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Full Length Research Paper

Technological gaps of agricultural extension: Mismatch between demand and supply in North Gondar Zone, Ethiopia

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This paper examines technological challenges of the agricultural extension in North Gondar Zone of Ethiopia. Understanding technological gaps in public agricultural extension helps to devise demand driven and compatible technologies to existing contexts of farmers. The study used cross sectional survey using quantitative and qualitative techniques. Data were generated from primary and secondary sources using household survey from randomly taken households, focus group discussions, key informant interview, observation and review of relevant documents and empirical works. The result of study shows that there are mismatches between needs of smallholders in crop and livestock production and available agricultural technologies delivered by public agricultural extension system. The existing agricultural technologies are limited and unable to meet the diverse needs of farm households. On the other hand, some of agricultural technologies in place are not appropriate to existing context because of top-down recommendations than need based innovation approaches.

Key words: Agriculture extension, challenge, mismatch, smallholder, technology.

INTRODUCTION

Attaining sustainable agricultural development, which can be able to feed steadily growing population and support emerging industrial development and overall transformation, is possible through promoting technology transfer and adoption, boosting demand driven commercial production, deepening agricultural markets, and improving infrastructure and setting agricultural

policies and strategies. Agricultural extension services have indispensable role (Federal Democratic Republic of Ethiopia - FDRE, 2014; United Nations Development Program - UNDP, 2013) through provision of applicable information, knowledge and skills along with dissemination of demanded agricultural technologies.

Ethiopia has taken series of poverty reduction strategies

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strategies and interventions under Agricultural Lead Industrialization (ADLI) framework. Various initiatives have been carried out to disseminate agricultural technology packages to farmers, which include commercial fertilizer, improved seeds, credit, soil and water conservation and provision of extension advisory services (Menale et al., 2011; Ministry of Finance and Economic Development - MoFED, 2002). However, there have been such great strides in agriculture as productivity remains low relative to the potentials (IFPRI, 2009). One of the major programs in the rural development in general and agriculture in particular is agricultural extension packages that support promotion of improved agricultural technologies and intensification (Gezahegn et al., 2006). This is expected to boost production and the productivity of smallholders.

Taken together, in order to be agricultural, extension services and technologies should be demand driven. According to Garforth (2004), demand driven denotes the information, advice and other services offered by extension professionals should be tailored to the expressed demands of the clients or recipients of the service. On the hand, studies indicate that agricultural extension is the first ranked among various service demands for rural farmers especially for those who are poor and disadvantaged groups (Kwapong, 2012).

It is apparently important to question whether the gaps in agricultural technologies are being addressed in line with felt need of smallholders. Therefore, this paper is intended to appraise technological challenges of agricultural extension services in meeting the needs of smallholder farmers with special reference to North Gondar Zone of Ethiopia.

STUDY METHODS

Description of the study areas

The study was conducted in the North Gondar Administration Zone of Amhara Regional State, located in Northwestern side of Ethiopia. It is bordered on the south by Lake Tana, West Gojjam Zone, Agew Awi Zone and Benishangul-Gumuz Regional State, on the west by Sudan, on the north by the Tigray Regional State, on the east by Wag Hemra and on the southeast by south Gondar Zone of Amhara Regional State. The area has diverse agro-ecology ranging from peak of the country which is 4,543 m above sea level (Ras Dejen) to 500 m above sea level (Alitash National Park). As the case in many parts of the country, agriculture is the dominant means of livelihoods encompassing, approximately 534,305 farm households. According to report of Amhara Regional State Bureau of Agricultural, North Gondar is the largest zone in Amhara Regional State in terms of population, area coverage and diversity of agricultural production.

Sampling and data collection methods

Cross-sectional survey involving quantitative and qualitative aspects was used and data were gathered from both primary and secondary sources. Multi-stage sampling technique was employed to catch representative areas and sample respondents. First, North Gondar

Zone was purposively selected taking its representation for different agro-ecology and relatively larger share of the region. Among 23 districts (*Woredas*), four districts namely, Wogera from highland (*Dega*), Demibia from midland (*Woina Dega*) and Metma and Quara from lowland (*Kolla*) areas were selected using purposive sampling techniques. From each district, 3-4 *kebeles* were selected using different representations in term of access to agricultural extension services. The distance from district center and availability of road and facilities were also considered as criteria to select *kebeles*. Thereafter, household respondents were selected from each *Kebele* using simple random sampling technique and 120 household respondents (representing 40 agricultural service centers) that were taken from four districts. Data were collected using different techniques and tools. Household survey using structured and semi-structured interview schedule; focus group discussion with farmers and extension experts and observation of farming systems, settlement pattern, available infrastructure including farmers training centers were important data collection techniques of the study. Data from secondary sources such as government reports, working documents and available literature were also exploited to consolidate primary data.

Data analysis methods

Data gathered from different sources, were organized and analyzed using quantitative and qualitative techniques. The quantitative data were analyzed mainly using descriptive statistics mainly using mean and percentage. The Statistical Package for Social Sciences (SPSS) application software was used to carry out the analysis of the study. Furthermore, the qualitative data obtained using focus group discussion, key informant interview and case studies were analyzed using qualitative techniques mainly by describing and contextualization.

RESULTS AND DISCUSSION

Smallholder agricultural production: Technological demand

Agricultural technologies requirements are expected to be responses to the demand of the farmers and felt problems in crop and livestock production. It is apparently important to look into crops and livestock production constraints before appraising existing technologies. Crop production, which is the main sources of income for about 68.3% of households in the study area is also the primary source of food for farm households. As far as the production is concerned, local government reports indicated that there is slight incremental trend in gross produce. However, evidences from different sources including the qualitative data of this study show that increase in gross agricultural output in the last decade was achieved by expanding land under crop cultivation, but not due to contribution of the agricultural technologies. Also, the limited supply of inputs such as improved seed and prices of fertilizer is the major pressing issues of the highland farm households. The problems of weed, pest control and labor shortage especially during the peak times of weeding and harvesting in the lowlands of the study areas are also identified to be the challenges at household level. The

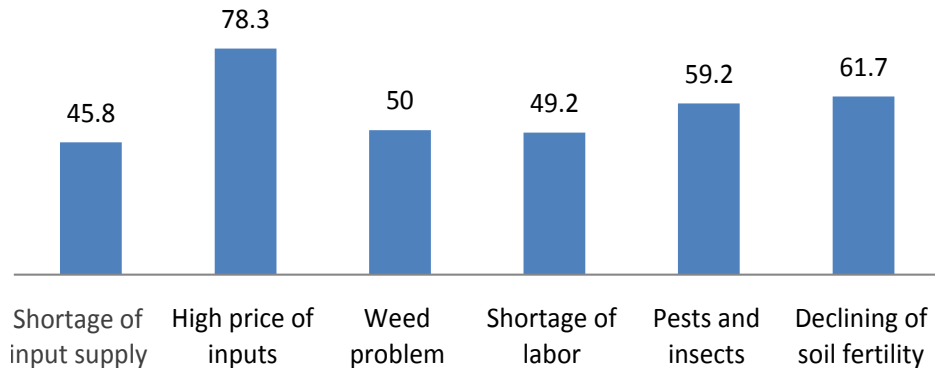


Figure 1. Problems associated with crop production as explained by farm households in %.
Source: Household Survey Data (2016).

findings of this study reveal that pest and insects infestation, declining trend of soil fertility with its impact on productivity has been observed to be the major constraining issues of crop production.

It was observed that fertility of smallholder farm plots has been dependent on inorganic fertilizer for optimum yield. This has become increasingly challenging for agricultural extension service providers and farmers in both midland and highland areas of this study. Moreover, the problem is exacerbated as the demand to increase production is increasing, so that the increased cost of fertilizer can be catered for from time to time. From Figure 1 above, we can deduce that high price of inputs (78.3%), declining of soil fertility (61.7%), as well as the problem of pests and insects (59.2%) were the main factors affecting crop production based on farm households' responses.

In addition, livestock production, which is an integral part of mixed agricultural production, plays a significant role in the livelihoods of farm households. In the study areas where there is no access to financial institutes, livestock accumulation serves as the means of the saving. From randomly taken households, 8.3% household respondents reported that their income is exclusively dependent on livestock production and allied products. On the other hand, average livestock holding per household excluding poultry is found to be 5.23 TLU (Tropical Livestock Units) with significant variation between lowlands and highlands of the study areas. The lowland areas like Metema and Quara districts have relatively larger livestock population per household due to agro-ecological advantages and relatively larger area for grazing. Similarly, like crop production, the livestock component of agricultural production in the study areas, face different challenges due to many factors.

Furthermore, the absence of improved livestock breed especially in rural areas, inaccessibility of the veterinary services and demonstration sites, scarcity of animal feed, shortage of grazing land, shortage of water and animal disease are found to be major problems of the livestock

production in North Gondar Zone of Amhara Region. This is illustrated in the Figure 2.

In general, major components of agricultural production have been constrained by different challenges, for instance, many farm households would require innovative technological responses to tackle the root causes of the problems and bring the system into the desired traction via gainful farm practices. Moreover, climate and environmental change problems are threatening production system and livelihoods of the rural households more than ever before, and expected to continue along with declining trends of natural resources including forest, waters and degradation of soil. In regard to this, it is important to question existing agricultural technologies, whether they are demanded or need to be embedded with innovative solutions that would take cognizance of the short comings of present day machines. This would definitely go a long way in addressing the pressing problems of smallholder farm households.

Agricultural technologies in place: The supply

Demanded, appropriate, affordable and technically feasible technologies have significant role in increasing agricultural production and productivity and lead to improvement of the livelihoods of the vast majority of smallholders. This study therefore investigates whether existing agricultural technologies are responses to the felt problems of smallholder farmers and demands. The endeavors to improve agricultural production and productivity through extension advisory and dissemination of technologies to farmers is found to be more of theoretical and political than practice. In connection with this, Rural Development and Agricultural Extension Series Report of the World Bank in 2010 noted that public agricultural extension service in Ethiopia and other developing countries is characterized by the tendency of politicians providing extension services to clients in exchange for political gains. Similarly, Bitzer et al. (2016),

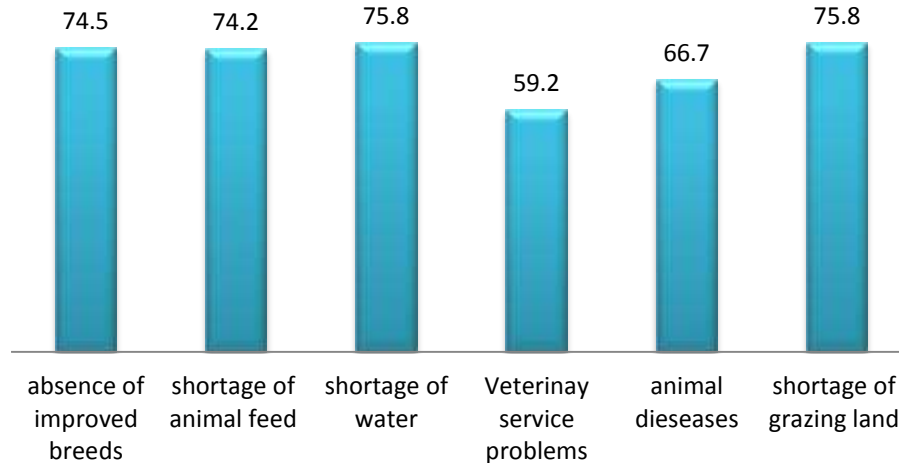


Figure 2. Problems associated with livestock production.
Source: Household Survey Data (2016).

in their review paper noted that supply driven technology transfer, weak interaction with agricultural research, misuse of extension officials for political purpose are signs of failure in agricultural extension system as it has been demonstrated in the study area. However, despite many pitfalls, agricultural extension still remains important intervention areas of government and since inception of the agricultural extension in the country in 1950s; there have been many attempts to modernize agriculture through knowledge and technology transfer in all parts of the country. In principle and structurally, almost in all parts of the study area, there are concerns that extension services is focusing on pressing issues of agriculture including crop production, animal production, natural resources management and recently irrigation in some potential areas.

