affected farmer's livelihood diversification strategies. Hence, female household head were better diversifier than male household head since they participated in nonfarm activities through renting their land for sharecropping.

Age

Age of the household head had a negative effect on livelihood diversification (Asfir, 2016; Kassie et al., 2017). As age of household head increases, the farmer will be getting older and could not be capable of diversifying and more likely to concentrate on farm activities for their subsistence. Less access to land to youngster population and increase in service and construction sectors in Ethiopia have better opportunity for youngsters than old farmers to diversify livelihood activities (Kassie et al., 2017). According to the Asfir (2016), age affects livelihood diversification negatively since older farmers were well established, more experienced in agricultural production, more resistant to new ideas and information hence less likely to diversify their livelihood. According to Debele and Desta (2016), age of household head had found a positive effect on livelihood diversification strategies because experience increases with age, and help to diversify livelihood strategies.

Family size

Family size was one of the positively affecting livelihood diversification (Asfir, 2016; Tamerat, 2016; Mentamo and Geda, 2016). This is due to the presence of large families to practice multiple activities as household laborer to diversify their livelihood strategies.

Educational level

Education level influenced positively the households' livelihood diversification (Demissie and Legesse, 2013; Gecho, 2017; Debele and Desta, 2016; Tamerat 2016; Aababbo and Sawore, 2016; Mentamo and Geda, 2016). This is due to probability of educated person ability to gain better skill, experience, knowledge and capability to find a job (Demissie and Legesse, 2013; Gecho, 2017). In lined with these, educated person had better ability to diversify livelihood strategies since they may have better skill, experience and knowledge (Debele and Desta, 2016). Nevertheless, Tamerat (2016) lacks detail information why education level had positive effect on farmer's livelihood diversification. According to Kassie et al. (2017), educational level of farm household had found a negative impact on livelihood diversification since educated farmers may be better specialized in on-farm activities by employing better farm technologies.

Agricultural extension visit

Agricultural extension visit was negatively affected livelihood diversification. Farmers having more contact with extension agent had better probability of livelihood diversification (Tamerat, 2016; Asfir, 2016). This may be due to the fact that farmers having better extension contact have better access to agricultural information and technical assistance on agricultural activities to increase production and productivity (Asfir, 2016). However, other studies revealed that frequency of visit by development agents had positive impact on livelihood diversification (Anshiso and Shiferaw, 2016).

Access to training

It was found out that to have a negative effect on livelihood diversification since trained farmers have better skills, knowledge and experiences to improve agricultural production and productivity for fulfilling their family requirements (Yishak et al., 2014; Asfir, 2016).

Social capital

Social capital is social assets such as networks, social

relations, associations, etc (Scoones, 2000). According to the review made, membership in cooperative, urban linkage, farmer's association membership and secure land right were social capital, which affects farmer's livelihood diversification.

Farmer's association membership

Farmer's association membership was found to have a positive and significant impact on household's livelihood diversification (Tamerat, 2016). The institutional factors like secure land right and being membership in cooperatives had direct relation with livelihood diversification strategies. Farmers having secure land right will have better diversification to agriculture, agro forestry and rent-out their land. Also being membership of cooperative may decrease households' financial constraint, increase in social capital and entrepreneur skill and increase in the bargaining power of farmers in selling and buying their products (Kassie et al., 2017). Also, cooperatives provide better option to promote sharing of knowledge, information, experience regarding different livelihood diversification and means for obtaining different employment opportunities (Asfir, 2016).

Leadership is positively determining the livelihood diversification. This may be due to leaders have more access for information, share more experience with others in social environment, create more social network with outside societies and get more access to formal as well as informal credits (Gecho, 2017). Linkage with urban people had positive effect on livelihood diversification since it may improve access to information, which is important to livelihood diversification (Yizengaw et al., 2015).

Financial capital

Financial or economic capital is cash, credit/debit, savings, infrastructure, and other economic assets (Scoones, 2000) or financial assets are organizational income, access to credit, grants or savings (Davidson et al., 2014). Financial capital that determine livelihood diversification includes oxen ownership, access to credit facilities, annual farm income, tropical livestock unit, food for work and remittance receiving.

Tropical livestock unit (TLUs)

Tropical livestock unit (TLUs) had negative effect on livelihood diversification (Ofolsha and Mansingh, 2015; Yizengaw et al., 2015; Debele and Desta, 2016; Gecho, 2017). Hence, farmers with large number of tropical livestock unit were less likely to diversify livelihood than those who own small number of TLUs due to better opportunity to earn more income from livestock production (Gecho, 2017; Yizengaw et al., 2015). They may also have less intention to non/off farm activities diversification (Debele and Desta, 2016). According to Asfir (2016), it had positive effect on livelihood diversification because farmers having more number of TLU had more money to invest in on farm and nonfarm activity.

The number of oxen owned

The number of oxen owned was negatively influenced the probability of diversifying livelihood. On the other hand, farmers having more number of oxen are less likely to diversify livelihood than less number of oxen (Ofolsha and Mansingh, 2015; Gecho, 2017).

Total annual cash income

Total annual cash income affects household livelihood diversification positively (Gecho, 2017; Yizengaw et al., 2015; Asfir, 2016). Therefore, households having large cash income were more likely to diversify livelihood into non/off farm activities. The possible reason is that those farmers who have adequate income sources can overcome financial constraints to engage in alternative income-generating activities (Gecho, 2017; Yizengaw et al., 2015; Asfir, 2016). This was due to easily meeting of consumption needs, possibility of creating demand-pull livelihood outcomes and other family requirements (Asfir, 2016).

Access to credit service

Access to credit service was found to have a positive effect on livelihood diversification. Hence, providing credit for resource poor farmer will enhance livelihood diversification (Debele and Desta, 2016; Anshiso and Shiferaw, 2016; Mentamo and Geda, 2016). On the other hand, access to credit service had negative impact on livelihood diversification because farmers having access to credit may inclined to purchase fertilizer to improve their agricultural production and productivity rather than diversifying their livelihoods (Asfir, 2016).

Use of modern fertilizers was found to have a positive and significant impact on household's livelihood diversification (Tamerat, 2016). Contrary to this, fertilizer use negatively influenced livelihood diversification because using fertilizer may increase production and productivity of farm family to access more food and generate more income to satisfy their family requirements (Asfir, 2016). According to Anshiso and Shiferaw (2016), remittance receiving positively determined livelihood diversification. Food for work (safety net) also positively determined the livelihood diversification (Mentamo and Geda, 2016).

Table 1. Challenges of rural livelihood diversification in Ethiopia.

Authors	Challenges of rural livelihood diversification
Wondimagegnhua et al. (2016), Yona and Mathewos (2017), Mentamo and Geda (2016), and Tenaw (2016)	Lack of capital
Debele and Desta (2016), Dadi (2016), and Mentamo and Geda (2016)	Lack of access to credit service
Debele and Desta (2016), Yona and Mathewos (2017), Dadi (2016), and Mengistu (2016)	Lack of access to market and marketing service
Asfaw et al. (2017), Yona and Mathewos (2017), Tenaw (2016) and Debele and Desta (2016)	Poor infrastructures (road, electricity, telecommunication and transport problem)
Tenaw (2016) and Yona and Mathewos (2017)	Lack of job opportunities
Tenaw (2016) and Mengistu (2016)	Lack of financial services
Debele and Desta (2016) and Wondimagegnhua et al. (2016)	Farmland scarcity
Debele and Desta (2016)	Agro-climatic condition
Debele and Desta (2016)	Decline in livestock productivity, crop and animal disease
Wondimagegnhua et al. (2016)	Low selling price for commodities produced, high cost of agricultural inputs, diseases and monkey attacks ,superstitious beliefs towards pottery and blacksmith
Yona and Mathewos (2017)	Negative attitude of the society, lack of raw materials, low institutional capacity, lack of time, lack of storage facilities and costly inputs and lack of coordination
Mengistu (2016)	Communal resource administration system and lack of proper extension services
Tesfaw (2015)	Political and economic marginalization, inappropriate development policies climate change and increasing resource competition
Yona and Mathewos (2017), Asfaw et al. (2017), Dadi (2016), Wondimagegnhua et al. (2016) and Tenaw (2016)	Lack of skill and experience, inadequate skill training, lack of technical support, lack of knowledge and lack of awareness

Physical capital

Physical assets are tools and equipments needed to be productive in buildings, space or infrastructure (Davidson et al., 2014). Distance from the nearest market, irrigation water and mass media were physical capitals, which determine rural livelihood diversification.

Market distance

Market distance negatively affected household's income diversification activities (Gecho, 2017; Kassie et al., 2017; Debele and Desta, 2016). As market distance increase from home, farmer's non/off farm income diversification will be discouraged (Gecho, 2017). The farmers having near market possibility to selling-out their labor to the nearest market to maximize their income and to smooth their annual consumption during the slack crop production period, promote the rural-urban linkages, develop the entrepreneurial skill of farm households to diversify their livelihood (Kassie et al., 2017). The result of Aababbo and Sawore (2016) revealed that farmers who reside far from the market center have better probability of diversifying income source.

Mass media

Mass media are positively related with livelihood diversification strategies because the access to mass media may improve rural households' information on non-farm activities (Yizengaw et al., 2015). In addition, irrigation water had positive relation with farming livelihood diversification (Mulugeta, 2013; Ofolsha and Mansingh, 2015).

Challenges of rural livelihood diversification in Ethiopia

Livelihood diversification in rural area is an important strategy to survive and accumulate asset. However, there are many challenges in Ethiopia to engage in successful livelihood diversification (Tenaw, 2016) and identified in Table 1. Nevertheless, scholars did not clearly show challenges for each livelihood diversification strategies.

CONCLUSION

Livelihood diversification strategies in Ethiopia were on farm, nonfarm and off farm. However, on farm livelihood activities were the most practiced livelihood strategies. Nevertheless, some of the scholars lack information regarding to clear and cut difference between nonfarm and off farm strategies and also they lack clear classification of livelihood diversification strategies. Based on their inferential statistics results, various scholars distinguish different determinans, which affect livelihood diversification. Some determinants that affect rural livelihood diversification were land holding size, sex, age, education level, agricultural extension visit, farmers association, access to credit and market distance. However, there were contradictory findings on determinants of livelihood diversification. In addition, some of the scholars did not reason out model outputs on livelihood diversification. Some of the major challenges which affect rural livelihood diversification were lack of capital, poor infrastructures, lack of access to credit service, lack of access to market and marketing service, lack of job opportunities and farm land scarcity. However, most of the studies lack detail information on each diversification strategies rather than generalization on livelihood diversification strategies. Therefore, governmental and nongovernmental organizations should give attention for rural livelihood improvement through providing information regarding to marketing, extension and credit services. Further studies should be conducted to fill information gap on determinants and challenges of rural livelihood diversification. Besides, policy makers should formulate and ratify appropriate rural development policies and strategies based on existing situation of rural livelihood to boost development of the rural community.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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Adoption determinants of row planting for wheat production in Munesa District of Oromia Region, Ethiopia

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Agriculture takes the lion's share in the economic development of many developing countries, including Ethiopia. Agricultural policy of the years has focused on supporting the introduction of improved technologies to boost production and reduce food insecurity. However, outcomes of such agricultural policies have been influenced by different factors of which low adoption of improved agricultural technology is a major constraint. The objective of this study was therefore, to analyze the determinants of adoption and intensity of use of row planting for wheat production. Data were obtained from both primary and secondary sources. Multi-stage sampling technique was used to select 140 wheat producer household heads from the Munesa district of Oromia region, Ethiopia. Data were collected through the administration of semi-structured questionnaires. Data were analyzed using both descriptive statistics and the Tobit econometric model. Descriptive result shows that, from 140 sampled households 97 are adopters of wheat row planting while the remaining are non-adopters. The model was used in estimating the determinants of adoption and intensity of use of row planting for wheat production. The model results revealed that education level, labor availability, extension contact, credit use, participation in training and access to improved seed had positively and significantly influenced adoption and intensity of use of row planting for wheat production. Based on the results of this study, it can be concluded that, policy and development interventions should focus on improving economic and institutional support system for high rates of adoption and intensity leading to improved productivity and income among smallholder farmers.