Crop production enhancement technologies are dominantly focusing on fertilizer, improved crop variety and seeds, row planting, pesticide and herbicide application with limited access and geographical disparities. The findings of this study reveals that despite the long lasting efforts in providing agricultural extension services across the country, there are significant proportion of farm households who are never advised or get any technical support for different agricultural technologies of crop production by concerned extension service providers. The data from household survey also show that agricultural extension advisory service for crop production component has given less attention to pest management and storage techniques, which are the major causes of pre and post-harvest losses respectively. Concerning technological practices, there is blind recommendation of agricultural technologies because they could fit into almost all areas. Blind recommendation of technologies has been the observed challenges of crop production since political leaders attempt to convince farmers taking the good experiences of other areas

without any adaptation trail and testing to the real context.

Figure 3 shows that relative to crop production, livestock production and management have attracted less attention in agricultural extension services in the study area. However, the demand for improved breeds, animal feeds, veterinary services and livestock product processing and marketing is high. As far as access to information and improved breeds is concerned, 66.7, 65.8 and 35% of farm households have neither access to information nor for improved breeds of milk cow, sheep and poultry respectively. Farmers from highland and midland areas have relatively better information about improved poultry and cattle breeds. On the other hand, pre-urban and urban areas have good practices for hybrid cattle (in most cases with Holstein Frisians breeds) for milk production compared to rural farm household.

Concerning post-harvest handling and processing of animal products, agricultural extension services and technologies in promoting the livestock products such as milk processing, hide and skin are all performing below expectation where the need and contributions of such products for gross domestic production (GDP) is significant. Thought to have their own technical and managerial problems, dairy cooperative in some areas especially near towns or market centers have relatively better experience in processing and marketing. However, cooperatives as important stakeholders for agricultural extension, have limited practice in disseminating dairy processing technologies to the nearby rural areas. Hence, the data obtained from household survey of randomly taken respondents indicate 77.5% of farm households do not have any information and practice about handling and management of skin and hides; whereas the rest 22.5% of respondents have information about good handling and management, but do not have any practices. The net effect of this technological gap is

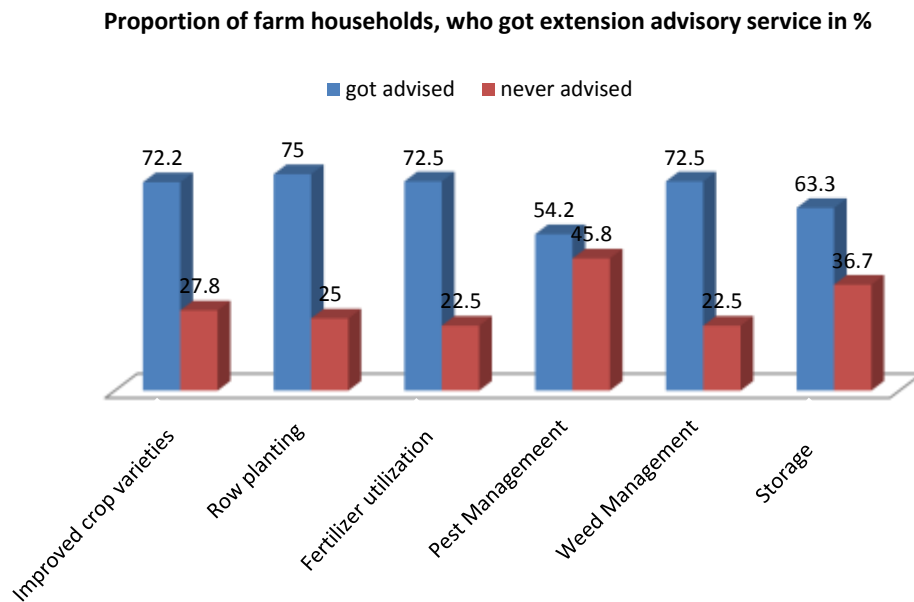


Figure 3. Available extension supports in crops production.
Source: Household Survey Data (2016).

demonstrated in hides and skins supplied by the vast majority of the rural community having poor quality with resultant farm loss to reduce the potential benefits from their byproducts.

This study observed that availability and affordability of technologies significantly affected utilization of agricultural technologies in the study area. Likewise, the high cost of technologies such as improved seeds, machineries and fertilizers have challenged farm households. Also this study finds that application of inorganic fertilizer by most of the highland and midland farms is mandatory as their plots have already developed dependency on it. However, the associated cost of fertilizer has forced farmers to use less than recommended rates of application. Furthermore, there is also forced recommendation of inorganic fertilizer in areas where there is no demand and there are also farm machineries which their applications and operation are not known by farmers and even by extension agents.

The practical observation of all agricultural technologies in different areas revealed that there are gaps in demand and supply of technologies. The demanded technologies of agriculture in most cases improved seeds and varieties such as Malt Barely as the case in Wogera district are introduced without recommended package of production. The high cost, poor quality and limited variety of agricultural technologies are however observed to be major bottlenecks when promoting the needed technologies to the needy smallholder farmers. This study also finds that weak agricultural extension system in the study areas and absence of other alternative technologies have resulted in unnecessary or higher cost for smallholder farmers and waste to public institutes due

to technological and supply mismatch (Figure 4).

In general, the agricultural technologies in place are neither based on the problems smallholder agriculture nor sufficient to the needs of smallholder farmers. The study has more to share with the study conducted by Belay (2003). As he has vividly noted, different extension approaches in Ethiopia have been planned and implemented without the participation of the very people for whom they have been designed. The finding of the this study also consolidate the case as planning and transfer of technologies follows top-down approach and is commanded than demanded by the needy people along with the lost linkage between farmers, extension workers and the sources of technologies.

Conclusion

Geographical and production diversity of agricultural areas as it is in north Gondar Zone of Ethiopia, have divergent problems and require different but system specific agricultural technologies both for crop, livestock and mixed cultivation. Major agricultural production components in the study area have suffered from different problems ranging from input supply to processing and marketing, demanding immediate technical support, technological response and timely information. It has been observed that existing public agricultural advisory and extension system is not designed and implemented based on felt needs of producers and it has been characterized by supply driven than participatory as well as demand driven.

As far as existing agricultural production and available



Figure 4. Unused farm machineries due to technical difficulties to demonstrate, July, 2016.

technologies are concerned, there is mismatch between the demanded and agricultural technologies available. In all, the affordability in terms of prices, for instance, the price of inorganic fertilizer, the technical feasibility of farm tools and machineries etcetera are bottlenecks of agricultural technology dissemination.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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REFERENCES

- Belay K (2003). Agricultural Extension in Ethiopia: the case of Participatory Demonstration and Training Extension System. *Journal of Social Development in Africa* 18(1):49-83.
- Bitzer V, Wennink B, Piters BS (2016). The governance of agricultural extension system. KIT Sustainable Economic Development and Gender Working Paper. Royal Tropical Institute.
- Federal Democratic Republic of Ethiopia (FDRE) (2014). National Strategies for Ethiopia Agricultural Extension Systems: Visions, Bottlenecks and Systemic Interventions. Addis Ababa, Ethiopia.
- Garforth C (2004). Demand-Driven Approaches to Agricultural Extension: Case Studies of International Initiatives (edited by Rivera W. & Alex G). In *Agriculture and Rural Development Discussion Paper 10: Extension Reform for Rural Development*. The World Bank <http://documents.worldbank.org/curated/en/184731468298459108/Demand-driven-approaches-to-agriculture-extension-Case-studies-of-international-initiatives-vol-3>
- Gezahegn A, Mekonnen B, Samia Z (2006). Productivity and Efficiency of Agricultural Extension Package in Ethiopia. The Ethiopian Development Research Institute, Addis Abeba, Ethiopia.

- International Food Policy Research Institute (IFPRI) (2009). Review and Recommendations for Strengthening the Agricultural Extension System in Ethiopia. IFPRI. <https://ethiopianagriculture.files.wordpress.com>
- Kwapong N (2012). Making Rural Service Work for the Poor: The roles of Uganda's Service Reform in Marketing and Agriculture Extension, Dissertation, Makerere University, Bernard Bashaasha. <https://edoc.huberlin.de/bitstream/handle/18452/17235/kwapong.pdf?sequence=1>
- Menale K, Zikhali P, Pender J, Köhlin G (2011). Sustainable Agricultural Practices and Agricultural Productivity in Ethiopia: Does Agroecology Matter?. Environment for Development, Discussion Series, EFD DP11-05.
- Ministry of Finance and Economic Development (2002). Ethiopia: Sustainable Development and Poverty Reduction Program. Addis Ababa, Ethiopia.
- United Nations Development Program (2013). Promoting ICT based agricultural knowledge management to increase production and productivity of smallholder farmers in Ethiopia. UNDP Ethiopia, No. 1/2013
- World Bank (2010). Agriculture and Rural Development Report Series. https://siteresources.worldbank.org/INTWDR2008/Resources/WDR_00_book.pdf

Full Length Research Paper

Factors affecting paddy farmers' perception of utilizing agricultural machines in Indonesia

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This paper aims to identify factors affecting farmers' negative perception on utilizing rice transplanters and combine harvesters. To this end, data obtained from interview survey in the westernmost part of Java Island, Banten Province was analyzed, where agricultural labor wages increase at a faster pace as compared to other regions and a rapid diffusion of agricultural mechanization is anticipated. The estimation results of multiple regression models clearly show that majority of coefficients of three independent variables: farm size extension, and farming experience, are statistically significant and take negative values. Therefore, it can be concluded that the larger the farm size, the more training provided by the government extension office, and the longer farming experience, the lesser the negative perception on the use of transplanters and combine harvesters. Educational background (formal human capital formation), the number of family members (within-household labor endowment), and yield per hectare are not found to significantly affect farmers' negative perception. Considering the above estimation results, it seems that the government agricultural extension service plays a significant role in lessening farmers' negative perceptions on transplanters and combine harvesters and thereby facilitates agricultural mechanization to cope with the rapid rise in agricultural labor wages.

Key words: Paddy farmer, perception, agricultural mechanization, Indonesia.

INTRODUCTION

It is well documented, in both developed and rapidly developing countries, that the adoption of labor saving technologies in the agricultural sector, in particular, the use of machines such as tractors, transplanters and harvesters, is inevitable for maintaining agricultural production (Otsuka et al., 2013). This is especially true in cases of massive labor outflow from the rural to urban

sectors. This phenomenon frequently leads to tightening of the rural labor market and an increase in the agricultural wage rates, and thereby inducing the substitution of labor for capital (agricultural machineries) (Liu et al., 2016; Wang et al., 2016; Yamauchi, 2016). Indonesia is no exception in this regard. Yamauchi (2016) who analyzed two times data of 98 villages in Indonesia,

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pointed out that an increase in real agricultural wages induces the utilization of hired-in agricultural machines, and this behavior is more predominant among relatively large-scale farmers when compared with small-scale farmers. In an effort to cope with the rapid increase in hired-in agricultural labor cost¹, improve labor productivity, increase crop intensity, and thereby partly regain self-sufficiency in rice production, the Indonesian government has been providing agricultural machinery, such as rice transplanters and combine harvesters, to the association of farmers' groups (called *gapoktan* in Indonesian language) since 2014. According to the Ministry of Agriculture, the use of agricultural machinery resulted in reduction in production costs by approximately 50%, and rice farmers were able to plant two to three times a year (*Tempo*, January 1, 2017).² However, the extent to which the participant farmers positively (or negatively) perceive the government-led introduction of mechanization in transplanting and harvesting operations through rice farmers' groups has not been clearly assessed so far.

Many previous studies have pointed out that perception about modern technology has a highly significant effect on adoption of such technology (Adesina and Baidu-Forson, 1995; Negatu and Parikh, 1999; Romadi and Lusianto, 2014). In relation to agricultural mechanization in Indonesia, it is reported that a farmer with negative perception on the adoption of agricultural machinery is more likely to be reluctant to use it (Romadi and Lusianto, 2014). Therefore, in order to promote agricultural mechanization in rice farming in a situation where hired-in agricultural wages tend to rise along with rapid economic growth, eliminating the detrimental factors that affect perception regarding the use of transplanters and combine harvesters is an urgent policy matter in the field of agricultural extension in Indonesia. However, few detailed studies have been conducted to identify factors determining rice farmers' perception on the adoption of agricultural machinery, with the exception of Romadi and Lusianto (2014) pointing out that governments' agricultural extension activities positively influence the farmers' perception to some extent. Therefore, this paper aims to identify factors affecting the participant farmers' negative perception on utilizing rice transplanters and combine harvesters. To this end, data obtained from interview survey in the westernmost part of Java Island, Banten Province was analyzed, where agricultural labor wages increase at a faster pace as compared to other regions and a rapid diffusion of agricultural mechanization is anticipated.

Overview of the Government Agricultural Machinery Grant Program

In 1998, the Ministry of Agriculture launched the agricultural machinery (tractors and water pumps) grant program (*Usaha Pelayanan Jasa Alat dan Mesin Pertanian*) to cope with the rapid increase in the cost of hired-in agricultural labor and to improve labor productivity (Departement Pertanian, 2008). However, both rice transplanters and combine harvesters were not included in the program, suggesting that, under the program, a rice farmer could only plough paddy fields using a hired tractor. In 2014, a pilot project in line with the concept of *Upaya Khusus Peningkatan Padi, Jagung dan Kedelai*³ known as UPSUS (roughly translated as "the Special Efforts to Increase Paddy, Corn, and Soybean Production"), which promotes self-sufficiency in staple and major food stuffs, was introduced in eight selected provinces (including Banten province where this survey was undertaken). The initiative aims to further accelerate agricultural mechanization (Winarno, 2017). A transplanter, combine harvester, hand tractor and water pump were granted to the association of farmers' group (*gapoktan*), established in each rural district (*desa*) and comprising several farmers' groups (*kelompok tani*). In 2016, the Ministry of Agriculture spent about 4.6 billion Indonesian rupia (IDR) on the procurement of 100,000 units of agricultural machineries for the grant program (USD 1 is approximately equivalent to IDR 14,000) to extend the program nationwide.⁴ Between 2014 and 2015, 10,000, two-wheel tractors, 1,000 four-wheel tractors, 3,425 water pumps and 5,000 rice transplanters were granted.⁵

Since government-subsidized fertilizers and seeds are distributed to rice farmers through farmers' groups, and non-members of such farmers' groups are not eligible to receive the government subsidized fertilizers and seeds, most rice farmers willingly affiliate with the farmers' group of their village. For example, in Banten province, which was selected as our case study, there are 1,136 associations of farmers' group (*gapoktan*) and 5,010 farmers' groups (*kelompok tani*) with 143,444 member farmers in 1,551 districts. This means one *gapoktan*, on an average, consists of 4.41 *kelompok tani* and has 126 member farmers.⁶ Every member farmer is eligible to rent a transplanter and a combine harvester at IDR 400,000–600,000 and IDR 1,500,000–2,500,000 per hectare, respectively. The total labor costs for employing

¹For example, according to the Badan Pusat Statistik (BPS), the real wage index of production workers in animal husbandry and fishery below supervisory level increased by 40 percentage point from 2007 to 2014.

²In Malaysia, which is a neighboring country of Indonesia, a rapid diffusion of labor saving technologies such as direct seeding and mechanization in ploughing and harvesting operations in rice sector have suppressed the rise in hired-in labor cost to some extent (Ishida and Asmuni, 1998).

³This concept was first advocated by President Joko Widodo who was elected as the seventh president of Indonesia in July 2014.

⁴The Ministry of Agriculture's home page (Pemerintah Tegaskan Bantuan Alisintan Gratis, <http://psp.pertanian.go.id/index.php/page/publikasi/309>, last accessed on 26 April 2018).

⁵See the above.

⁶Of 1,551 rural districts, *gapoktan* is not established in 415 districts where there are mountainous terrain areas not popular with rice farming.

Table 1. Distribution of rice transplanters and combine harvesters in Banten Province in 2014.

District/City	Rice Transplanters	Combine Harvesters
Pandeglang	3	2
Lebak	2	3
Serang	5	4
Tangerang	2	1
Tangerang City	0	0
Cilegon City	0	0
Serang City	0	0
Tangerang Selatan City	0	0
Total	12	10

Source: Banten Assessment Institute for Agricultural Technology.

agricultural workers to manually transplant paddy nurseries and harvest paddy seeds are expected to be approximately IDR 750,000–1,000,000 (15–20 workers multiplied by IDR 50,000 per worker) and IDR 3,000,000–3,600,000 (60 workers multiplied by IDR 50,000–60,000 per worker) per hectare, respectively. Therefore, utilizing rent-in transplanters and combine harvesters has a considerable labor cost reduction effect.

MATERIALS AND METHODS

Data collection

For this study, a face-to-face interview survey was carried out in three districts of Pandeglang, Lebak and Serang of Banten Province, which is in the westernmost part of Java Island. It lies next to DKI Jakarta State, which is the national capital. Banten has four regencies: Pandeglang, Lebak, Tangerang and Serang, and four autonomous cities: Tangerang City, Cilegon City, Serang City and Tangerang Selatan City. The population of Banten is 11,955,243 (cited from homepage of Badan Pusat Statistik (BPS)) and occupies a land area of about 9,663 sq km. The reasons for the selection of Banten Province as the research site are (1) the major agricultural commodity is rice, (2) domestic rural labor migration from Banten Province to the capital city of Jakarta⁷ is occurring at a fast rate, causing a rapid increase in hired-in agricultural labor costs, and (3) rice farming mechanization is one of the utmost important measures emphasized by the provincial office of the Ministry of Agriculture.

In 2014, when the government initially launched the rice farming mechanization program in Banten Province under the UPSUS, 12 rice transplanters and 10 combine harvesters were granted to 22 associations of farmers' groups (*gapoktan*) in four districts (Table 1). In this study, 116 members from three farmers' groups to which a rice transplanter had been granted and 119 members from another three farmers' group to which a combine harvester had been granted were chosen. Therefore, a total of 235 farmers were randomly selected and were interviewed regarding their perceptions on utilizing government-granted agricultural machinery. The interview survey, which was carried out from April to September 2015, used the semi-structured questionnaire.

Measuring rice farmers' perception on transplanters and combine harvesters

According to the diffusion of innovation theory presented by the very well-cited Rogers (2003), the adoption rate of an innovation depends largely on the adopter's perceptions on the technological innovation characteristics. Specifically, the adopter's perceptions on an innovation are categorized into the following five classes (Rogers, 2003): (1) relative advantage (the degree to which an innovation is perceived as being better than the idea it supersedes); (2) compatibility (the degree to which an innovation is perceived as consistent with the existing values, past experiences and needs of potential adopters); (3) complexity (the degree to which an innovation is perceived as relatively difficult to understand and use); (4) trialability (the degree to which an innovation may be experimented with on a limited basis); and (5) observability (the degree to which the results of an innovation are visible to others).

To measure the degree of the aforementioned five perceptions on utilizing the rice transplanters and combine harvesters, five negative statements related to each perception, or a total of 25 statements for five perceptions, were provided to respondents to assess their degree of negative perceptions (Table 2). Responses were provided on a Likert-type scale with scores ranging from 1 to 5 (1: strongly disagree, 2: disagree, 3: neutral, 4: agree and 5: strongly agree). The total score of five statements for each perception was calculated, meaning that the higher the score, the greater the negative perception on the use of the transplanters and combine harvesters.

Model specification

To identify factors determining the level of the aforementioned perceptions on utilizing transplanters and combine harvesters, multiple regression models with the perceptions as dependent variables are applied. Although, few detailed studies have been conducted to identify the factors determining rice farmers' perception on the adoption of agricultural machinery, Romadi and Lusianto (2014) pointed out that government agricultural extension activities improved the farmers' perception on rice farming mechanization in Indonesia. Rasouli et al. (2009) found that factors such as farm size and farm income affect the decision-making on farmers' adoption of agricultural mechanization on sunflower seed farms in Iran. Therefore, in addition to basic attributes of respondents such as age (year), educational level (primary level=1, secondary level=2, tertiary level=3), number of family members (person), farm size (ha), farm experience (year), farm income (IDR), and government extension dummy (yes=1, no=0) are used as

⁷ The northern part of Banten Province is directly connected to the capital city by the Jakarta-Merak toll road.

Table 2. Scores of negative perceptions on utilizing transplanters and combine harvesters.

	Transplanters		Combine harvesters	
	Mean	s.d.	Mean	s.d.
Relative advantage	13.828	2.061	12.882	2.949
Renting rice transplanters or combine harvesters is less profitable than the traditional way.	2.526	0.597	2.529	0.779
Using transplanters or combine harvesters seems to increase yield when compared with the traditional way.	2.733	0.517	2.588	0.718
Renting transplanters or combine harvesters does not increase income when compared with the traditional method.	2.776	0.529	2.454	0.661
Rental fee of transplanters or combine harvesters is high, which negatively affects profit from rice farming.	2.862	0.603	2.580	0.670
Since maintenance and its cost are required, using transplanters or combine harvesters is not more beneficial than the traditional way.	2.931	0.586	2.731	0.647
Compatibility	15.957	3.368	14.294	3.954
Using transplanters or combine harvesters is less suitable for the current environment than the traditional way.	3.241	0.742	2.782	0.967
Recommendation to use transplanters or combine harvesters is not in accordance with the existing customs.	3.267	0.762	2.849	0.870
Renting transplanters or combine harvesters makes me change the existing customary practice in rice farming.	3.422	0.712	2.882	0.845
Renting transplanters or combine harvesters does not match community's or farmers' need.	3.086	0.890	2.899	0.896
I hesitate to rent transplanters or combine harvesters since I am afraid that the result is not as expected.	2.940	0.907	2.882	0.761
Complexity	16.440	3.113	16.092	3.059
Operating transplanters or combine harvesters is more difficult than the traditional manual way.	3.431	0.805	3.269	0.733
Renting transplanters or combine harvesters is not practical since it requires additional costs.	3.207	0.704	3.185	0.747
Renting and operating transplanters or combine harvesters is difficult because of unavailability of skilled drivers.	3.353	0.725	3.261	0.786
I do not rent transplanters or combine harvesters because Gapoktan does not have enough equipment and spare parts.	3.414	0.735	3.277	0.663
Operating transplanters or combine harvesters is technically difficult.	3.034	0.658	3.101	0.643
Trialability	15.940	2.739	14.723	2.728
Limited opportunity of trying test run affects your decision to rent transplanters or combine harvesters.	3.060	0.805	3.042	0.681
Possible risk of loss arising from renting transplanters or combine harvesters affects decision/choice.	3.078	0.621	3.025	0.657
Limited availability of rental transplanters or combine harvesters makes it difficult to rent when required.	3.336	0.685	2.882	0.640
Group's occupation of transplanters or combine harvesters leads to limiting opportunities of renting.	3.241	0.538	2.857	0.628
High rental fee makes me hesitate to rent transplanters or combine harvesters.	3.224	0.661	2.916	0.591

Table 2. Contd.