Key words: Adoption, row planting, Tobit model, Munesa, wheat.

INTRODUCTION

Reducing poverty in developing countries like Ethiopia depends on the growth and development of the agricultural

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sector (World Bank, 2008). Wheat is a strategic food security crop grown for food and cash by smallholder farmers in Ethiopia and occupies about 17% of the total cereal crop area (Central Statistical Agency of Ethiopia, 2013).

The demand for the crop has been on the increase due to rapid population growth, urbanization and upsurge of food processing industries (Dorosh and Rashid, 2013). The country produces 75% and imports 25% to make up for the shortfall(Global Agricultural Information Network, 2014).The country is thus unable to meet the high demand and remains a net importer despite the potential to increase production (Rashid, 2010). According to Ethiopian Ministry of Agriculture, farm level productivity is 2.1 t/ha using traditional broadcasting while potential yield stands at 2.45t/ha (MoA, 2012). Farm productivity in 2012, was 29, 13 and 32% below that of Kenya, African as a continent and world at large, respectively (Food and Agricultural Organization, 2014b). The research systems together with other stakeholders have played a major role in delivering improved technologies for increasing productivity in the country (Biftu et al., 2016). Efforts have also being underway by the national agricultural research system through which a number of technologies have been released for the farming community. In spite of these efforts, a productivity gain has not been impressive. One major factor contributing to low productivity in the country is the low adoption rate of improved technologies (Hassen et al., 2012; Ahmed et al., 2014). Among these is the low adoption of row planting despite its ability to contribute to high yields (Joachim et al., 2013).

Recent studies in Ethiopia have shown that yields are very responsive to row planting for wheat production. Tolosa et al. (2014) reported average yield of 2.8t/ha (19.7%) in the highland areas using row planting which is above national average yield of 2.45t/ha in the country. Vandercasteelen et al. (2014) also found an increase in *teff* yields between 12 and 13% in farmers' experimental plots and 22% in demonstration plots managed by extension agents by using row planting.

In addition, in the United States, planting wheat in wide rows in combination with inter-row cultivation reduced weed density by 62% and increased yield by 16% (Lauren et al., 2012). Furthermore, according to the Ministry of Agriculture and Rural Development (MoARD, 2012) row planting on average increases production by 30% and reduces the amount of seed consumption to one-fifth of existing seed use. Despite the advantages of row planting, it is not widely accepted in the study area. Studies on adoption of row planting are scanty and less focused on intensity. The main objective of this study was therefore to estimate and evaluate determinants of adoption and intensity of use of row planting for wheat production among smallholder farmers. This is expected to provide information to stakeholders in their quest to formulate policies and programs to upscale row planting for sustainable crop production.

MATERIALS AND METHODS

Description of the study area

This study was conducted in the Munesa district located in the East Arsi zone of Oromia region, Ethiopia. The district is situated at latitudes 7°12' to 45 N and longitude 52° to 39°03'E in central Ethiopia. Munesa is located at 57 km away from the southern part of zonal town called Asella and 232 km south west of Addis Ababa. The total land area covered by the district is 1031 km^2 and altitude of the area ranges from 2080-3700 m.a.s.l and characterized by mid sub-tropical temperature ranging from 5 to20°C. Munesa is organized into 32 rural kebeles and 3 rural towns with a total population of 211,762 (MDAO, 2015). Crop-livestock integration is the dominant farming system within the district. Major cereal crops cultivated include; wheat, barley, and maize. Among cereal crop produced, the district is well known by wheat production. Major livestock reared in the district include cattle, sheep, goats and hoarse (Figure 1).

Sampling techniques and sample size determination

Respondents for this study were sampled using the multi-stage sampling technique. In the first stage, major wheat producing districts was purposively selected. The selected districts were Munesa district. The main reason for purposive selection was due to its high potential for wheat production, and introduction and application of row planting level of wheat production. There are also strong research and extension intervention programs embracing wheat producers in the district. Moreover, newly released improved wheat varieties and wheat row planting practices were relatively more disseminated and practiced in this district. Hence, it was plausible to assess the adoption intensity of wheat row planting in the district. In the second stage, of the probability sampling, a list of major wheat growing lower administrative divisions (kebeles) within the selected district was prepared. Taking in to account the resources available, four kebeles were selected from the district, based on their high potential in wheat production and wheat row planting practice compared to the remaining kebeles of the district. In the third and final stage, a list of wheat farmers was prepared for each selected kebele. Sample farmers were selected by simple random sampling technique. The sample size was determined based on the formula given by Yamane (1967), and allocation of sample size to each kebele was made proportionate to the size of farm household heads population of each kebele.

$$n = \frac{\mathrm{N}}{1 + \mathrm{N}(e)^2}$$

Where n is the sample size, N is the population size (total households in the four kebeles which is 1,880) and e is the level of precision. After calculating by formula, 140 households were selected. See proportion of sample respondent from each sample kebele (Table 1). Accordingly, from a total of randomly selected 140-sample size, 43 were non-participant farmers and 97 were participant farmers in row planting of wheat in 2016/2017 cropping season.

Data collection methods

Primary and secondary data were collected for the study using both formal and informal methods. For the primary data, a household level survey was conducted between Nov 2016–Jun 2017 using semi-structured questionnaire. Prior to the field data collection,

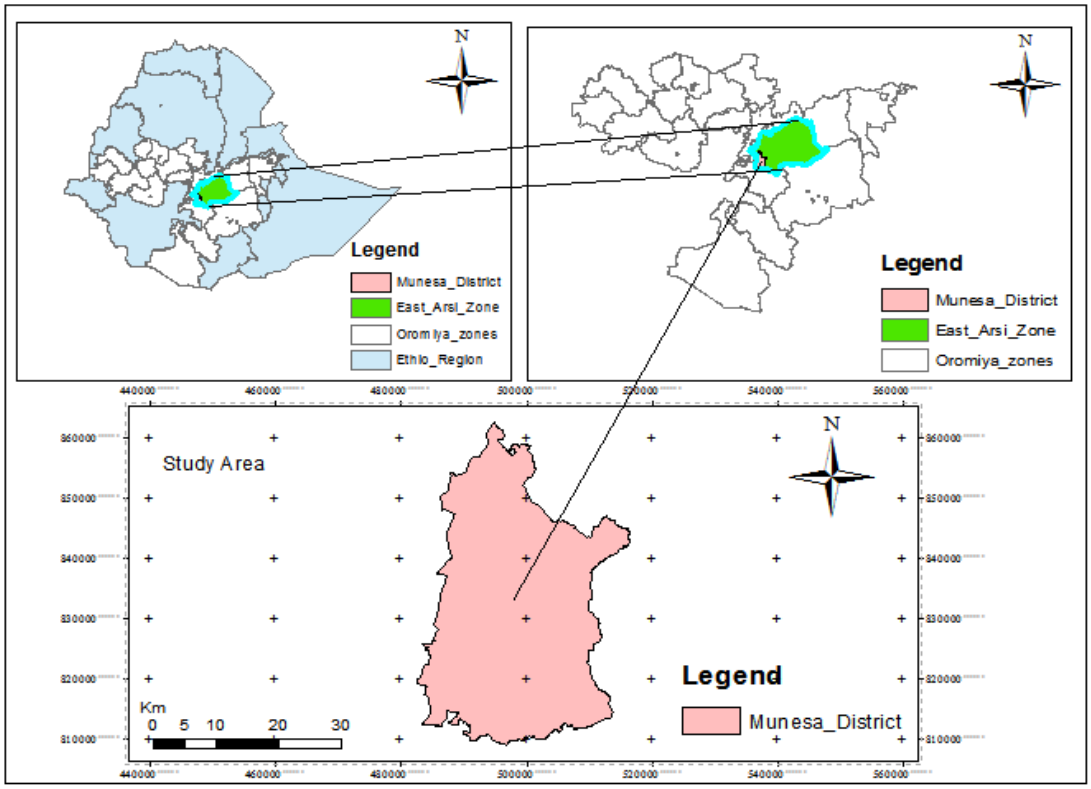

Figure 1. Map of the study area.
Source: Author, 2016.

Table 1. Number of respondents in each selected kebeles and selected respondents.

Name of Kebeles	Total number of households	Sample household
Didibe Yadola	439	33
Oda Lenca	520	39
Garambota Lole	513	38
Shumbulo	410	30
Total	1,880	140

Source: own computation, 2016/2017 from Munesa district administration office.

testing was done to validate the data collection tool. The semi-structured questionnaire was used to collect data on household demographic, socio-economic structure, institutional factors and production activities. Besides, a checklist was prepared and used for group discussion and key informants with wheat grower farmers and purposively selected knowledgeable respondents regarding wheat row planting to elicit data that cannot be collected from individual respondents, respectively. Secondary data were also collected from relevant governmental and non-governmental offices, published and unpolished sources to consolidate the primary data.

Method of data analysis

In order to achieve the stated objectives of the study, the survey data were sorted out, edited, coded, organized, summarized and analyzed using descriptive and Tobit model using STATA version 13. Descriptive statistical tools such as mean, standard deviation, frequency, and percentage were applied to describe the characteristics of the respondents. Results are presented in the form of tables. Test of hypothesis was done using Chi-square test and F- test. In the econometric part, Tobit model was used to identify the determinants of adoption and intensity of use of row planting for wheat production.