Observability	14.552	2.548	13.849	2.875
Renting transplanters or combine harvesters is not immediately apparent in increasing value added from rice farming.	2.871	0.612	2.790	0.712
Although using transplanters or combine harvesters increases gross profit, it does not seem to increase net profit.	3.129	0.626	2.824	0.633
Quality of using transplanters or combine harvesters is not superior to the traditional manual ways.	2.802	0.701	2.782	0.653
Cost of renting transplanters or combine harvesters is more expensive than the traditional manual way.	2.741	0.724	2.655	0.775
Maintenance cost of transplanters or combine harvester is so expensive that its utilization is not more beneficial than the traditional manual way.	3.009	0.519	2.798	0.619

All scores are calculated from authors' survey data.

independent variables shown in Table 3 (age is dropped and farm income is replaced with land productivity (kg per ha) due to high correlation with farm experience and farm size, respectively).

RESULTS AND DISCUSSION

Rice farmers' perception on transplanters and combine harvesters

Results on rice farmers' negative perceptions of relative advantage, compatibility, complexity, trialability and observability are shown in Table 2. The Cronbach's alpha values of reliability for the transplanters range from 0.710 to 0.909, while those for the combine harvester range from 0.830 to 0.947. All the Cronbach's alpha values are more than the threshold limit of 0.70, indicating acceptable reliability levels. Therefore, the total score of the five statements for each perception is used as a dependent variable for regression analysis.

The highest score of negative perception on transplanters is 'Complexity' (16.440), followed by

'Compatibility' (15.957), while the lowest score was in 'Relative advantage' (13.828). The highest score of negative perception on combine harvester is also 'Complexity' (16.092), followed by 'Trialability' (14.723), while the lowest score was in 'Relative advantage' (12.882). Therefore, rice farmers tend to perceive transplanters and combine harvesters as relatively difficult to understand and use.

Factors affecting rice farmers' negative perception

Adjusted R-squared values range from 0.127 to 0.462 and the hypothesis that all coefficients are equal to zero can be rejected at the 1% significance level in all estimated equations, except the hypothesis about the 'Observability' of combine harvesters, which can be rejected at the 5 percent significance level (Table 3). In addition, the average variance inflation factor is 1.41 for transplanters and 1.39 for combine harvesters. Considering all indicators together, the estimation

results are largely acceptable for further discussion and justify the need for further examination.

The estimation results clearly show that all coefficients of the two independent variables, farm size and extension, are statistically significant and take negative values, with an exemption of 'Observability' of combine harvester, where none of coefficients are significant. Following farm size and extension, farming experience with its coefficients being significant for seven of ten values seems to lessen farmer's negative perceptions. Educational background (formal human capital formation), the number of family members (within-household labor endowment), and yield per hectare are not found to significantly affect farmers' negative perception.

With regard to farm size, it can be highlighted that the larger the farm, the lesser the negative perception of the use of transplanters and combine harvesters. This finding may be consistent with Yamauchi (2016) who pointed out that, in Indonesia, an increase in labor cost induced relatively large farmers to substitute labor

Table 3. Estimation results on farmers negative perception

Transplanter	Relative advantage			Compatibility			Complexity			Triability			Observability			Mean	SD
Education																	
Secondary	-0.003	-0.009	-	-0.762	-1.170	-	-0.557	-0.922	-	-0.061	-0.105	-	-0.650	-1.091	-	0.345	-
Tertiary	-0.474	-1.104	-	-1.055	-1.428	-	-1.395	-2.036	*	-0.669	-1.012	-	0.086	0.127	-	0.267	-
Family member	-0.334	-2.341	*	0.252	1.024	-	-0.003	-0.012		0.210	0.958	-	-0.098	-0.437	-	4.362	1.099
Farming experience	-0.060	-2.888	**	-0.052	-1.443		-0.066	-1.989	*	-0.084	-2.645	*	-0.009	-0.273	-	17.276	8.629
Farm size	-1.670	-4.792	**	-4.490	-7.479	**	-3.650	-6.558	**	-2.372	-4.419	**	-1.797	-3.275	**	0.446	0.446
Yield	0.000	1.748		0.000	0.706		0.000	0.880		0.001	1.909		0.001	2.420	*	5536.724	642.697
Extension	-2.519	-5.969	**	-1.678	-2.308	*	-2.546	-3.778	**	-2.051	-3.156	**	-1.316	-1.980	*	0.853	-
Area																	
Pandeglang	0.020	0.056	-	-0.476	-0.761	-	0.330	0.569	-	-0.100	-0.179	-	0.175	0.307	-	0.345	-
Serang	0.642	1.784	-	-0.101	-0.164	-	0.691	1.202	-	0.979	1.766	-	0.686	1.211	-	0.319	-
Constant	16.925	11.011	**	18.392	6.945	**	19.848	8.086	**	15.503	6.548	**	12.176	5.031	**	-	-
Adjusted R-squared	0.462	-		0.402	-		0.399	-	-	0.277	-	-	0.127	-	-	-	-
Combine harvester																	
Education																	
Secondary	0.738	1.487		1.641	2.285	*	0.705	1.180		-0.125	-0.230		-0.160	-0.279		0.387	
Tertiary	0.363	0.565		0.488	0.525		0.862	1.115		-0.343	-0.490		-1.240	-1.671		0.176	
Family member	0.039	0.171		0.699	2.117	*	0.334	1.215		0.390	1.567		0.121	0.458		4.387	1.106
Farming experience	-0.057	-2.006	*	-0.051	-1.240		-0.069	-2.025	*	-0.129	-4.164	**	-0.124	-3.788	**	17.899	9.098
Farm size	-1.513	-4.369	**	-2.788	-5.568	**	-1.856	-4.457	**	-1.005	-2.661	**	-0.775	-1.938		0.545	0.638
Yield	-0.001	-2.239	*	0.000	0.174		0.000	0.045		0.000	0.213		0.000	-0.843		5884.454	572.006
Extension	-3.089	-4.798	**	-3.407	-3.660	**	-1.626	-2.100	*	-1.579	-2.250	*	-0.920	-1.238		0.866	
Area																	
Pandeglang	-0.835	-1.572	-	0.704	0.918	-	-0.916	-1.435	-	0.420	0.725	-	-1.340	-2.186	*	0.353	-
Serang	0.309	0.575	-	0.146	0.188	-	-0.018	-0.028	-	-0.368	-0.627	-	-1.176	-1.893	-	0.303	-
Constant	22.284	8.971	**	15.006	4.178	**	18.060	6.046	**	16.758	6.188	**	20.126	7.017	**	-	-
Adjusted R-squared	0.430	-		0.337	-	-	0.234	-	-	0.208	-	-	0.200	-	-	-	-

** And * represent 1 and 5% significant levels, respectively.

with rented or hired machines.⁸ Farmers with large

⁸As pointed out by Yamauchi (2016), it should be noted that majority of small-scale farmers on Java, where land is scarce, can be trapped

in high-cost farming in terms of land market rigidities. Therefore, it is suggested that agricultural mechanization in situations of rising labor costs seems to be in more favor of large farmers (Foster and

Rozenweig, 2010; Otsuka et al., 2016).

rice fields tend to have a strong entrepreneurial mind-sets and are more dependent on hired labor for transplanting nursery and harvesting paddy. It is well documented that a new agricultural technology is more likely to be diffused to large-scale farmers on the basis that they are more resilient to crop failure or unexpected profit loss and will be more accepting of technology, as profit-seeking risk takers. For small-scale farmers who heavily rely on their own family's labor, replacing family labor with rent-in transplanters or combine harvesters increases expenditures. The effects of adopting agricultural mechanization for shortening the required time for transplanting or harvesting paddy is in favor of large-scale farmers. For example, harvesting time per hectare is approximately 60 man-days with the traditional manual way and one man-day with a combine harvester. This suggests that a farmer with a one-hectare paddy field can save 59 man-days in harvesting operations through agricultural mechanization. However, a small-scale rice farmer with 0.2 hectares of rice field can save only 11.8 man-days, which is roughly equivalent to four days' work by three family laborers.

As for the government extension service, a farmer who gets training provided by agricultural extension workers is less likely to have negative perceptions on transplanters or combine harvesters. This finding is consistent with Romadi and Lusianto (2014). Before 2014, when the government initially launched the rice farming mechanization program in Banten Province, a majority of rice farmers in Banten were not familiar with agricultural mechanization. In such a situation, it should be noted that the government extension service lessens rice farmers' negative perceptions on utilizing transplanters and combine harvesters, to some extent. Therefore, the government agricultural extension service plays a significant role in lessening farmers' negative perceptions on transplanters and combine harvesters and thereby facilitates agricultural mechanization to cope with a rapid rise in agricultural labor wages.⁹

As for farming experience, although coefficients of 'Compatibility' for both transplanters and combine harvesters and 'Observability' for transplanters are not significant, all others are significant at one or five percent level and take negative values. Thus, it seems that the longer the farming experience, the lesser the negative perception on the use of transplanters and combine harvesters. This is probably because more experienced farmers tend to have more knowledge on rice farming through their own farm experiences and have a wider social network that aids access to information on various agricultural technologies.

⁹Many previous studies also reveal that the government extension service positively affects productivity, technical efficiency, and technological adoption (Elias et al., 2013, 2014; He et al., 2007). However, a few studies have tried to identify factors determining farmers' satisfaction with agricultural extension service with a few exemptions by Elias et al. (2015) pointing out that regular extension contact is one of the driving factors for farmers' satisfaction.

Before concluding, the shortcoming of farmer-managed agricultural mechanization in Indonesia should be highlighted. It is widely accepted that tractor hire services in the public sector tend to be a particular cause of operational inefficiency and poor longevity in many developing countries (Pingali, 2007). In the case of irrigation water management, many previous studies pointed out that farmers' own management is more efficient than government-led management. For example, Bhatta et al. (2006) who compared the performance of farmer-managed and agency-managed irrigation systems in Nepal, pointed out that equity in distribution of irrigation water and leakage had significantly improved after the water users' group took over management responsibilities from the government department. Kosanlawit et al. (2017) also pointed out rice farmers' active participation in local irrigation operations is likely to be more effective in facilitating irrigation operations in Thailand. However, in the case of farmer-managed agricultural mechanization in Indonesia, we were told by several informants that some of the government-provided agricultural machineries were broken and abandoned in warehouses without being repaired, mainly due to severe budget constraints and poor management of the farmers' groups associations (*gapoktan*) and difficulty in the procurement of necessary parts. Although, the farmer managed mechanization program seems to contribute to lessening the negative effect of rising wages in the agriculture sector to some extent, such operational inefficiencies may jeopardize its longevity and be a waste of government funds in some farmers' associations. Therefore, there should be proper intervention, assistance, and monitoring by the district extension office, a nonprofit organization, and/or an international donor agency to ensure that transplanters and combine harvesters are not lying unused.¹⁰

Concluding remarks and policy implications

This paper aims to identify factors affecting farmers' negative perception on utilizing rice transplanters and combine harvesters. To this end, an interview survey is conducted in the westernmost part of Java Island, Banten Province, where agricultural labor wage increases at a faster pace as compared to other regions and a rapid diffusion of agricultural mechanization is expected. The estimation results of multiple regression models clearly show that majority of coefficients of three independent variables- farm size, extension and farming experience, are statistically significant and take negative values. Therefore, it can be concluded that the larger the farm size, the more training provided by the government

¹⁰Although, it may be controversial whether the farmer managed mechanization program inhibits the growth of the machinery rental or hire market led by the private sector, detail regarding this cannot be given because reliable data has not been collected yet and it is beyond the scope of the paper.

extension office, and the longer farming experience, the lesser the negative perception on the use of transplanters and combine harvesters. Educational background (formal human capital formation), the number of family members (within-household labor endowment) and yield per hectare are not found to significantly affect farmers' negative perception. Considering the above estimation results, it seems that the government agricultural extension service plays a significant role in lessening farmers' negative perceptions on transplanters and combine harvesters and thereby facilitates agricultural mechanization to cope with the rapid rise in agricultural labor wages. However, it should be noted that some of the government-provided agricultural machineries are damaged and disposed in warehouses without being repaired, mainly due to severe budget constraints of associations of farmers' groups (*gapoktan*) and the difficulty in procuring the necessary parts. Therefore, the government should ensure appropriate intervention and assistance, to prevent transplanters and/or combine harvesters from being left unused.

Finally, it should be noted that our study uses a small sample of 235 rice farmers who live in the westernmost part of Java Island, Banten Province, thus making it difficult to generalize the findings to the whole of Indonesia. In addition, several important factors that are likely to affect farmers' perception of utilizing transplanters and combine harvesters, such as management and maintenance of agricultural machineries by farmers' groups, leaders' abilities and interpersonal relationships among group members were not examined. These limitations suggest the need for further research. A more representative picture of farmers' perception on the use of agricultural machineries in Indonesia is required to promote rice farming mechanization more effectively and efficiently.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

- Adesina AA, Baidu-Forson J (1995). Farmers' perceptions and adoption of new agricultural technology: Evidence from analysis in Burkina Faso and Guinea, West Africa. *Agricultural Economics* 13(1):1-9.
- Bhatta KP, Ishida A, Taniguchi K, Sharma R (2006). Performance of agency-managed and farmer-managed irrigation systems: A comparative case study at Chitwan, Nepal. *Irrigation and Drainage Systems* 20(2-3):177-191.
- Departemen Pertanian (2008). Peraturan Menteri Pertanian Nomor 25/Permentan/PL.130/5/2008 tentang Pedoman Peningkatan dan Pengembangan Usaha Pelayanan Jasa Alat dan Mesin Pertanian.
- Elias A, Nohmi M, Yasunobu K, Ishida A (2013). Effect of agricultural extension program on smallholders' farm productivity: Evidence from three peasant associations in the highlands of Ethiopia. *Journal of Agricultural Science* 5(8):163-181.
- Elias A, Nohmi M, Yasunobu K, Ishida A (2015). Farmers' satisfaction with agricultural extension service and its influencing factors: A case study in North West Ethiopia. *Journal of Agricultural Science and Technology* 18(1):39-53.
- Elias A, Nohmi M, Yasunobu K, Ishida A, Alene AD (2014). The effect of agricultural extension service on the technical efficiency of teff (*Eragrostis tef*) producers in Ethiopia. *American Journal of Applied Sciences* 11(2):223-239.
- Foster A, Rosenzweig MR (2010). Barriers to farm profitability in India: mechanization, scale and credit markets. In *Conference Agriculture for Development-Revisited*, University of California at Berkeley, October 24 Sep pp. 1-2.
- He XF, Cao H, Li FM (2007). Econometric analysis of the determinants of adoption of rainwater harvesting and supplementary irrigation technology (RHSIT) in the semiarid Loess Plateau of China. *Agricultural Water Management* 89:243-250.
- Ishida A, Asmuni A (1998). Poverty eradication and income distribution in Malaysia. *Journal of Contemporary Asia* 28(3):327-345.
- Kosanlawit S, Soni P, Shivakoti GP (2017). The relationship between effective and equitable water allocation, local rice farmer participation and economic well-being: Insights from Thailand's Chiang Mai Province. *Water* 9(5):319.
- Liu Y, Violette W, Barrett CB (2016). Structural transformation and intertemporal evolution of real wages, machine use, and farm size-productivity relationships in Vietnam. IFPRI Discussion Paper 01525. Washington, D.C.: International Food Policy Research Institute.
- Negatu W, Parikh A (1999). The impact of perception and other factors on the adoption of agricultural technology in the Moret and Jiru Woreda (District) of Ethiopia. *Agricultural Economics* 21:205-216.
- Otsuka K, Liu Y, Yamauchi F (2013). Factors endowments, wage growth, and changing food self-sufficiency: evidence from country-level panel data. *American Journal of Agricultural Economics* 95(5):1252-1258.
- Otsuka K, Liu Y, Yamauchi F (2016). The future of small farms in Asia. *Development Policy Review* 34(3):441-461.
- Pingali P (2007). Agricultural mechanization: Adoption patterns and economic impact. Evenson R, Pingali P (eds). *Handbook of Agricultural Economics*, Vol. 3, Amsterdam: Elsevier.
- Rasouli F, Sadighi H, Minaei S (2009). Factors affecting agricultural mechanization: A case study on sunflower seed farms in Iran. *Journal of Agricultural Science and Technology* 11:39-48.
- Rogers EM (2003). *Diffusion of Innovations*. Fifth Edition. The Free Press: New York.
- Romadi U, Lusianto D (2014). Persepsi petani padi terhadap pemanfaatan rice transplanter di Kecamatan Pohjentrek Kabupaten Pasuruan Provinsi Jawa Timur. *Agrica Ekstensia* 10(2):61-66.
- Wang X, Yamauchi F, Otsuka K, Huang J (2016). Wage growth, landholding, and mechanization in Chinese agriculture. *World Development* 86:30-45.
- Winarno K (2017). Factors shaping the operation of machinery hire services: Case studies on the implementation of the institution for rental service of agricultural machinery (IRSAM) Programme in the Special Region of Yogyakarta, the Republic of Indonesia. Master's Thesis submitted to Massey University.
- Yamauchi F (2016). Rising real wages, mechanization and growing advantage of large farms: Evidence from Indonesia. *Food Policy* 58:62-69.

Full Length Research Paper

Participatory on farm evaluation of improved mungbean technologies in the low land areas of North Shewa Zone Amhara Region, Ethiopia

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The study was conducted in four selected potential areas of North Shewa zone namely; Kewot, Efratana gidim, Ensaro and Merhabete district. The main objective of the study was to evaluate, select the best performing mungbean varieties and to assess farmer's technology preference. The experiment was done using three improved varieties namely; Rasa (N-26), NLV-1, and Arkebe improved varieties and local variety as a check. The analytical result showed that Rasa (N-26) variety was preferred by the farmers followed by NLV-1. The result gotten from the analysis of variance indicated that the difference among the means of the mungbean varieties for grain yield, pod length and hundred seed weight are significant at 5% probability level for both locations. The highest yield (1541.3 kg/ha) was recorded from Rasa (N-26) variety at Jema valley followed by the local variety (1243.3 kg/ha), while the lowest yield (735.7 and 676.3 kg/ha) was obtained from the varieties NLV-1 and Arkebe, respectively. The partial budget analysis result also revealed that only Rasa (N-26) had the highest net benefit return compared to the local variety. The marginal rate of return for changing from using local variety to improved Rasa (N-26) variety was 1074%. Therefore pre-scaling up of Rasa (N-26) variety with its improved management practice should be done.

Key words: Mungbean, farmer preference, participation, rasa variety.

INTRODUCTION

Endowed with varied agro-ecological zones and diversified natural resources, Ethiopia has been known as the home land and domestication of several crop plants. Pulses, which occupy approximately 13% of cultivated land and account for approximately 10% of the agricultural value addition next to cereal crops, are critical to smallholder livelihoods in Ethiopia (CSA, 2016; Chilot et al., 2010). It is ranked 13th among pulse producing countries in the world (FAO, 2015).

Pulse crops are important components of crop production in Ethiopia's smallholders' agriculture, providing an economic advantage to small farm holdings as an alternative source of protein, cash income, and food security (CSA, 2016; USAID, 2014). The crops have been used for many years in cropping system practices. Some of them have played an important role in the export sector generating foreign currency for the country (ATA, 2015; Boere et al., 2015). Although the availability of

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pulses have never been in surplus in the subsistence farming community, recently it is observed that the production and supply of some pulses is increasing due to the demand increase both in local and international markets.

Mungbean (*Vigna radiata* L.), which is introduced recently, is an annual herb of the legume family. It has green skin and is also called green bean (MoA, 2011). It is sweet in flavor and cold in nature (EPP, 2004). The crop matures early; special features include high yield, good nutritive value, the earliness, drought resistant features and the reasonable cost of production. It is a warm season annual grain legume and the optimum temperature range for good production is 27 to 30°C and requiring 90 to 120 days of frost-free conditions from planting to maturity depending on the variety (Itefa, 2016).

According to Asfaw et al. (2012) in Ethiopia mungbean is mostly grown by smallholder farmers under drier marginal environmental condition and the production capacity is lower than other pulse crops. Green mungbean is less used domestically, but it is a common ingredient in Chinese and Indian cuisines. It is attributed with having high nutritional value, including protein content (24 to 26%), and helps reduce cholesterol and diabetes (Ali and Gupta, 2012; Habte, 2018).

Despite its growing demand in the international market, there is a huge gap of production in Ethiopia. Ethiopia's mungbean export trend has grown slightly mainly due to Ethiopian Commodity Exchange that installed mungbean as the sixth commodity to be traded on its floor since 2014 (ECX, 2014). This inspired many farmers to get involved in mungbean production. More than 136,392 small holder farmers were engaged in mungbean production (CSA, 2016).

According to CSA (2014), mungbean grown in 2013/2014 covered only 0.09% (10,692.38 hectares) of the grain crop area and 0.03% (about 8,064.01 tones) of the grain production nationally with average productivity of 0.75 t/ha. About 91.73% (9,808.22 hectares) of the total national mungbean production area and 99.97% (8,062.36 tone) of the total production of the country was from Amhara region (CSA, 2014). The regional average productivity was 0.82 t/ha which is very far below its potential.

However, the demonstrated potential in Ethiopia reaches 1.5 tons under research field and 0.5 to 1.0 t/ha under farmer field with research recommended practices (MoA, 2011). The low acreage and yield are attributed to the absence of links to seed suppliers and hence a lack of improved seeds and a high use of local varieties (on more than 95% of the total pulse cropped area) (Chilot et al., 2010) was the major production constraints.

Therefore, the study aims to evaluate and select the best performing mungbean varieties and to identify farmers preference and selection attributes in the study sites.

MATERIALS AND METHODS

Description of the study area

The experiment was conducted in the low lands of North Shewa areas of Efratana gidim, Kewot, Ensaro and Merhabete district, during main cropping season of 2015 under rainfed condition. These sites are known to be suitable for mungbean production and selected purposively based on their potential (CSA, 2016).

Materials and research design

The experiment was done using three improved varieties including Rasa (N-26), NLV-1 and Arkebe varieties which were released and recommended by the national research system of the country. The experiments were laid out in a simple plot design with six farmers' fields as a replicates. A unit plot size of 100 m² (10 m x 10 m) with plant spacing of 30 cm x 5 cm was used. A seed rate of 38, 33.7, 24.7 and 25 kg/ha was administered to Rasa (N-26), NLV-1, Arkebe and Shewa Robit local varieties. NPS was used at the rate of 30 kg/ha. The experiment was planted starting from third week of July depending on the rainfall intensity and distribution.

Data collected

Farmers and experts participated during the evaluation of the experiment from all study sites while three varieties were evaluated against their local by setting the criteria and giving weight for each attributes by them. A total of 94 (3.2% female) farmers and 24 (1 female) experts were participated during the evaluation of the experiment from each experimental site. Agronomic data like yield and other attributes of the variety was examined both on plant and plot basis in order to evaluate the performance of the technologies across each agro ecologies. Ten plants were taken randomly from each plot to determine plant height at maturity, number of primary branches, number of pods per plant and number of seeds per pod. Hundred seed weight (g), biomass yield (kg/ha) and grain yield (kg/ha) were collected on plot basis. Cost and benefit analysis was also done by using partial budget analysis method.