Econometric estimation of adoption and intensity of use of row planting

The adoption and intensity of use of wheat row planting was estimated based on the approach by Roger (1962) and Feder et al. (1985) using the Tobit model. The Tobit model was used since the proportion of area under row planting had a censored distribution. The use of linear programming models, logistics and probit models were therefore inappropriate (Tobin, 1958). Solomon et al. (2011)

viewed that the decision to adopt and intensity of use are assumed to be made jointly and factors affecting them are assumed to be the same. These were the basis for the use of the Tobit model instead of other adoption models. Following Johnston and Dinardo (1997), the Tobit model was specified as:

$$AIi^{*}=B_O + B_iX_i+U_i, \text{ where i=1, 2……n}$$

$$AI = AIi^{*}, \text{ if } AIi^{*}>0$$

$$=0 \text{ if } AIi^{*} \leq 0 \quad (1)$$

Where,

AI_i = adoption intensity of wheat row planting of i^{th} farmer measured by dividing area under wheat row planting for total area allocated for wheat production.
AI* = the latent variable and the solution to utility maximization problem of intensity of adoption subject to a set of constraints per household and conditional on being above a certain limit,
X_i= Vector of factors affecting adoption and intensity of use of wheat row planting,
B_i= Vector of unknown parameters, and
U_i= is the error term normally distributed with mean 0 and varianceσ^2.
Equation (1) represents a censored distribution of intensity of adoption since the value of AI for all non-adopters equals zero. According to Maddala (1992), the model parameters of a censored distribution are estimated by maximizing the Tobit likelihood function of the following form:

$$L = \prod_{AIi>0} \frac{1}{\sigma} f\left(\frac{AIi - \beta Xi}{\sigma}\right) \prod_{AIi\leq 0} F\left(\frac{-\beta iXi}{\sigma}\right) \quad (2)$$

Where, *f* and F are respectively the density function and cumulative distribution function AIi^{*}. $\prod_{AIi\leq 0}$ Means the product over those i for which $AIi^{*} \leq 0$, and $\prod_{AIi>0}$ means the product over those i for which$AIi^{*} > 0$.

Coefficients of a Tobit model do not directly represent the marginal effects of the associated independent variables on the dependent variable. However, their signs show the direction of change in probability of adoption and the marginal intensity of adoption as the respective explanatory variable changes. It is therefore not appropriate to interpret the coefficients of a Tobit model in the same way that of uncensored linear model (Johnston and Dandiro, 1997). To interpret the coefficients as marginal effect, derivatives of the model has to be computed. Johnston and Dandiro (1997) proposed the decomposition of explanatory variable effects into adoption and intensity of usage. A change in X_i (explanatory variables) affect the conditional mean of AIi* in the positive part of the distribution and the probability that the observation will fall in that part of the distribution. Marginal effects of explanatory variables for this study were therefore estimated as follows:

1). The marginal effect of an explanatory variable on the expected value of the dependent variable was:

$$\frac{\partial E(AIi)}{\partial Xi} = F(z)\beta i \quad (3)$$

$\frac{\beta iXi}{\sigma}$ is denoted by z, following Maddala (1997).

2). The change in probability of adopting of wheat row planting as independent variable Xi changes is:

$$\frac{\partial F(z)}{\partial Xi} = f(z)\frac{\beta i}{\sigma} \quad (4)$$

3). The change in the intensity of use of wheat row planting with respect to a change in an explanatory variable among user is:

$$\frac{\partial E(AIi/AIi^{*}>0)}{\partial Xi} = \beta i\left[1 - Z\frac{f(z)}{F(z)} - \left(\frac{f(z)}{F(z)}\right)^2\right] \quad (5)$$

Where: F (z) is the cumulative normal distribution of Z,
f(z) is the value of the derivative of the normal curve at a given point (that is, unit normal density),
Z is the Z score for the area under normal curve,
β is a vector of Tobit maximum likelihood estimates and
∂ is the standard error of the error term.

Prior to the econometric model estimation, multicollinearity was tested using the Variance Inflation Factor (VIF) and Contingency Coefficient (CC), simultaneously.VIF for continuous explanatory variables (Xi) were estimated such that:

$$VIF = \frac{1}{1-R^2} \quad (6)$$

Where, R^2 is the coefficient of correlation among explanatory variable. Variables with VIF exceeding 10 were deem to be highly collinear (Gujarati, 2004). Dummy variables with CC values greater than 0.75 were deem to be collinear (Healy, 1984). CC was specified as:

$$CC = \sqrt{\frac{x2}{n+x2}} \quad (7)$$

Where n= sample size and x^2= chi-square value.

Estimation of adoption index

The adoption index was used to measure the level of adoption under row planting for each sample households at the time of the survey. The adoption index score was calculated by dividing area allocated for wheat production using row planting to total cultivated area for wheat production by the i^{th} farmer. The rational for calculating the adoption index was to know the level of adoption of row planting for wheat production in the study area following the work of Alemitu (2011), Abreham and Tewodros (2014), and Rahmeto (2007). The adoption index for each respondent farmer was calculated as:

$$AI_i = \frac{\text{Area under wheat row planting technology (AWi)}}{\text{Total area allocated for wheat production (ATi)}}$$

Where: AI_i is adoption index of the i^{th} farmer, and i represent respondents (farmers).

Once the AI scores was calculated, respondents were classified into non- adopter, low, medium and high adopter depending on their AI value. The actual adoption index score ranges from 0 to 1. Adoption index score of zero point implies non-adoption of the row planting for wheat production and greater than zero (>0 and ≤ 1) implies adopters with three category; namely low adopters, medium adopters and high adopters. The mean adoption index scores of non-adopters, low, medium and high adopters groups were 0.00, 0.20, 0.48 and 0.85, respectively (Table 2).

Table 2. Summary of variables and their expected signs.

S/N	Dependant variable	Description	
	Area under row planting	**Non-negative continuous variable**	
	Independent variable	**Description**	**Expected sign**
1.	Age of household head	Continuous variable measured by years	-
2.	Sex of household head	Dummy variable (1=Female, 0 =Male)	+
3.	Education	Education level of household head (years of schooling)	+
4.	Farm size	Continues variable measured in hectare	+
5.	Labor availability	Continuous variable measured by ME	+
6.	Access to improved seed	Dummy variable (1, if available, 0 otherwise)	+
7.	Extension contact	Continuous variable measured by number	+
8.	Access to credit	Dummy variable(1, users, 0 otherwise)	+
9.	Participation in row planting training	Continuous variable measured by number	+
10.	Perception on row planting	Dummy variable (1, if perceived as superior, 0 otherwise)	+
11.	Membership to social association/group	Dummy variable (1, if membership, 0 otherwise)	+

RESULTS AND DISCUSSION

Here, presents findings and discussions on row planting adoption rate, and intensity. It also looks at socio-economic, demographic and institutional determinants of wheat farmers in the study area.

Status of adoption and intensity of use of wheat row planting technology

In this study, farmers who did not grow wheat through row planting were considered as non adopters and while the farmers who grow wheat with row planting were taken as adopters. The adoption index of sample households indicated that 43 of the sample respondents (30.7%) had adoption index score of 0, which shows they are non adopters, 26 respondents (18.6%) had adoption index ranging from 0.01 to 0.33. This indicates low adopters, while 40 respondents (28.6%) had adoption index score stretching from 0.34 to 0.66 indicating medium adopters, and 31 respondents (22.1%) had adoption index score ranging from 0.67 to 1.00, which show high level of adoption (Table 3). The difference in area coverage under wheat row planting may be attributed to varying land holding and stage of an individual in the adoption process. One way analysis of variance revealed the existence of significant mean difference (F=628.19, P=0.000) among the adoption index score of the four adoption categories at 1% significance level, implying the existence of variation in level of adoption among sample households.

Descriptive results

As observed in the Table 4, the mean age of the non-adopter sample respondents were about 45.88 years, while the mean age of low, medium and high adopter categories were 42.88, 43.6, and 39.61, respectively. The mean test using one-way ANOVA show the significant mean difference at 10% probability level among adoption categories. The mean labor availability of the sample households measured in Man Equivalent (ME) was 3.41. The mean of sample household contact with extension agents and participate in training regarding wheat row planting was 5.72 and 2.41, respectively in survey year. The mean test of analysis of variance (ANOVA) also shows the significant mean difference among adoption categories of wheat row planting interims of labor availability, extension contacts and frequency of participation in training at 1% probability level. The average size of land owned by the sample respondents were 4.27 ha.

As indicated in Table 5, the descriptive analysis indicated that (121)86.43% of the sample households are male and the rest (19)13.57% are women, who are single, widowed or divorced. Among the respondents, 33.57% (47) of them were obtained and used the credit from different sources and the remaining 66.43% (93) have not received and used the credit. The Chi-square test ($\chi2=2.944$, P=0.400; and $\chi2=1.622$, P=0.654) revealed that there is no significant difference between sex of household head and credit uses with respect to adoption categories of wheat row planting in the study area. Out of 140 sample respondents, 45.71%(64) were reported availability of improved wheat seed on time with required quantity and the remaining 54.29%(76)of farmers were reported unavailability of improved wheat seed on time with required quantity during production period. And also, 92.86% (130) of sample respondents had participated in social group while 7.14 %(10) did not participate in social group/ association. The result of chi-square test ($\chi2=22.791$, P=0.000; and $\chi2=8.734$ and

Table 3. Distribution of sample respondents by level of adoption of wheat row planting technology.

Adopter category	N	%	Adoption index(AI)	Mean of AI	STD	Min	Max
Non-adopt	43	30.7	0.00	0.000	0.0	0.00	0.00
Low	26	18.6	0.01-0.33	0.200	0.07	0.05	0.33
Medium	40	28.6	0.34-0.66	0.480	0.05	0.34	0.63
High	31	22.1	0.67-1.00	0.850	0.17	0.67	1.00
Total	140	100%	0.00-1.00	0.360	0.33	0.00	1.00
F-value			628.19***				

Source: Own survey data (2017); *** indicates at 1% significant mean difference.

Table 4. Characteristics of wheat grower farmers by adoption levels of wheat row planting: Continuous variables.

	Adopter category					
	Non	Low	Medium	High	Total	F-value
AGE EDUCL	45.88	42.88	43.6	39.61	43.29	2.32*
LABOUR	2.55	3.68	3.65	4.05	3.41	15.946***
LANDSIZE	4.64	3.93	4.13	4.23	4.27	1.209(NS)
EXTENCONT	4.65	6.31	5.93	6.45	5.72	4.706***
TRAINING	0.51	2.81	3.33	3.52	2.41	45.97***

Source: Field Survey (2017); NS= indicate non-significant mean difference; and ***, *****indicates the mean difference is significant at 5% and 1% level, respectively.

Table 5. Characteristics of wheat grower farmers by adoption levels of wheat row planting: Dummy variables.

Variable		Adoption categories					
		Non	Low	Medium	High	Total	
		%	%	%	%	%	χ2- value
SEX	Male	(39)32.2	(23)19	(35)28.9	(24)19.83	(121)86.43	2.944(NS)
	Female	(4)21.1	(3)15.8	(5)26.3	(7) 36.84	(19) 13.57	
CREDTUSE	No	(14)31.2	(11)16.1	(11)31.2	(11)21.51	(47)66.43	1.622(NS)
	Yes	(29)29.8	(15)23.4	(29)23.4	(20)23.40	(93)33.57	
SOCIALPART	No	(7)70	(0)0.0	(1)10	(2)20	(10)7.14	8.734**
	Yes	(36)27.7	(26)20	(29)30	(29)22.3	(130)92.9	
ACCIMPSEED	No	(36)47.4	(9)11.8	(16)21.1	(15)19.74	(76)54.29	22.791***
	Yes	(7)10.9	(17)26.6	(24)37.5	(16)25.00	(64)45.71	

Source: Field survey (2017); NS=indicate non-significant mean difference; and ****, *****indicates the mean difference is significant at 5 and 1% level, respectively.

P=0.033) also shows statistically significant difference between adoption categories of wheat row planting with respect to availability of improved wheat seed and participation in social group/association in the study area.

Econometric results

Tobit econometric model was used to analyze factor affecting adoption and intensity of use of row planting on wheat production. The model was selected based on theoretical background and review literature on related studies and previous justification point up in methodology part. The R^2 value of 0.6784 implies that the variable included in the model accounted for 67.84% of variation in adopting and intensity of use of wheat row planting. The log likelihood function indicates a Chi-square value of 136.50 significant at 1% significance level. This means the model as a whole fits significantly (P≤0.001). On the

Table 6. Determinants of adoption and intensity of row planting in wheat production.

Variable	Estimated coefficients	Standard error	t-ratio
SEX	-0.017	0.089	-0.19
AGE	-0.003	0.003	-0.91
LABOR	0.098***	0.029	3.35
EDUCT	0.022**	0.01	2.27
LANDSIZE	-0.011	0.018	-1.11
EXTCONT	0.030*	0.016	1.87
CRDITUSE	0.112*	0.061	1.84
PARTSOCIALG	0.085	0.117	0.73
ACCSEED	0.232***	0.076	3.054.00
PARTTRA	0.084***	0.021	-0.94
HHPRPTECH	-0.029	0.031	-1.5
CONST	-0.406	0.271	
Sigma	0.281	0.021	

Note: *, ** and *** represents significance at 10%, 5% and 1% probability levels, respectively.
Log likelihood = -32.35428; Pseudo R2 = 0.6784; Prob > Chi2 = 0.0000;
LRCh2 (15) =136.50
Source: Model output (2017).

other hand, it implies that all explanatory variables included in the model jointly influence the adoption and intensity of use of row planting for wheat production in the study area. The result of maximum likelihood estimates of Tobit model are summarized in Table 6.

Education level of household head (EDUCT)

The result of the Tobit regression model analysis shows that education had positively and significantly influenced the household adoption and intensity of use of row planting for wheat production at 5% probability level of significance. This was because educated household heads understood the importance of row planting and why the needed to adopted it. The high number of farmers who had accessed education could independently make adoption decision with effect on adoption rate and intensity. Leake and Adam (2015) and Abrhaley (2016) also reported the positive influence of farmer's education on agricultural technology adoption. They explained that farmers with higher education level can easily process information and search for appropriate agricultural technologies to alleviate their production constraints.

Labor availability (LABOR)

Labor availability was measured in Man equivalent. The availability of economically active labor force in the household is found to be among the most influential variables in the model. It has a positive significant influenced on adoption and intensity of use of row planting for wheat production at 1% significance level. The result indicates that when labor availability increases, the area under row planting also increases. The reason for this positive effect was that row planting was labor intensive and hence its availability could increase area under cultivation. This finding is consistent with findings of Hailu (2008), Motuma et al. (2010), and Leake and Adam (2015). They argued that farmers who have more family labor could supply the required labor for different operations and undertake the agricultural activity in time and effectively manage the wheat fields.

Extension contact (EXTCONT)

As the model result indicates, extension contact had a positive significant effect on adoption and intensity of use of row planting for wheat production at 10% significance level. This implies an increase in the frequency of visits by extension officers during the production will lead to an increase in the size of land for wheat productions using row planting. This result also indicates that, the households who frequently contact with extension agent are more likely to expose to updated information about the importance and application of row planting for wheat production through counseling and field demonstrations on a regular basis. The effect of extension visit for this study is consistent with the findings of Tolosa et al. (2014) which indicate that frequency of extension contact was positively related to adoption of row planting for wheat production.

Credit use (CRDITUSE)

Credit use was one of institutional variable, which was

Table 7. Effect of change in significant explanatory variable on probability of adoption and intensity of use of wheat row planting.

Variable description	Change in probability of adoption	Change in intensity of use	Overall change
EDUCT	0.0209	0.0134	0.0181
LABOR	0.092	0.05890.0181	0.071
EXTCONT	0.0283	0.0672	0.0246
CRDUSES	0.1049	0.1337	0.0912
ACCISEED	0.2347	0.0505	0.1824
PARTTRA	0.0789		0.0686

Source: Model output (2017).

found to have positive and significant influence on the probability of adoption and intensity of use of wheat row planting at 10% significance level. The result is in line with the hypothesis set forth. The probable reason for positive result is that, credit use is one way of improving financial constraints for purchasing different agricultural inputs like improved seed, modern fertilizer, weed chemicals and hiring labor/row planting machine from private owner farmer has to improve labor constraints in the study areas. As a liquidity factor, the more farmers have received and used the credit, the more likely to adopt row planting that could possibly increase their yield. Thus, credit use facilitates the uptake of improved agricultural technologies. The result is consistent with the finding of Simtowe et al. (2016) and Frank et al. (2016) indicated that the availability of credit enables households to pay for external hired labor and other expenses incurred in the process of technology adoption.

Access to improved seed (ACCISEED)

Availability of improved wheat seed at the right time with required quantity has the expected positive and significant influence on adoption and intensity of use of row planting for wheat production at 1% significant level. The positive influence of this variable implies that supplying improved seed at the right time with required quantity increases the farmer's probabilities of being adopter of row planting for wheat production. This is because improved seed gives high yield at harvesting period than old seeds especially when used with row planting. Quite often improved seed are in short supply in the study area and hence adoption becomes a question of timely availability and provision of the enough quantities for farming households. The result is in line with the finding of Tolesa (2014) and Tolesa et al. (2014) which indicated that availability and access to improved wheat seed have a positive effect on adoption of row planting for wheat production.

Participation in training (PARTTRA)

Training is one of the extension events and the means of teaching and learning process where farmers get practical skill and technical information for adoption of new agricultural technologies. As expected, this variable were influenced the probability of adoption and intensity of use of row planting for wheat production positively and significantly at 1% significance level. This may be explained by the fact that farmers who have an opportunity to participate frequently in training regarding row planting given at farmer training center (FTC) and attend training at demonstration site of wheat row planting gain better knowledge and technical skill on the application of row planting. They are therefore more likely to adopt and use the row planting for wheat production than others. The result is agreed with the findings of Beyan (2016), and Alemitu (2011).

Effects of change in significant explanatory variables on adoption and intensity of use of wheat row planting

Not all variables that were found to influence the adoption and intensity of use of wheat row planting might have similar contribution in influencing the decision of farm households. Therefore, change in explanatory variables from a Tobit model could be decomposed in to changes due to probability of adoption and changes due to intensity of use as suggested by McDonald and Moffit (1980). Accordingly, the marginal effect of significant explanatory variables in explaining adoption and intensity of use of wheat row planting are listed in Table 7.

The marginal effect result computed in Table 7, revealed that an intervention ensuring the availability and provision of improved wheat seed to farmers in required quantity and at the right time increases the probability of adoption and increases the intensity of use of wheat row planting by 23.47 and 13.37%. The overall effect of this variable on adoption and intensity of use of wheat row planting was 0.1824. Labor availability was found statistically significant at 1% probability level and positively related with adoption and intensity of use of wheat row planting. The model result revealed that, a unit increase in man equivalent increases the probability of change on

adoption and intensity of use of wheat row planting by 9.20 and 5.89%, respectively. Moreover, the overall effects of a unit increase in man equivalent on adoption and intensity of use of wheat row planting was 0.071.

Credit uses and frequency of participation in training regarding row planting are other positive and significant explanatory variables, which have profound effect on adoption decision and intensity of use of wheat row planting. Marginal effect result (Table 7) reveals that creating awareness among farmers on credit uses and improving credit supply institution increase the probability of change on adoption and intensity of use of wheat row planting by 10.49 and 6.72%, respectively. The overall effect of this variable on adoption and intensity of use of wheat row planting was 0.0912. The marginal effect result in the Table 7 also indicated that a unit increase in farmer's frequency of participation in training given at FTC and demonstration center of wheat row planting increases the probability of change on adoption and intensity of use of wheat row planting by 7.89 and respectively. The overall effect of the variable was 0.0686.

The model result also showed the positive and significant influence of frequency of extension contact and household education on adoption and intensity of use of wheat row planting at 10 and 5% significance level. The marginal effect result (Table 7) confirms that as a frequency of extension contact increase by one, the probability of change on adoption and intensity of use of wheat row planting was 2.83 and 1.81%, respectively. The overall effect from this variable was 0.0246. In addition, increasing education level of household by one increases the probability of change on adoption and the intensity of use of wheat row planting by 2.09 and 1.34%, respectively. The overall effect of this variable on adoption and intensity of wheat row planting was 0.0181.

CONCLUSION AND RECOMMENDATIONS

Generally, in Ethiopia particularly in the study area wheat is an important food security crop and an economically important cash crop, which serves as a major means of income for the livelihood of wheat producer households. Besides, the wheat crop plays a vital role in the economy of the country, which is used as a means of input for different food industries. Therefore, institutional support service should be given to this sub-sector to improve production and productivity, such as credit service, extension and research service, which there service provision, is not at expected level. These factors together with other household personal, demographic, socio-economic and psychological factors highly affected the adoption and intensity of use of wheat row planting and consequently production and productivity of the crops.

As shown above, in this research the Tobit model indicated that education level of household head, farm positive and significant effect on adoption and intensity of use of wheat row planting.

The study suggested that participation of farmers in different training regarding wheat row planting prepare for them either at FTC or technology demonstration cite or peasant association has to be strengthened so as to improve farmers' indigenous knowledge, and technical skill on the application of wheat row planting. In addition, farmers' frequent contact with extension agent should be strengthened to improve farmers' access to update information and get advice regarding improved agricultural technology available to them. Since manual wheat row planting is labor intensive, agricultural machinery/ equipment with relatively less labor requirement should be designed and made available to farmers. Moreover, education campaigns and adult education strategies should be designed and implemented by local governments to improve farmer's education level.