Data analysis

Finally, social data and farmers' preference was analyzed by using pair wise and preference ranking techniques. To estimate difference among the varieties all measured variables were subjected to analysis of variance (ANOVA) using SAS software version 9.00 (SAS Institute, 2004). Analysis of variance was done following the standard procedure given by Gomez and Gomez (1984). Mean separation was carried out using least significant difference (LSD) test at 5% of significance.

RESULT AND DISCUSSION

Mean values of different agronomic traits

The result was presented based on two categories as Jema valley (Ensaro and Merhabete district) and Kewot, and Efratana gidim district as one location. The result gotten from the analysis of variance for Jema valley indicated that the differences among the means of the mungbean varieties for only grain yield, pod length and

Table 1. Mean values of yield and yield components of Ensaro and Merhabete district.

Varieties	ppp	spp	pibr	plh	pl	Hsw	Gy	bm
Rasa (N-26)	9.75	11.9	4.15	39.35	9.65 ^{ab}	5.05 ^a	1541.3 ^a	4688
Local	13.25	11.3	4.45	45.05	8.45 ^{bc}	3.48 ^c	1243.3 ^a	4583
NLV-1	10.75	12.15	3.85	39.8	10.5 ^a	4.65 ^{ab}	735.7 ^b	5000
Arkebe	10.65	11.25	3.65	41.65	7.95 ^c	4.05 ^{bc}	676.3 ^b	3750
Mean	11.1	11.65	4.03	41.46	9.14	4.31	1049.2	4505.2
CV (%)	20.56	8.72	15.56	15.29	8.79	9.43	22.12	21.15
LSD (0.05)	NS	NS	NS	NS	1.28	0.65	371.3	NS

Where: ppp = Number of pods per plant; spp = Number of seeds per pod; pibr = Primary Branching; plh = Plant height (cm); pl = Pod length (cm); hsw = Hundred seed weight (g); gy = Grain yield (kg/ha); bm = Biomass (kg/ha).

Table 2. Mean values of yield and yield components for Kewot and Efratana gidim areas.

Variety	ppp	spp	pibr	plh	PL	Hsw	Gy	bm
Rasa	11.28	9.24	3.92	43.26	9.42 ^a	5.38 ^a	1342 ^a	3837 ^a
Local	14.04	9.6	3.72	46.08	7.11 ^b	3.54 ^b	1267 ^{ab}	3703 ^a
NLV-1	9.76	9.8	3.24	34.28	9.60 ^a	5.22 ^a	1021 ^{bc}	3000 ^{ab}
Arkebe	12.32	9.44	3.64	41.84	7.92 ^b	3.92 ^b	690.3 ^c	2413 ^b
Mean	11.85	9.52	3.63	41.36	8.51	4.52	1080.2	3237.97
CV (%)	22.39	13.77	11.98	20.13	8.48	6.24	18.48	21.52
LSD	NS	NS	NS	NS	0.995	0.388	275.14	960.04

hundred seed weight are significant at 5% probability level. The highest yield (1541.3 kg/ha) was gained from Rasa (N-26) variety followed by the local variety (1243.3 kg/ha), while the lowest yield (735.7 and 676.3 kg/ha) was obtained from NLV-1 and Arkebe varieties, respectively.

Similarly, Adhiena et al. (2015), Habte (2018), Rasul et al. (2012), Teame et al. (2017) and Wedajo (2015) found that mungbean cultivars had significant effect on grain yield. As revealed in Table 1, yield gained from Rasa (N-26) was almost more than two folds of NLV-1 and Arkebe varieties. However, no big difference of yield was observed in between the local and Rasa (N-26) varieties in all sites. The highest hundred seed weight was obtained from Rasa (N-26) variety, while the lowest was gotten from local cultivar. The longest pod length (10.5 cm) was recorded from NLV-1 variety followed by Rasa (N-26) variety. Likewise, Mondal et al. (2012) reported the existence of significant difference in thousand seed weight among different cultivars.

Similarly, Table 2 indicated that the differences among the means of the mungbean varieties for grain yield, pod length, hundred seed weight and biomass are significant at 5% probability level for Kewot and Efratana gidim districts. Here also, the highest yield (1342 kg/ha) was gotten from Rasa (N-26) followed by the local variety (1267 kg/ha). The variety NLV-1 has relatively good compared to Jema valley with average yield of 1021 kg/ha even though it still remains below the local variety.

The lowest yield (690.3 kg/ha) was still recorded from Arkebe. The highest hundred seed weight (5.38 g) was obtained from Rasa (N-26) variety; however it was statistically at parity with NLV-1 (5.22 g). The lowest value was recorded from Arkebe and local varieties. The variety Rasa (N-26) performs well in all the study location. It returns higher yield in Jema valley when compared to Kewot and Efratana gidim district. Figure 1 shows the average yield obtained from each variety for the two sites.

Farmer's selection criteria

Farmers from Ensaro and Merhabete districts identified and listed all the attributes which was very important for them and gave weight according to their importance. The major selection attributes identified by farmers were disease resistance, number of pods per plant, pod length, biomass yield and grain size for boldness. The matrix aforementioned compares the different attributes of varieties showing which of the attributes are of greatest importance for mung bean production in the area (Table 3). Using the same procedure for farmers at Kewot and Efratana gidim districts, they were also setting major attributes and prioritizing disease resistance first, pod per plant, branching ability, earliness, pod length, grain size for boldness and yield of biomass in its order of importance. It indicates that the major problems of the area for mungbean production were disease and pest

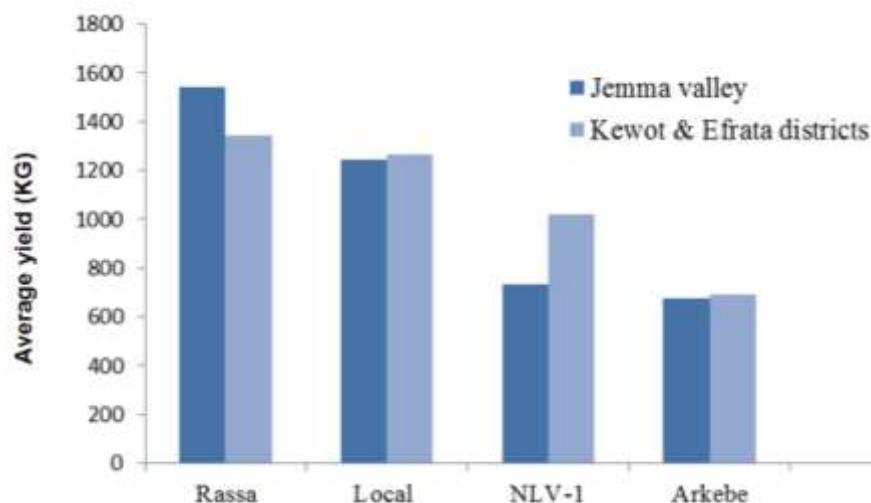


Figure 1. Average yield in kg per hectare.

Table 3. Pair-wise ranking matrix for selected farmers variety evaluating criteria.

Major attributes	Disease resistance	Pod per plant	Pod length	Biomass yield	Grain size	No. of times preferred	Rank
Disease resistance (DR)	-	DR	DR	DR	DR	4	1st
Pods per plant (PPP)	-	-	PL	PPP	GS	1	4th
Pod length (PL)	-	-	-	PL	GS	2	3rd
Biomass yield (BY)	-	-	-	-	GS	0	5th
Grain size (GS)	-	-	-	-	-	3	2nd

infestation which results to yield penalty according to farmers point of view.

Farmer preference ranking matrix

The common and most important selection criteria's in all locations that farmers identified were disease resistance, pod per plant, pod length, seed size for boldness and biomass in their order of importance, respectively (Figure 2). As highlighted in Table 4 in Jema valley farmers were selecting Rasa (N-26) variety. Similarly based on their selection criteria's in Kewot and Efratana gidim woreda Rasa (N-26) variety was preferred by the farmer (Table 5). As illustrated earlier in Figure 2 in almost all attributes, farmers were selecting Rasa (N-26) first and NLV-1 second. On the other hand, Arkebe was not adaptable to the area and hence farmers did not prefer it.

Partial budget analysis

Partial budget analysis helps to evaluate the profitability

level of the agricultural production practices due to treatment effects on a business venture. The cost of production for mungbean technology in different areas is relatively similar with no significant differences in both Jema valley and Kewot and Efratana gidim areas. The costs of production included costs of seed, labour, chemical and fertilizer costs. According to the data collected from the activity only seed costs vary along the varieties due to differences in seed rate. Seed rates for Rasa (N-26), NLV-1, Arkebe and local varieties were 38, 33.7, 24.7 and 25 kg/ha, respectively. The data collected from the local market shows that the cost of a kilo of mungbean seed during planting season was 35Birr, while the price of grain and its straw at immediate harvest was respectively 23 and 0.48 birr per kg (Table 6). In the experiment, the net benefits for Rasa (N-26) variety are higher than that of the local variety (Table 6). The net benefits from Rasa (N-26) variety at Jema valley and Kewot and Efratana gidim districts are 32,600.9 and 28,107 birr per hectare, while for the local varieties are 26,841.2 and 26,951 birr per hectare, respectively. On the other hand, the varieties NLV-1 and Arkebe has a return below the local variety in both study sites and are

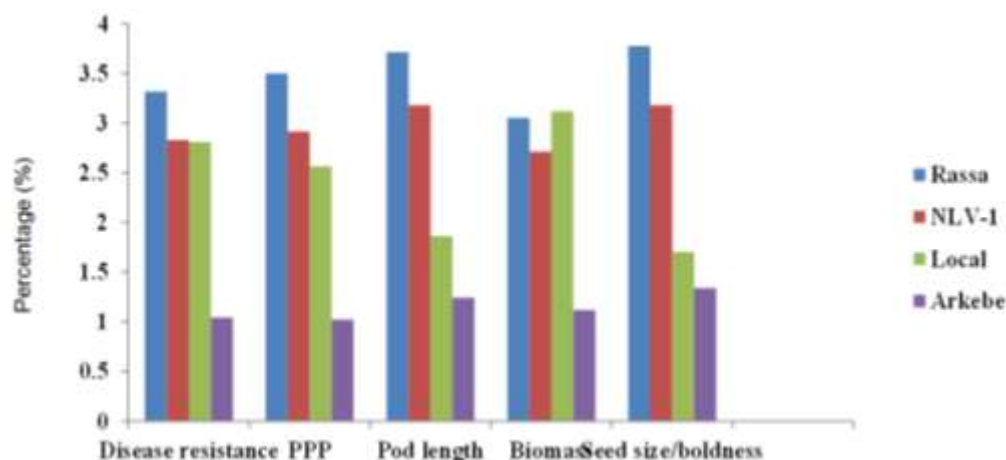


Figure 2. Combined farmers' most important variety selection criteria's.

Table 4. Farmer variety preference ranking matrix summary sheet for Jema valley.

Varieties	Farmers selection Attributes					Mean	Rank
	DR	PPP	PL	BM	GS		
Rasa, N-26	3.18	3.41	3.56	3.26	3.66	3.41	1st
NLV-1	3.18	3.32	3.41	3.07	3.34	3.26	2nd
Arkebe	1.02	1	1.09	1	1.22	1.06	4th
Local	2.62	2.27	1.94	2.66	1.78	2.25	3rd

Scoring value: 4- Best, 1- Poor.