Finally, organizing and strengthening wheat producers' to form a cooperative will alleviate procurement on inputs like improved seed and sale of outputs in collective basis, which will help to overcome market barrier to some extent. Barrier on the supply side of credit (high interest rate, high bureaucracy on credit service) should be overcome if a valid major means of income for the livelihood of wheat producing farmers' is to be achieved in the study area. The concerned bodies should formulate a strategy for rewarding and recognizing the model farmers through giving certificate and material support for those who adopt and use the row planting intensively on wheat production.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Assessment of forest management practices and livelihood income around Arero dry Afromontane forest of Southern Oromia Region in Borana Zone, South Ethiopia

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Forest resources are often well managed by local communities either through their own initiatives using traditional institutions or being organized with assistances from development actors such as non-governmental organization (NGOs) and governmental organizations (GOs). The study was aimed to assess forest management practices, and the contribution of forest resource for communities' livelihoods of Arero forest of Oromia Regional State. Secondary and primary data was collected from household survey, forest management groups. The socio-economic importance of the forest resources was assessed by interviewing, 85 households randomly selected from three villages. A semi-structured questionnaire was used for the survey. To assess forest management practices, group discussion was used with selected key informants and local administrators. For socioeconomic survey households (HHs) were used. SPSS software was used for data analyses. Results showed that informal institutions of the Oromo '*Gadaa'* systems and formal institutions like SOS Sahel Ethiopia were collaborated and played to manage the Arero forest in the region. Furthermore, the forest users' (local communities) collect various forest based products such as honey, wild fruit and medicinal plants. The annual income derived from direct forest related activities constituted 16.5% of the total household income. This figure is not including the role that the forest plays in the form of forest grazing. The contribution from the forest ranks third in terms of relative importance in household income generation after livestock and wage labor. Forest management activities like fire protection, control expansion of settlement, controlled forest grazing and enrichment planting was practiced to improve forest conditions by traditional forest management communities in collaboration with other development institutions. The observation of the population of some dominant plant species experiences poor regeneration. This also implies that current management practices are not satisfactory to sustain the forest conditions. Unless improved management interventions are made, the sustainability of the contribution to livelihoods income from the forest will be in question in the future.

Key words: Arero, Borana, community, 'Gadaa' system institution, forest, livelihood, management.

INTRODUCTION

Tropical forests are habitat of numerous species of both plants and animals, which constitute biodiversity through a web of life. It supports various life forms including human beings who dwell in settlements in and around

forests (FAO, 2016). According to Wakshum et al. (2018), report on the state of the world's forests about 11.9% (closed forest plus woodlands) of Ethiopia's land area is covered with forests. According to FRA (2015) report, between 1990 and 2000, 141,000 ha of the forest of Ethiopia were lost every year, which equals an average annual deforestation rate of 0.93%. On the other hand, between 2000 and 2005, the rate of deforestation increased by 10.4 to 1.03% per year (or around 2,114,000 ha) of forest cover loss in the 15 years between 1990 and 2005. Estimates by Narita et al. (2018) showed that the area of closed forest declined to about 3.0 to 4.0% of the country. A recent report (FAO, 2016) showed that 124,990 km^2 (11.4%) of the total land area of Ethiopia (1,096,310 km^2) was covered by forests.

Deforestation has important local, national, and global implications. At all levels, forests are not the only assemblage of biodiversity and ecosystems but also causes loss of ecosystem goods and services like soil erosion, land degradation, water and air pollution which in turn affect the livelihoods of rural people. This is even more important in developing countries like Ethiopia where the majority of the people are dependent on natural resources (Husmann, 2015). The local households generate income from different activities like agriculture, livestock, and forestry related activities. The forest resources have input to local household economy providing timber and Non-Timber Forest Product Resources (Tugume et al., 2015). The input from Non-Timber Forest Product Resources (NTFPs) highly depends on the quality of forest resources, market availability and access situation. The quantity and quality of forest resources, in turn, depend on sound forest management and conditions of managing institutions. These can be attained when forest resources are well managed by local communities in collaboration with government and/or other development institutions (Asare et al., 2013). As used to be thought in the past, keep local households out of forest management areas is not a sufficient condition to improve the status of forests (Lalisa et al., 2018). According to Pandey et al. (2016), the only direct sustainable incentive to forest management is to secure forest use rights and revenues, through managed utilization of forest resource. That means people will only manage forest if they own rights to the resource and gain more benefits by conserving the forest than removing it, and if that benefit is directly linked to the existence of the forest and /or improvement of forest conditions[1]. The Borena lowland forests are within the Somali- Masai Regional Center of endemism (White, 1983). This forest is located in Borena zone, Southern Ethiopia near the town Meta Gafarsa capital of Arero district.

In Ethiopia where the livelihood of 83% of the population resides in rural area and dependent on natural resources particularly renewable natural resources, the pressure on forest resources are high. The depletion and deterioration of the forest resources in turn resulted in reduced agricultural productivity quality of life (Melaku, 2006). To improve the conservation of the remaining natural forests of Ethiopia, the remnant forest resources have been blocked into 58 National Forest Priority Areas (NFPA's) covering, an area of 3.6 million ha (SFCDD, 1990). These areas comprise natural forests, plantations, and non-forested land. Arero forest is one of these delineated as priority forest area in Boreana zone. Accelerated human population growth in the tropics mostly coupled with poverty has enhanced the negative human impact on the forest resources. Among the tropical forests, dry forests have been preferred for human settlement than wetter forest zones, due to different biological and ecological reasons (Tugume et al., 2015). In Ethiopia where the livelihood of 83% of the population resides in the rural area and dependent on natural resources particularly renewable natural resources, the pressure on forest resources are high. The depletion and deterioration of the forest resources, in turn, resulted in reduced agricultural productivity quality of life (Sundstrom et al., 2014). As the result the forest area of the Arero forest was declined to 29,226.39 ha.

Like most forests of the country, the Arero forest is experiencing deforestation and degradation. Several studies covering wider disciplines have been conducted in the area to contribute to the improved understanding of the ecological and socio-economic conditions for better management of the forest. Studies such as plant diversity and Ethnobotany (Kujawska et al., 2017), vegetation change (Habtamu, 2018), invasive woody plant species (Garuma and Wendawek, 2016) and socio-economic importance of Boke salt house (Wakshum et al, 2018), and population status and socio-economic importance of gum and resin bearing species (Adefris et al, 2012). However, most of these studies were made in the lowlands (rangeland and woodland) of Borana zone and only a few studies are made in the Arero forest to capture the relation between livelihoods, traditional forest management practices of communities in collaboration with formal (governmental and non-governmental) institutions and forest conditions. Therefore, the study aims to assess (1) forest management practices of the Arero district, and (2) the contribution of forest resources for communities' [1]livelihood of Oromia Regional Arero

[1]Livelihood is more than just a person's job or a way to earn a living. Livelihood has also been defined as comprising the capacities, assets (including social resources, physical, monetary assets) and activities required for a means of living (Khanal, 2007).

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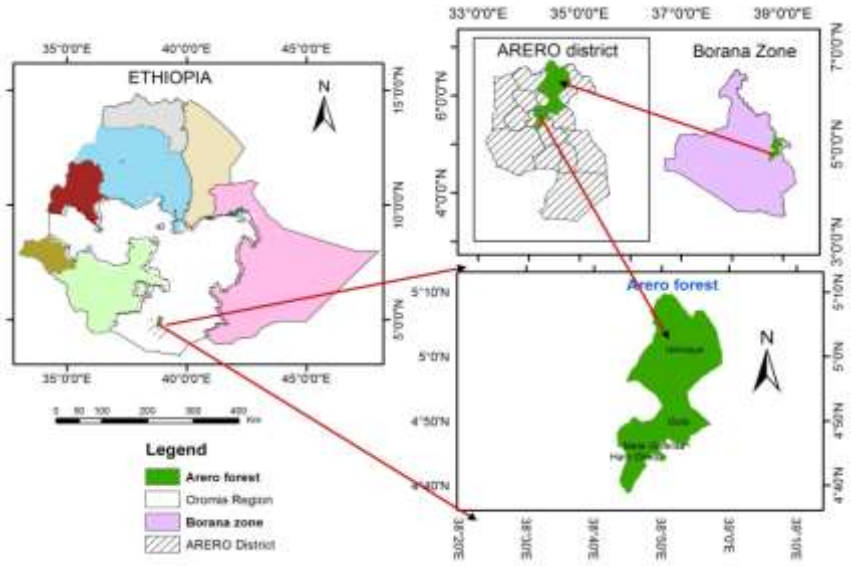

Figure 1. Map of the study area.

forest. National State and respond answers for the following questions; (1) what are the contributions of the forest to the local livelihoods, (2) What are external inputs of institutions for forest management practices for communities' participatory forest management?

MATERIALS AND METHODS

Description of the study area

This study area was carried out in Oromia Regional State, Borana zone, Arero district (Figure 1). Out of the 37 forests given priority in Oromiya 5 of them are found in Borana and Guji zones. They are Anferera-Wadera, Bore, Nagale Dawa, Galana- Abaya, and Arero-Yabalo. This study was carried out in Arero forest. The forest area is divided into three forest management units, namely Haro-Dimtiu Meta Gefersa, Guto and Guto Hirmaye forest blocks. The forest is located 670 km south of Addis Ababa on the left-hand side of the high way running to Moyale, 96 km from Yabelo town and 38 km from Wachile village. The boundary of the forest is approximately 7 km from the district town of Meta Gafarsa. The forest is located between 38°45' and 39°02' East and 4°40' and 5°09'north and at an altitude ranging from 1, 606 m up to 1, 805 m above sea level. Arero forest has a total area of 29,226.39 ha.

Population

The population of Arero district was estimated to be 74,119 out which 11,859 or 16% are categorized as semi and sedentary farmers, while 62,260 (84%) are pastoralists and mixed farmers. There are about 12,595 households in the district of which 3,108 households are members of different forest user groups organized by SOS Sahel Ethiopia (FSDPPO, 2009). The forest user groups are Borana and Guji people.

Climate

Since there was no meteorology station at Arero district, data from the nearest station (Mega station) was used for Arero. Hence, based on 20 (1984-2004) years meteorological data the mean monthly rainfall at the nearby station was 47.1 mm. The mean annual rainfall of the district was 532.2 mm. There is a slight variation in mean temperature throughout the year. The rainfall regime in Borana drylands is bimodal with two rainfall seasons (Figure 2). The main rainy season, known as the long rainy season is between March and May with the pick in April, and short rainy season is between September and November, with the pick in October. The mean monthly minimum and maximum temperature of Arero as taken from Mega station were 16.2 and 18.3°C, respectively. The mean annual temperature was 18.9°C.

Geology and soil

The dominant soil types found at Arero district were Chromic and Eutric Luvisol, Calcaric, and Eutric Fluvisol and Chromic, Eutric and Calcarius (OBPED, 2000). According to Gemedo et al (2005) cited in Adefris et al. (2012), bottomlands of the Borana rangeland are predominated by vertisols. The Arero forest was upland dry evergreen forest dominated by *Juniperus procera* but also consists of plant species such as *Olea europea*, *Compretum molle*, *Terminalia brownie*, *Croton macrostachyus*, *Canthium schimpeanium*, *Carissa edulis*, *Ehretia cymosa*, *Acokanthera schimperi*, *Dodonea viscosa*, *Balanites eagyptica*, *Calpurina aurea*, *Acacia tortilis*, and *Acacia mellifera* (Wakshum et al., 2018).

Sampling techniques

Socio-economic survey

Semi-structured questionnaires were developed for data collection based on the major contribution of forest resources to livelihoods of communities in the areas. Nearly 2.7% of the total households of forest user groups near or inside the forest as well as members of the households organized by SOS Sahel Ethiopia at Arero district were randomly selected. These HHs were selected based on their indigenous knowledge about the natural resources and use of the forest in the district. Sample households (HHs) were stratified into sex and age categories and selected using simple random sampling

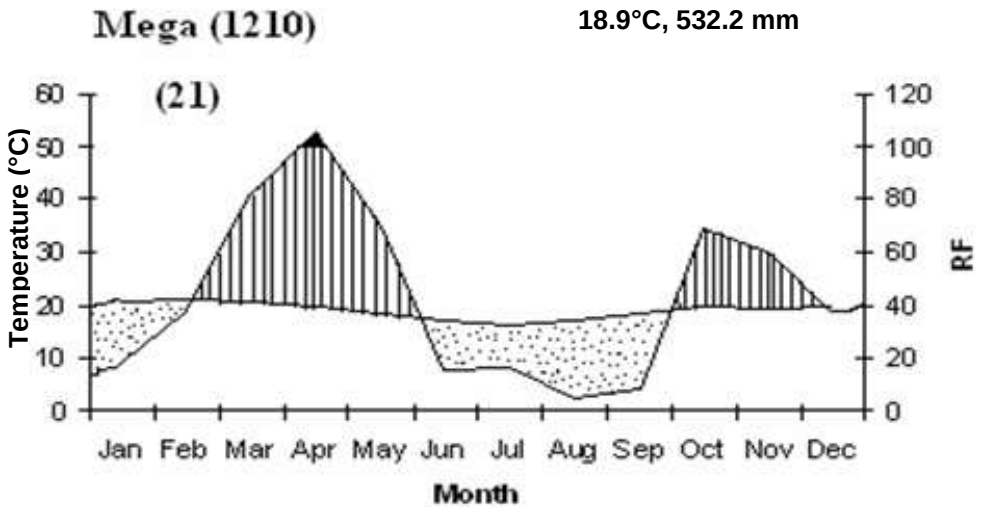

Figure 2. Climatic diagram of Mega, Borana zone, Ethiopia.
Source: Adefris et al. (2012).

technique from total HHs.

That is these were represented by about eight-five households from forest management units and interviewed for the role of forest resources to livelihoods. These sample households were only taken because Boana communities are pastoralist and mobile for grazing their cattle in the forest anywhere from Boana zone. No one in Boana zone is non-user group of this forest. During the household interview all age, sex and education were taken into consideration.

Forest management practices

Forest management practices which have been carried out by the community in collaboration with various development actors were assessed. Using district experts, key informants were selected for identifying existing institutions and the commonly used forest improvement activities in the forest. Only key informants and district experts were used for the interview because during the reconnaissance survey the result of checklist showed the same ideas. Furthermore, key informants are reflecting traditional forest management ideas of the society. Each Arero forest management units have also the objectives and are applying the same management culture. Therefore, discussions were held with six key informants from local communities, other experts and administrators. Checklists for data collection of existing institutional set-up of forest management activities were categorized into formal and informal ones.

Data processing and analyses

The socio-economic data were analyzed using descriptive statistics (SPSS version v 16.0) computer software. The results have presented in percentages, graphs and mean values.

RESULTS

Socio-economic characteristics of the sampled households

Of the sampled households, majorities (76.47%) were male headed and (23.53%) were female-headed. The age of the respondents was mostly ranged between 15-64 years and accounted for 85.9% of the households, while only (14.1%) of the respondents' ranged above 64 years. The educational level of the majority of the respondents (69%) was unable to read and write, 4.7% were adult education, 10.6% were at 1 to 5 grade level, and 2.4% were at 9 to 12 grade levels and the remaining of the respondents (1.2%) were at the college level of education.

The role of forest resources to livelihoods

The livelihood activities in the study area include crop production, animal production, forest-related activities in terms of NTFPs, petty trade, and wage labor. Among the selected households animal production, wage labor hired in protecting the forest and other works in nearby town, and forest-related activities were ranked 1st (52.9%), 2nd (18.8%) and 3rd (16.5%) as the main source of livelihood activities. Petty trade and crop production were also ranked 4th (5.9%) each as livelihood activity (Figure 3).

Collection of honey

Honey is one of the major forest-related products used by the local communities. Summary of the amount of cash income generated by a household from the sale of this product is presented in (Table 1). As shown in this table, the total annual income generated per households is 43.35, 41.42, and 7.71 $ at Haro Dimtu Meta Gefersa (HDMG), Guto and Guto Hirmaye forest blocks respectively. However, respondents mentioned that the annual income that can be generated from honey could

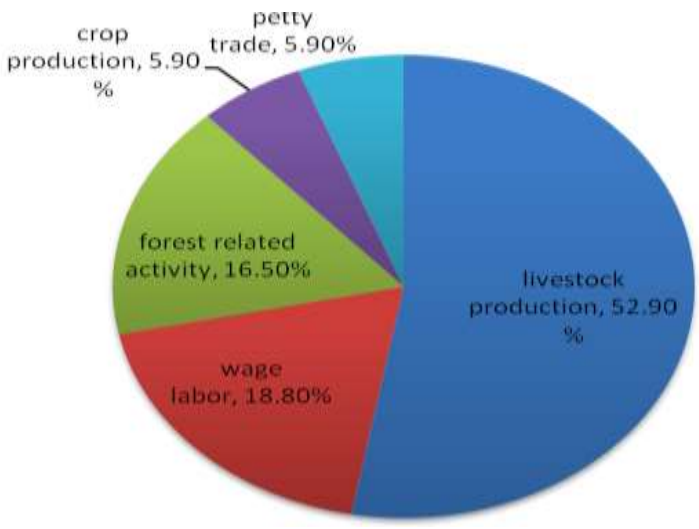

Figure 3. The contribution of different livelihood activities to household income.

Table 1. Amount of honey collected annually and Annual income generated by Arero forest user groups.

Forest Blocks	Number of households	Annual collection (kg) per total HH	Local price in birr/kg	Annual income (birr)	Annual income per household (birr)
HDMG*	19	45	20	900	47.36
Guto	42	43	20	860	20.48
Guto Hirmaye	24	8	20	160	6.66
Total	85	96	-	1536	74.50

*Haro Dimtu Meta Gefersa.

have been far more as the potential for production is very high in the area.

Collection of wild fruits and medicinal plants

Arero forest user extracts various types of wild fruits and medicinal plants for household consumption and health treatments respectively (Tables 2 and 3). About 137 kg of wild fruits and 35 kg medicinal plants are collected annually from the forest.

Forest grazing

Since Borana and Guji people are typically pastoralists, they are not used only the forest resources but animal feeds (pasture) and water without which they cannot survive. According to discussions held with key informants, water, animal feed and fuelwood were the main forest resources used in the areas. Meanwhile, they ranked water, animal feed and fuelwood one to three in order. The forests are usually dry season grazing reserve and are the only place to revert during drought periods, and thus are essential natural resources without which the pastoralist cannot survive. Borana and Guji people are mainly driving income from their livestock which has been grazing in the forest during dry seasons directly is the main annual household income of the area.

Under current state law, local communities do not have rights to extract major forest products, but they do have rights to access NTFPs such as pasture, wild honey, firewood, medicinal plants, wild fruits, roots, aromatic plants of cosmetic value and hay at the caution of the forest development. The households' socio-economic of Arero district in terms of NTFPs were wild honey, wild fruits, and medicinal plants and were insignificant because the Boran society depends mainly on the forest largely for livestock grazing. Even if this income in terms of livestock production is not quantified directly, it has a great contribution in the local communities' livelihoods. Because as they graze in the forest in the dry season their income from livestock products and productivity increases.

Unless the Boran communities are assured of a source of water for their herds, they will not benefit from the collective pasture. To this extent, any part of the Borana land is generally inhabited by those clans and clan's

Table 2. Wild fruit and medicinal plants collection for consumption by the Arero forest user groups.

Forest resources	Annual collection (kg) per total HH	Annual collection (kg)/HH	Local price in birr	Annual income (birr)/HH
Wild fruit	137	1.6	-	-
Medicinal plant	35	0.4	-	-

***Notice:** No sell, but only for domestic uses for instance children can use it because they were a pastoralist.

Table 3. Some of the plant species used as wild fruits and medicinal plants species.

Wild fruit species	Medicinal plant species
Olea europaea	*Acacia brevispica*
Dodonaea viscose	*Microchloa kunthii*
Papea Cappensis	*Solanum spp*
Pavetta gardenifolia	*Papea Cappensis*
Ficus vasta	-
Rhus nathlensis	-
Acokanthera schimperi	-
Haplocoelum foliolosum	-

associates who have access to the wells within it. Forests are a very important resource for the Borena. However, the '*Gadaa'* rulings prohibited forest destructions; for instance the cutting of *Juniperus procera* was remains outlawed. A forest is not necessarily distinguished from pasture by the Borana because the values of forests are used as dry season grazing reserves. Before urbanization came to expand in the area, local communities living adjacent to the forest exploited for dry season grazing.

Tourist attraction (ecotourism)

Southern Ethiopia Borena and Guji zones forests particularly Arero forest is known with the home of endemic birds. Furthermore, the different sites in Borana and Guji zones attract several tourists interested in watching birds like *Ruspolis turaco*, *Salvadoris seed eater*, and *Bare eyed thrush*, *Borana cisticola*, *Banded perisoma, Tiny cisticola*, *Pygmy bats* and several other bird species. The revenue obtained from the income supports the livelihood of rural poor through institutionalized cost sharing which strengthening the forest management groups while managing the forest area. The local communities were benefited from tourism by securing income from tour guide and the government incurred budgets for managing the forest indirectly to sustain the forest resources in the region.

Cultural values/sacred places

The spiritual significance of the forests as ceremonial sites is central to the cultural integrity of the Borana Oromo clans. According to oral tradition of elders, a ritual ceremony is only possible with the ritual plants found in the forests. Today, the remaining patches of the forests constitute an important part of traditional ritual practices, which is also playing key role in reducing the pressure on the forest.

Forest management institutions

The forests of the Borana lowlands have traditionally been considered by the Borana as an integral part of their pastoral land, with forest management being the responsibility of the '*Borana'* '*Gadaa'* system. However, they have currently gazetted reserves, registered as National or Regional Forest Priority Areas, and the Oromiya Forest and wildlife Enterprise is responsible for controlling, protecting and managing the forest resources on behalf of the Regional Government.