Where DR= disease resistance, PPP= Number of pods per plant, PL= pod length, BM= biomass, GS= seed size (boldness).

Table 5. Farmer variety selection ranking matrix for Kewot and Efratana gidim districts.

Varieties	Farmers selection attributes							Mean
	DR	PPP	PL	Earliness	BM	GS	BA	
Rasa, N-26	3.53	3.63	3.87	3.88	3.04	3.91	2.38	3.46
NLV-1	2.51	2.57	2.96	2.94	2.34	2.99	1.82	2.59
Arkebe	1.08	1.06	1.38	1.43	1.19	1.47	1	1.23
Local	2.88	2.74	1.79	1.76	3.43	1.63	2.03	2.32

Where DR= disease resistance, PPP= Number of pods per plant, PL= pod length, BM= biomass, GS= seed size/boldness and BA= Branching ability).

dominated by the local variety (Figure 3).

Marginal analysis

Although the calculation of net benefits accounts for the costs that vary, it is necessary to compare the marginal costs with the extra net benefits. Higher net benefits may not be attractive if they require very much higher costs. Therefore if the farmers were to adopt Rasa (N-26) variety, it would require an extra investment of 455 birr

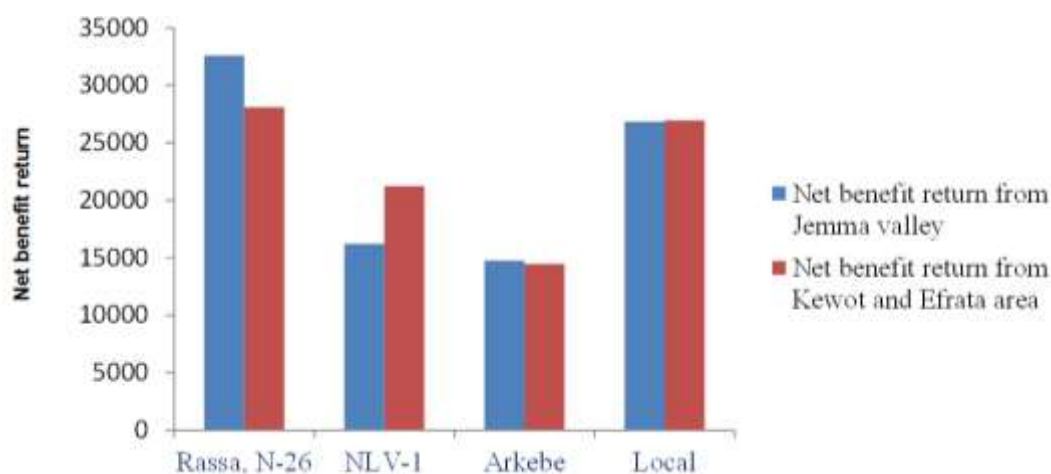
per hectare; in return, they will obtain extra benefits of 4884.7 and 1155.9 birr for Jema valley and Kewot and Efratana gidim districts, respectively. The marginal rate of return (MRR) is a ratio of the change in net benefits (NB) to change in total variable input costs (TVC) between treatments.

$$[MRR = \Delta NB / \Delta TVC * 100]$$

In this case, the marginal rate of return for changing from using local variety to improved Rasa (N-26) variety at

Table 6. Partial budget analysis.

Cost and benefit components	Jema valley				Kewot and Efratana gidim districts			
	Rasa	NLV-1	Arkebe	Local	Rasa	NLV-1	Arkebe	Local
Total grain yield (kg/ha)	1541.3	735.7	676.3	1243.3	1342	1021	690	1267
Adjusted grain yield (kg/ha)	1387.2	662.13	608.67	1118.97	1207.8	918.9	621	1140.3
Total straw yield (kg/ha)	4688	5000	3750	4583	3837	3000	2413	3703
Adjusted straw yield (kg/ha)	4219.2	4500	3375	4124.7	3453.3	2700	2171.7	3332.7
Benefit from grain/ETB	31905.6	15229	13999.4	25736.3	27779.4	21134.7	14283	26226.9
Benefit from straw/ETB	2025.25	2160	1620	1979.86	1657.58	1296	1042.42	1599.7
Gross field benefit/ETB	33930.9	17389	15619.4	27716.2	29436.98	22430.7	15325.42	27826.04
Seed rate (kg/ha)	38	33.7	24.7	25	38	33.7	24.7	25
Total costs that vary/ETB	1330	1179.5	864.5	875	1330	1179.5	864.5	875
Net benefit/ETB	32600.9	16209.5D	14754.9D	26841.2	28107	21251.2D	14460.9D	26951

**Figure 3.** Net benefit return of each variety per location.

Jema valley was 1074%, while for Kewot and Efratana gidim districts it was 254%. This means that for every 1.00 birr invested in improved Rasa (N-26) variety, farmers can expect to recover their 1.00 birr, and obtain an additional 10.74 and 2.54 birr for Jema valley and Kewot and Efratana gidim areas, respectively.

Farmers experience in mungbean production

The farmers were growing mungbean mainly for cash. Most of the time farmers preferred bulge season for producing mungbean. All the participants were preferring bulge season to grow mungbean. It was due to low pest and disease incidence, high seed quality, yield advantage and to avoid land resource competition in main season according to the farmers during focus group discussion. So far, farmers were planting it before and they were plough only one time to cover the seed. But now they started ploughing 3 to 4 times. They were planting through

broadcasting because of lack of awareness and experience. They were also practicing intercropping and/or mixed cropping system with maize, sesame and sorghum mungbean as a major crop. To improve soil fertility through nitrogen fixation, they had to generate additional income, to break the disease and pest cycle and also as an alternative source of animal feed. Farmers were using local seed due to lack of access to improved seed with seed rates ranging from 16 to 20 kg per hectare and they were harvesting a yield which is very far below the potential of the area according to the farmers. They also said that in the area there is no experience of applying any inorganic chemical fertilizer. However they were applying pesticide chemicals especially in the main production season intensively three to four times on average and they were using a mixture of chemicals at a time. Farmers gave reasons why they were growing mungbean and the potential opportunities of the area as: As a potential rotational crop, it fits well in Teff and sorghum cropping system where there are no other

options, it has high market value, it can easily grow with a few available soil moistures with no land resource competition in bulge, it has short date of maturity, an alternative source of animal feed and it can be easily grown with a minimum labor requirement. Although improved mungbean is a profitable crop in the study areas, there are several constraints to its higher production. Lack of access to improved varieties was the most important challenge for mungbean production. It was also identified that disease (mungbean yellow mosaic virus) and insects (apeon) are challenges of the farmer in the growing area. It was also constrained as lack of access to quality chemicals with reasonable cost. Moreover, farmers had no awareness on the stage that chemicals would be use and its amount. They were gotten from traders that sell the chemical with high cost and they don't know which chemical is appropriate. Farmers have also suffered from lack of access to improved seed, low market price during harvesting and price fluctuation across traders and time, and postharvest loss due to weevils.

CONCLUSION AND RECOMMENDATION

Mungbean is a widely grown cash crop in the low land areas of North Shewa. However its productivity was very low due to lack of improved seed and high pest and disease infestation problem. According to farmers evaluation and the agronomic data, variety Rasa (N-26) perform better with grain yield and yield components. So by introducing the new variety and integrated pest and disease management practice, the productivity of mungbean can be improved to 1.54 t/ha. Therefore based on the findings, this variety will be prescale integrated next with pest and disease management practice.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

- Adhiena M, Muez M, Mizan T (2015). Evaluation of mung bean genotypes for seed yield and other yield related traits in low lands of South Tigray, Ethiopia. *Journal of Natural Sciences Research* 5(13):165-167.
- Agriculture Organization of the United Nations (FAO) (2015). Analysis of price incentives for haricot beans in Ethiopia for the time period 2005-2012. <http://www.fao.org/3/a-i4525e.pdf>
- Ali M, Gupta S (2012). Carrying capacity of Indian agriculture: pulse crops. *Current Science* 102:874-881.
- Asfaw A, Gurum F, Alemayehu F, Rezene Y (2012). Analysis of multi-environment grain yield trials in mungbean (*Vigna radiata* L.) Wilczek based on GGE bipot in Southern Ethiopia. *Journal of Agricultural Science Technology* 14:389-398.
- Agricultural Transformation Agency (ATA) (2015). Seed system development strategy: Vision, systemic challenges, and prioritized interventions. Ethiopian Agricultural Transformation Agency (ATA) working strategy document, Addis Ababa, Ethiopia.
- Boere A, Rutgers T, Willems D, Dawit K, Dolfen W (2015). Business Opportunities Report Oilseeds and Pulses #5 in the series written for the "Ethiopian Netherlands Business Event 5-6 November 2015, Rijswijk, The Netherlands".
- Central Statistical Agency (CSA) (2014). Agricultural Sample survey Area and production of major crops (Private peasant holdings, Meher season): Annual report. The Federal Democratic Republic of Ethiopia Central Statistical Agency Addis Ababa, Ethiopia.
- Central Statistical Agency (CSA) (2016). Agricultural Sample survey Area and production of major crops (Private peasant holdings, Meher season): Annual report. The Federal Democratic Republic of Ethiopia Central Statistical Agency Addis Ababa, Ethiopia.
- Chilot Y, Shahidur R, Befekadu B, Solomon L (2010). Pulses Value Chain potential in Ethiopia: Constraints and opportunities for Enhancing Exports. Working Paper International Food Policy Research Institute (IFPRI).
- Ethiopia Commodity Exchange (ECX) (2014). ECX Rings Bell for mungbean Addis Ababa, Ethiopia. <http://www.ecx.com.et/downloads/whatsNew/20140124123601437Mung%20Bean%20Enters%20ECX%20Trade.pdf>
- Ethiopian Pulses Profile (EPP) (2004). Ethiopian Pulses Profile: Ethiopian Export Promotion Agency, Product Development & Market Research Directorate, May 2004, Addis Ababa, Ethiopia.
- Gomez KA, Gomez AA (1984). Statistical procedures for agricultural research (2 Ed.) John Wiley and sons, New York, 680pp.
- Habte U (2018). Evaluation of adaptability of mungbean varieties in moisture stress of Eastern Harerghe Zone. *Agricultural Research and Technology* 13(2): 555880.
- Itfa D (2016). General characteristics and genetic improvement status of mungbean (*Vigna radiata* L.) in Ethiopia: Review article. *International Journal of Agriculture Innovations and Research* 5(2):2319-1473.
- MoA (2011). Ministry of Agriculture: Animal and Plant Health Regulatory Directorate. Crop Variety Register Issue No. 14. Addis Ababa, Ethiopia.
- Mondal MMA, Puteh AB, Malek MA, Ismail MR, Rafii MY, Latif MA (2012). Seed yield of mungbean (*Vigna radiata* (L.) Wilczek) in relation to growth and developmental aspects. *The Scientific World Journal Article ID* 425168, 7 p.
- Rasul F, Cheema MA, Sattar A, Saleem MF, Wahid MA (2012). Evaluating the performance of three mungbean varieties grown under varying inter-row spacing. *Journal of Animal and Plant Sciences* 22(4):1030-1035.
- SAS Institute Inc. (2004). SAS/INSIGHT® 9.1 User's Guide, Volumes 1 and 2. Cary, NC: SAS Institute Inc.
- Teame G, Ephrem S, Lemma D, Getachew B (2017). Adaptation study of mungbean (*Vigna radiata*) varieties in Raya valley, Northern Ethiopia. *Current Research in Agricultural Sciences* 4(4):91-95.
- United States Agency for International Development (USAID) (2014). United States Agency for International Development Works to Strengthen Ethiopia's Pulses, Oilseeds and Spices Sector, November 12.
- Wedajo G (2015). Adaptation study of improved mung bean (*Vigna radiata*) varieties at Alduba, South Omo, Ethiopia. *Research Journal of Agriculture and Environmental Management* 4(8):339-342.