In the Borana traditions, all the resources in the forest like water, medicinal plants, pasture, wild fruits, and roots are used in common and managed by the traditional institutions. Borana pastoralists have their own cultural by-laws structured hierarchy. Borena traditional resource management (pasture, forest, water) institutions are:

(1) Family = '*Abbaa Warraa'* =Control resources at the family level
(2) Neighbor = '*Abbaa Ollaa'* = Manage resources at the neighbor level
(3) Elders controlling grazing = '*Abbaa Dheedaa'* = Elders controlling resources like a pasture in overall Borena

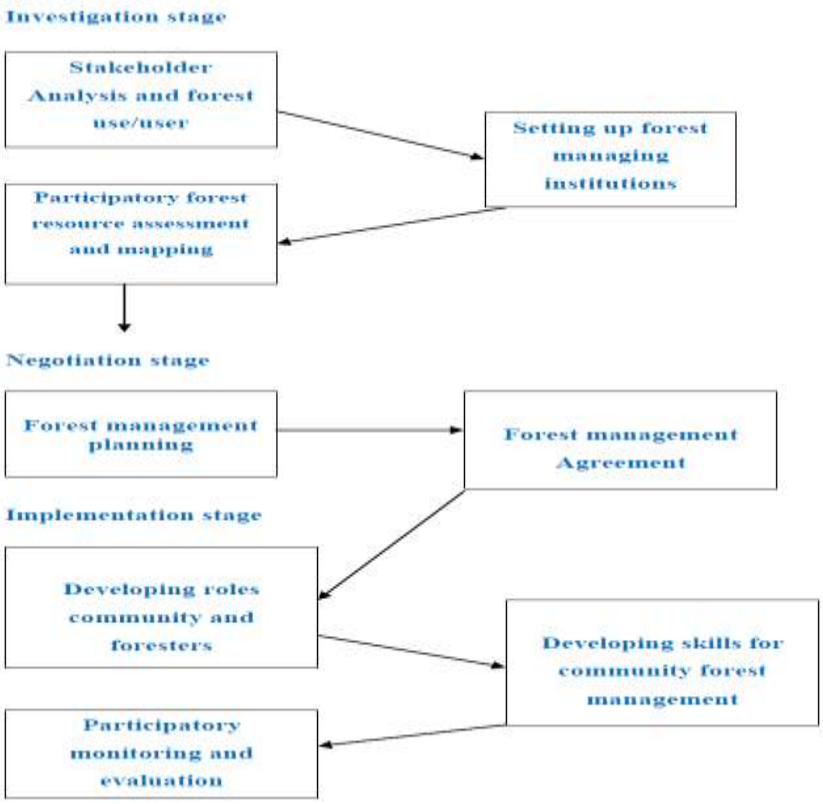

Figure 4. Key elements in a refined PFM approach model.

society
(4) Higher courts = '*Raaba Gadaa'* = '*Gadaa'* ruling assigned for resource governance and conflict resolution in Borena zone.

At the phase-out of this Non-Governmental Organization (NGO) or SOS Sahel Ethiopia, the management of this forest is questionable.

Traditional forest management practices

By-laws are revised and formulated every eight years during '*Gadaa'* assembly. Through this hierarchy, different traditional forest management practices such as controlled grazing (browsing), fire protection and reducing expansion of settlements are practiced in this forest area. The forest areas in the Borana and Guji zones are governed traditionally by Communal resource management. Forest resources such as water and pasture are a communal property resource in Borana and Guji pastoral areas. Traditional institutions govern these resources and decide institutionally how best they could be utilized in equity.

For instance, epiphytes which are growing on *J. procera* and other old tree species is named by '*Borana'* people as '*Areeda jaarsaa'* mean that elders' hair and the old tree of this species is also believed to represent elder of the people. This is an indicator of Borana people conserves traditionally forest resources. Borena society value forest resources particularly some tree species for spiritual purposes. However, conflicts between Borana people and other ethnic groups, population growth, resettlement, forest grazing, bush encroachment, farmland expansion, demand for fuelwood, drought-weakened traditional institutions, policy enforcement, and urbanization are some of the causes for the deteriorating of the forest conditions in the area.

Modern forest management institutions organized by SOS Sahel Ethiopia

To strengthen these management institutions under sub section 6.3, other management institutions were built from the smallest units ('*Ollaa'* and '*Maddaa'* levels) up to the district and Zonal Participatory Forest Management (PFM) working groups. Forest management institutions or Borana Collaborative Forest Management Project (BCFMP) supported by SOS Sahel Ethiopia in Borana forest priority areas are shown in Figure 4. It is within this context that SOS Sahel in Ethiopia set up the BCFMP in

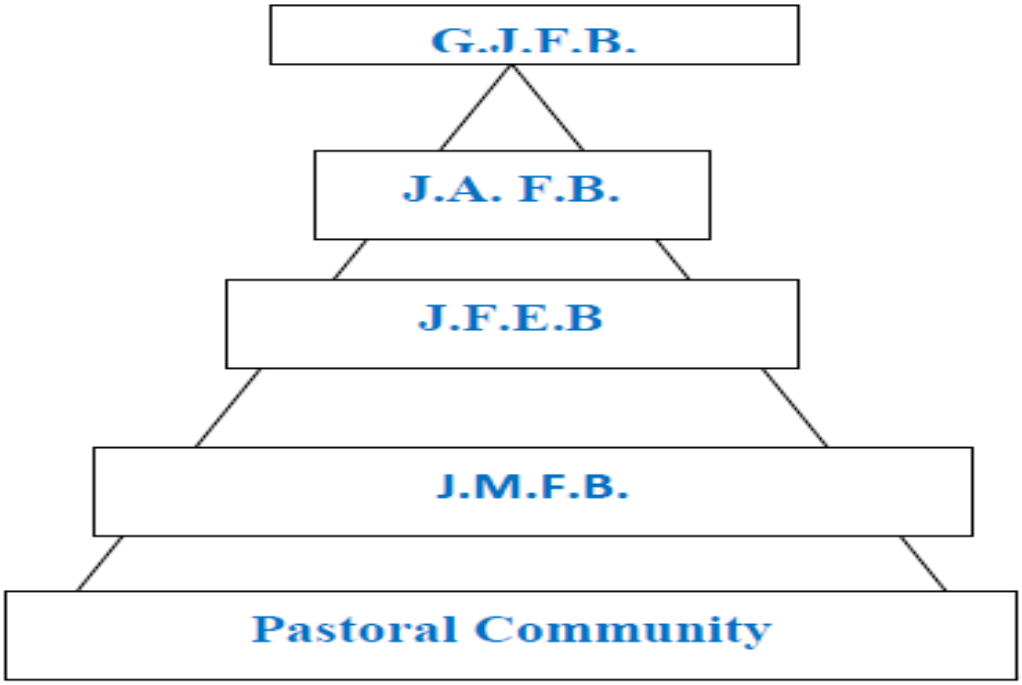

Figure 5. Participatory forest management working group structure.
* Ejja= Forest block, 'Maddaa'= Management unit (PA), 'Baddaa' =Forest.

2002 in Borena zone. The project's principle aim is to establish management systems over which local people or institutions have control and by which natural resources can be used sustain ably by local communities.

Furthermore, increasing human population and urban settlement pressure has negatively impacted on forest resources mainly on *J. procera* products which are harvested for construction purposes because of its inherent property to resist termites. All these have necessitated the introduction and institutionalization of the forest management system. With better management, income could be generated from the products based on the protection and promotion of the Juniper where Juniper berries, leaves, and stems can be used for the production of different products for newly established enterprise in the Oromia Regional state.

Over the last decades, SOS Sahel Ethiopia has been working with the Borena and Guji to tackle poverty through sustainable natural resource management, and natural resources based enterprise development. Borena Collaborative Forest Development Forest Management Programe is one of such efforts that has succeeded in putting the community at the center of natural resources management particularly forests in the areas. This has become SOS Sahel Ethiopia with BCFMP/PFM as a catalytic; transform where the '*Gadaa'* actively engaged. The three phases of developing a PFM plan, that is, the investigation, negotiation, and implementation phases exercised to protect the forest resources and the rangeland (Figures 4 and 5).

Roles of modern management institutions

1). '*Ummata'* (Pastoral Community)
These are wider Borana and Guji people from which members of forest management groups at PA are selected.
2).*'Jaarsa Madda Finna Baddaa'* (J.M.F.B.) =Managing at PA level
These are elders managing forest at PA levels like guarding, fire protection, controlled settlements, controlled grazing, control logging, and collection other live and dead trees. They were organized elders from wide pastoral communities. There are five PAs namely Haro Dimtu, Mata Gafarsa, Bokoda, Guto, and Hirmaye.
3). *'Jaarsa Ejja Finna Baddaa'* (J.F.E.B.) =Managing at the forest Block level
These elders are managing forest at forest block level; in this particular forest, there are three blocks namely Haro Dimtu Mata Gafersa, Guto and Guto Hirmaye. They were organized from elders at PA levels. Many Maddas (source of communities) have organized into J.F.E.B. They are also patrolling the delineated forest from destruction and smaller in number than management groups number 3.
4). *'Jaarsa Aanaa Finna Baddaa*' (J.A.F.B.) = Combination of government and elders at district
These elders are organized from J.F.E. B., experts, administrators, and polices at the district level. They are controlling forest through the enforcement of customs, rules, and laws of institutions and the state. They can

apply sanction individuals violating rules at this level. The sanction is 5 animals per individual. If the individuals are beyond their control they report individuals to the highest court at zone level (G. J.F.B) for sanction.

5). *'Gadaa Jaarsa Finna Baddaa'='Raaba Gadaa'* (G.J.F.B.) =Higher court of elders.

These elders are organized from J.A.F.B. at zone level and this institution is the final decision of sanction that violates the rules below institutions. Note that each member in the numbers 1 through 5 has decreased up as shown in (Figure 5) from the community to G.J.F.B. at the zone level.

The *J. procera* forest which suffered from series of forest fires and destruction during 1999/2000 was able to regenerate and maintain its ecological health once again through the participatory forest management process. Traditional resource governance system within the common property regime was implemented to build upon the customary institution and to enable the full participation of different community members in resource management. The customary institution mainly the Gadaa played a vital role in the negation of rights in resource governance and use. Through the forest management institutions, the integration between the different sectors offices and the customary institution (the Gadaa) was a break through to prove the key roles of communities in the management of forest resources. The multiple use of the forest was fully recognized by the community which resulted in improved ownership and sustainability of the interventions. BCFMP was successful in working very closely with the rural communities in all forest adjacent areas through the smallest units: the '*Ollaa'* and '*Maddaa'*. Project staff camped at the different sites to discuss forest management issues with community members.

However, there remains a challenge that was not addressed and thus an issue of concern that emerges. This needs the joint efforts of all stakeholders that are working for sustainable management and utilization of natural resources; forest and rangeland. Accordingly, issues of concern are described as follows:

(i) Increasing of enclosures

Within the common property regime, there is an evolving trend of privatization. Extensive private ranches and privately established enclosures and farmlands constrain the mobility of the livestock and impact upon the livelihood of the pastoral communities.

(ii) Expansion of farmland

These days there has been increasing settlement of other groups which mainly depended on agriculture in the pastoral areas. This is putting pressure on pastoralist livelihoods and shrinking the rangeland. Most forest areas and rangelands have been altered to agricultural lands. Some parts of the rangelands in Borena have been completely changed to farmlands. The denial of access to dry season grazing reserves in the forest areas and lack of access to the deep wells in the forest also constrain the livelihood of the pastoral communities. This has hampered the pastoralists from livestock corridors to access resources. The farmlands which are randomly placed here and there constrain grazing patterns for the pastoral communities.

(iii) Conflicts within and between institutions

There are conflicts between institutions organized SOS Sahel Ethiopia; however, it is managed by '*Gadaa'* systems every time. Some cause of the conflicts is on position leading each institution, hiring of guards for protection of the forest and other forest resource benefits either woody or Non-Timber forest Product Resources.

Modern forest management practices

There were also forest guarding, planting, and fire protection by a government organization in collaboration with a non-governmental organization. In Arero forest, planting was carried out where the forest is damaged by the fire. Enrichment planting of forest during damage of fire was funded by SOS Sahel Ethiopia to strengthen capacity of the governmental institution. Participatory planting by communities was high input for rehabilitation of damaged forest.

The forest management agreement was signed between the local institution, the '*Gadaa*' and the Pastoralist Area Development Commission. The power to manage and govern resources was thus developed by the local communities. Expansion of farmlands within the pastoralist livestock-based economy and erosion of the pastoralist social and institutional systems has led to destruction of forest resources and subsequent loss of biodiversity potentials. Examples of community-based forest monitoring systems emerging from PFM experiences include:

(i) Monitoring of farmland in the forest;
(ii) Forest boundary monitoring;
(iii) Regular patrolling by the forest management group members; and,
(iv) Either written or verbal reporting
(v) Regeneration counting to develop data concerning seedling regeneration from year to year is also being carried out.
(vi) Regular district level PFM working group meetings to bring key government and community PFM actors together to discuss issues arising and resolve problems have also emerged as a useful monitoring and evaluation mechanism. According to the discussion held with key informants, this project has brought significant change

than before on forest management and forest conditions in Arero forest.

DISCUSSIONS

Forest resources and livelihood strategy

Natural resources such as forests play a key role in the livelihoods of local people in developing countries. Forests and rural livelihoods are basically connected. Forest values include various products of wood, non-wood, and environmental services (Tsegaye et al., 2009). On average, the contribution of forest related activities to cash income in this study was 16.5% (Figure 4) and higher than percentages found in studies by Ambrose-Oji (2003) in Cameroon (6-15%) and Elizabeth et al. (2009) in Tanzania (12%). This finding is also almost similar with results of other study in Bangladesh Satchari National Park (Belal and Mukul, 2006) which had a significant component of their livelihood strategies, accounting for 19% of their total annual income.

Studies suggest that the poor are highly dependent upon forest income for their livelihoods but the total value of what they obtain from the forest is less than that which better-off households obtain (Yemiru et al., 2010; Watson, 2016; Langat et al., 2016). While in this case both groups are interested in maintaining the forest, this is not necessarily always the case. Even if in the Borana society particularly in this particular study area it is difficult categorize households in to classes within short period of time and limited budget and because they are mobile with their herds from place to place, it was recognized that different socio-economic groups have different views of the forest. The poor usually have to live hand to mouth through doing a variety of tasks (Wood, 2007). One reason they are poor may be because they do not have enough farmland or other assets. In some cases, they will see the forest as the source of that additional land, although wage labor opportunities for immediate cash are probably more attractive to them. Certainly they have no capital reserves to build up enterprises based on the production, harvesting and marketing of NTFPs once or twice a year. Middle income households expanding their economic basis with a growing family may also see forestland as a way to expand their farmland, given their labor resources and capital. On the other hand middle income and rich households may have enough agricultural production to support them and see forest maintenance as a way of diversifying their income-generating opportunities, and so reduce their risks (Wood, 2007).

Collections of wild frits and medicinal plants were indications of the contribution forest resources for a household annual subsistence income. But these forest resources were not taken to local markets. The findings of this study in terms of income generated from forests are far lower than most studies in Ethiopia. For instance, the study by Mohammed (2007) found an income of 96.33USD per household from various NTFPs in South Western Ethiopia, which is even greater than the total income generated by the entire households interviewed in this study. Similarly, the study by Arsema (2008) shows 47% of annual cash income contribution of bamboo as NTFPs in Shedem Peasant Association (PA) in Goba district, while Neima (2008) in the same region reports that various NTFPs extracted from vegetation of the region contribute on average 54% of household total annual income. In Bench Maji, 52% of annual cash income of households is obtained from NTFPs, while in Sheka it contributes to about 41% of household income (Mohammed, 2007). In Gore district 88% of households collect NTFPs, and generate 23% of their average annual income of 1,895 ETB (Berhanu, 2004). NTFPs also contribute a similar Figure of 27.4% to the average annual income of households around Menagesha Forest (Aramde, 2006). The mean annual income from beekeeping among households in Walmara district was between 47 and 347 USD or 11.6 and 81.9% of total household income depending on wealth status of the households (Debissa, 2006). Fuel wood, fodder, honey and construction material productions from Chilimo forests contribute significantly to the livelihoods of households in Dendi district, contributing an average to 39 % of the annual household income (Getachew et al., 2007). These studies all reported an income contribution from forest that is far higher than what the current study recorded. This probably shows many things: household asset base, market access, culture and resources endowment of the forests in terms of stock and quality of NTFPs. Indeed, the role of forests in general and their NTFPs in particular in household livelihoods needs to be explained and assessed context specific. Hence, the role of forest resources particularly forest grazing for communities leads them to manage forests traditionally and in collaboration with other governments and non-governmental organization institutionally. The *'Gadaa'* leaders with traditional and state laws are decisive for sustainable management of the Arero forest.

Forest management practices

As the result of the above forest related activities to their livelihood strategies, the forest management groups in collaboration with other institutions have setup new forest management arrangement. These forest management institutions in Arero forest are part of the PFM approach largely promoted throughout Ethiopia. It is facilitated by SOS Sahel in collaboration with Oromia Regional State. Such a move is common in Southeast Asia as well as in most of the countries in Africa. Although PFM is found good from the forest, the role it played in Arero forest's conservation and management is hard to comprehend

since there is no original data at the start of the project. However, local people are of the opinion that the approach has contributed to improvement of the forests through reduced illegal forest product harvest and unregulated grazing. These achievements confer with many PFM reports from various countries such Damayanti et al. (2007) in India, Golam Rasu and Karki (2009) in south Asia, Dominik et al. (2008) East Africa, and Paul (2007) from Kenya.

The forest management by-law, Karra Mataa (control resources) was taken to be the working customary by-law to control and monitor people who abuse the resources. Violation of the by-laws is sanctioned by five animals or five years prison penalty per head. As the result the forest user groups in Arero forest were either traditionally organized or reorganized in collaboration with SOS Sahel Ethiopia to manage the forest in the area. Furthermore, forest resources were managed by forest users in the forest or in the surrounding to generate subsistence income sources. These results indicated that there were an interaction between forest resources management practices to improve conditions of forest thought their livelihood forced them to use the forest resources like animal feeds (pasture), water or fuel wood and others directly. Forest resources are also used as supplement the income obtained from major livelihood activities particularly livestock production (Mitiku and Ginjo, 2008).

Conclusions

Livestock production is the dominant occupation in Borena zone particularly in the study area, is influenced by the recurrent drought and the consequent fodder shortage thereby leading to food insecurity and famine. Hence, looking for other alternative strategies that diversify the pastoral and agro-pastoral livelihoods is very important. This study revealed the fact that exploitation of forest resources especially NTFPs integrating this sector with other land use options forms one of the sustainable livelihoods to the community while leading to environmentally friend to forest resource management while providing several socio-economic contributions.

Arero forest provides diverse forest products for local community. The most valued product is forest grazing but also honey production, medicinal and wild fruits. However, except through forest grazing, the overall contribution of the forests in terms of other NTFPs is very low compared to many reports from various parts of Ethiopia. Forest grazing the local communities most income of livelihoods in Arero because they depend largely on animal production without which they cannot survive. Water and fuel wood sources for their life and animals are also the main source of income as livelihood roles are derived from this forest. This does not mean that contribution of NTFPs like wild honey; wild fruit, medicinal plants, and others in relative terms are small. Even in relative terms, the contribution of Arero forests to local livelihood is comparable with many reports from outside Ethiopia.

Community in the study area employ traditional institutions supported with modern new institutions called forest user groups whose formation is facilitated by NGOs to manage their forest resources in a participatory manner. Borena Gadaa is the most useful in both traditional and modern new institution with other external state laws to control natural resources especially forests in Borena zone. Borana society cannot separate grazing land from forest land. Hence, they are grazing their animals in the forest during drought period.

The impact of the management system has a contribution for improving forest resources for livelihoods role as well as conditions of the forest and also opinions of the local community's show a positive and progressive contribution. The result of the contribution of forest resources could have been better if wider time and sufficient budget allowed accomplishing during data collection. However, the structural analyses of the population of some dominant species experience poor regeneration. This also implies that current management practices are not satisfactory to sustain the forest conditions. Indeed, it deserves concerted effort by local traditional '*Gadaa'* and SOS Sahel Ethiopia institutions to improve its conservation and sustainable use of forests. Unless improved management interventions are made the sustainability of contribution to livelihoods from the forest will be at stake in the future.

RECOMMENDATIONS

Since Arero forest is one of the 37 Regional Forest Priority Areas (NFPA's) under Oromiya Regional Forest and Wildlife Enterprise now a day to be conserved. This forest under discussion might probably be the last few remaining forests in Ethiopia with distinct vegetation zones could be used to carry more scientific studies. It could also be considered as resources for livelihoods of communities, climate change mitigation and habitat for wildlife, especially endemic animals. However, from the foregoing discussion, it can be seen that the forest requires better management so that its resources could be effectively utilized on sustainable bases. Therefore, the following recommendations are made to meet these requirements:

(1) Creating awareness on the various uses of the forest resources so as to utilize and facilitate a market for various resources in the forest.
(2) Control bush encroachment on grazing land so that pressure of grazing in the forest can be reduced.
(3) Extension program including forest management (tree planting) should be extended so as to reduce pressure on forest resources and awareness creation for communities

in utilization of the forest.
(4) Selective logging from the forest should be minimized and if possible stopped.
(5) Livestock husbandry (a common practice in the forest) should be reduced so that regeneration of the species in the forest can be improved.
(6) Improved management interventions for sustainability of forest resources will improve contribution of livelihoods in the future.
(7) Eventually, to conserve the forest resources and improve the socio-economic benefits, for instance, research on postfire succession of species, causes of natural damage of *Juniperus procera* in the forest, soil seed bank should be investigated to sustain the forest resources for ecosystem services as well. In general, the dynamics of forest conditions in Arero forest needs detail studies in the future.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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