Full Length Research Paper

Choices and implications of livelihood diversification strategies on smallholder farmers' income in Saesietsaeda Emba District, Eastern Tigray Region of Ethiopia

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Farmers' life without livelihood diversification into off-farm and non-farm income activities becomes difficult due to unstable and meagre agricultural context of the study area. Farm income alone cannot feed the ever increasing population. Hence, livelihood diversification is a matter of life or death for majority of the households in the study district. The objectives of the study were to identify household livelihood diversification options; to identify reasons why smallholder farmers need to diversify; and to analyze the implication of livelihood diversification strategies on smallholder farmers' income. A multistage sampling technique was used to select the study area and 485 sample respondents. Data was collected using structured interview and key informants interview. The poor and less poor households' livelihood diversification was primarily for survival whereas the objective of the better-off households was for better wealth accumulation. It was found that 43% of the overall annual income of the farmers comes from off-farm and non-farm activities. This implies that non-farm and off-farm activities have significant implication on improving farmers' livelihood. Therefore, more efforts are required from the regional government on supporting livelihood diversification into off-farm and non-farm activities than sticking on the drought vulnerable, limited farm-land and rain dependent farm income.

Key words: Livelihoods, diversification strategies, income, Saesietsaeda Emba, Ethiopia.

INTRODUCTION

Africa as a continent is identified by subsistence farm households involved in livestock, crop or fish production as their main source of livelihood and in other non-farm income generating activities to augment their main

source of income. Previous empirical studies found that rural residents across the developing world earn about 35 to 50% of income from non-farm activities and confirmed that more than 50% of income in rural farming

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communities in developing countries comes from non-farm sources (Haggblade et al., 2010; IFAD, 2010). In Ethiopia, empirical studies also indicate that non-farm income accounts for as much as 40 to 45% of average household income (Bezabih et al., 2010; Kassie, 2017). Furthermore, agriculture is highly dependent on weather patterns and given the very high number of people depend on rain-fed agriculture in sub-Saharan Africa (SSA) (FAO, 2015). Any impacts of climate change may potentially affect all aspects of food security, including food availability, access, utilization, and stability (Challinor et al., 2010; IPCC, 2012; 2014).

In many parts of Ethiopia including the study district in particular, agriculture is plagued with problems of soil infertility, drought, erratic rainfall, seasonal migration, risks of climatic uncertainty, and the challenge of feeding the rapidly growing population of the country. Contrary to this, the government of Ethiopia often believe that agriculture on its own could achieve the goals of poverty reduction by raising agricultural productivity continuously overtime. However, given the context of the study area which is drought prone and high rain fed dependence coupled with the ever increasing population and limited cultivable farm-land, agriculture by its own cannot provide the means of poverty alleviation and improving household livelihood. Thus, smallholder farmer's livelihood diversification of income sources is necessary to cope with increasing vulnerability associated with agricultural production through diversification and/or moving out of farming into non-farm income sources.

It is against this backdrop this study was undertaken if smallholder farmers need to participate in other off-farming and/or non-farm productive economic activities to enable them generate better income for their sustainable livelihood. This is very important to protect and improve the livelihoods of the poor and to ensure food security at household level, although the motivations and outcomes may vary significantly (FAO, 2015). It is also understood that different households adapt different livelihood strategies according to their particular asset and asset status (Barrett et al., 2001, Ellis, 2000; Gebru and Beyene, 2012), and the prioritized objective they have. In fact, access to natural and man-made resources is also different from place to place and determines the capacity of the household on which livelihood diversification strategy to choose and apply. For this research, smallholder farmer's income livelihood diversification strategies were the main focus. For the poorest, who have the least capacity to effectively manage risk, diversification may be a response to constraints imposed upon them by increasing climate risk and unstable farm income. In this sense they are pushed into diversification by lack of alternatives for risk coping and it is necessary for their survival. In contrast, wealthier households may be pulled into diversification by the existence of welfare increasing diversification options as well as their own capacity to access the better income generating non-farm

activities (Eshetu and Mokonnen, 2016; FAO, 2015 Loison, 2015, Khatun and Roy, 2016).

Before now, location and context specific understandings of what exactly constitutes the choices and needs of livelihood diversification strategies and its implication on-farm households income were lacking. Here, relative community based wealth ranking criterion was used in selecting poor, less poor and better off sample households. Because, households' wealth status has a pivotal role in household's choice and practice of better income earning livelihood strategies and then able to improve their standard of living. Therefore, the objectives of the study were: (1) to identify household livelihood diversification options by their community based relative wealth ranking; (2) to assess the main reasons why smallholder farmers need to diversify into off-farm and non-farm livelihood strategies; and (3) to analyze the implication of household livelihood diversification strategies on smallholder farmer's income.

RESEARCH METHODS

The study area

The study was conducted during the year 2016/2017, in Saesietsaeda Emba district, Eastern Zone of Tigray National Regional State of Ethiopia at about 883 km north of Addis Ababa (FDRE, 2011). The district has population size of 157,099, of which 73,997 are male and 83,102 are female (CSA, 2013). Of the total human population in the district, 26,853 (17.1%) and 130,246 (82.9%) are urban and rural dwellers, respectively (CSA, 2013). Economy of the study district largely depends on how its smallholder farmers perform. The average farm size is approximately less than 0.5 ha, which is too small to achieve food self-sufficiency. The agro-ecology of the district experiences semi-arid climate which is characterized by sparse and irregular rainfall, low vegetation cover, poor quality of soil fertility and severe degradation, and highly drought prone area (FDRE, 2011). The district receives an average annual rainfall ranging from 350 to 500 mm and temperature ranging from 13 to 20°C. There is a single cropping season lasting between late June and August, and a dry season that spans between September and June. The predominantly unimodal rainfall from June to August is characterized by high temporal and spatial variability (CSA, 2013).

Types and methods of data collection

The study used multi-stage sampling, a combination of purposive, stratified, systematic random and proportional sampling techniques to select the study area and sample respondents. The study district, Saesietsaeda Emba, was purposively selected from the seven districts in Eastern Tigray region of Ethiopia. This is because of its drought proneness (FDRE, 2011), high population pressure, land degradation, high cultivable land scarcity, existence of high out-migration, prevalence of food insecurity and dependence on food aid programmes (FDRE, 2011). Of the total twenty five rural Kebele administrations (KAs) (lowest administrative unit in Ethiopia), five namely Sewne from low-land, May-Megelt and Sendeda from Middle land, and Hawile and Raele from High land agro-ecological zones were selected using stratified sampling technique. In addition, community based relative wealth ranking criteria was used in selecting the relatively better off (n=130), less poor (n=177) and

poor (n=178) sample households.

In fact, wealth status of the household is essential for households to choose and adopt certain livelihood diversification strategies and able to earn better income. Finally, 485 sample households were selected using proportional sampling followed by systematic random sampling technique from the five Kebele administrations of the study district.

Primary data was collected from the 485 households using structured interview triangulated with data collected from focus group discussion and key informant interviews. Head of the study district of agricultural office, extension experts, elders, model farmers and Kebele administration chairmen and representatives from NGOs working in the district were part of the focus group discussion. On the other hand, the secondary data were retrieved from relevant journals, books, conference proceedings and project reports.

Data analyses

Data were collected using structured interviews which were coded and processed using SPSS software version 20 for further analysis. Descriptive statistics such as percentage, frequency, mean, standard deviation, minimum, maximum, t-test and chi-square test were used for further analysis. Narrative/Content based analysis was also used to analyze qualitative type of data collected from key informant interviews and focus group discussion to enrich and illustrate qualitative conclusion.

RESULTS AND DISCUSSION

Community based wealth ranking of sample households in the study district

Relative community based wealth ranking was conducted to understand the wealth status difference among the better off, less poor and poor households in the study area. Because understanding wealth status of the household plays a vital role to clearly indentifying the reasons for why farm households need to diversify, who are diversifying their livelihood activities and why the others, and to know the crucial role of wealth played for smallholder farmers to choose and adopt certain livelihood diversification strategies and assess its implication on improving households income.

Farmers in the study area have their own relative community based wealth grouping criterion. For instance, the better-off households are those who are more food secure at least for ten months and above, own greater than 0.5 ha of farm land, have access to irrigation, better annual income and diverse sources of income (e.g. get regular remittance income that can be used for economic resilience to drought). They have also access to market centre, have collateral capacity to access credit from relatives and formal saving and credit institutions, have strong social network or bond with different groups of people, able to save money in bank, own more than eight tropical livestock unit (TLU), own basic farm equipments, own quality house with permanent roofing (stone walled and zinc sheeting roofed house). In addition, they also own valuable household assets like TV, radio, bed, sofa, wives wear gold made jewellery weighing more than

45 gram, have access to electric city, have access to public clinic centres, able to send both their boys and girls above five years to school, have family members who have successfully completed their education and got employed; and have large size productive household members who can participate in diversified livelihood strategies.

On the other hand, the less poor households are those who are moderately food secure at least for six months, own less than 0.5 ha of farm land, have no access to irrigation, less annual income and diverse sources of income (e.g. do not receive remittance income regularly that can be used for economic resilience to drought). In addition to this, they have limited access to market centre, have no collateral capacity to access credit from formal saving and credit institutions, and have poor social network or bond with different groups of people. Furthermore, less poor farmers were unable to save money in bank, own at least 4 tropical livestock unit (TLU) including oxen, own basic farm equipments, own stone walled and wood with soil roofed house), own household assets like radio but no bed, sofa, and their wives do not wear a gold-made jewellery. Besides, they have no access to electricity, have little access to public clinic centres, highly illiterate, unable to send all their sons and girls above five years equally to school, and may have family members who have successfully completed their education and but unemployed; and have large-sized dependent household members and participate in temporary, low return and unskilled labour based diversified livelihood strategies. They also have a serious lack of initial capital and business skills.

The poor households share all the characteristics of the less poor but differ in some points. Here, the poor are characterized by severe food insecurity and can only feed themselves for only less than 4 months at good production season. They are confronted with regular seasonal and transitional period of stress due to drought and low harvest, lack of rural job opportunities, have very limited access to protein and vitamin foods e.g. meat and forced to reduce the quantity and quality of their food type and meal frequency consumption. It is also clear the life of the poor household is regularly dependent on productive safety net program and emergency food aid programmes. Let alone to save many almost all they do not even have a personal bank account. They are people forced to diversify their livelihood income primarily for their survival and own less than 2 tropical livestock unit (TLU) and have less than 0.35 ha of farm-land and forced to reduce the quantity and quality of their food type and meal frequency consumption. It is also clear the life of the poor household is regularly dependent on productive safety net and emergency food aid programmes. Most of them do not even have accounts with any bank, let alone saving money in the banks. They are people forced to diversify their livelihood income primarily for their survival. In all, it does not mean all the better off households are food secure. It is only relative comparison among the

Table 1. Percentage distribution of households' livelihood diversification choices by their community based wealth status.

Livelihood diversification strategies	Relative wealth category, N=485			Total n (%)	Chi-square
	Better off	Less poor	Poor		
On-farm only	12	22	48	82 (16.9)	28.129***
On-farm + Off-farm	16	20	20	56 (11.5)	
On-farm + Non-farm	78	113	99	290 (59.8)	
On-farm + Off-farm + Non-farm	24	22	11	57 (11.8)	
Total	130 (26.8)	177 (36.5)	178 (36.7)	485 (100)	

***Indicates significant at less than 1% probability level.

Source: Field survey (2017).

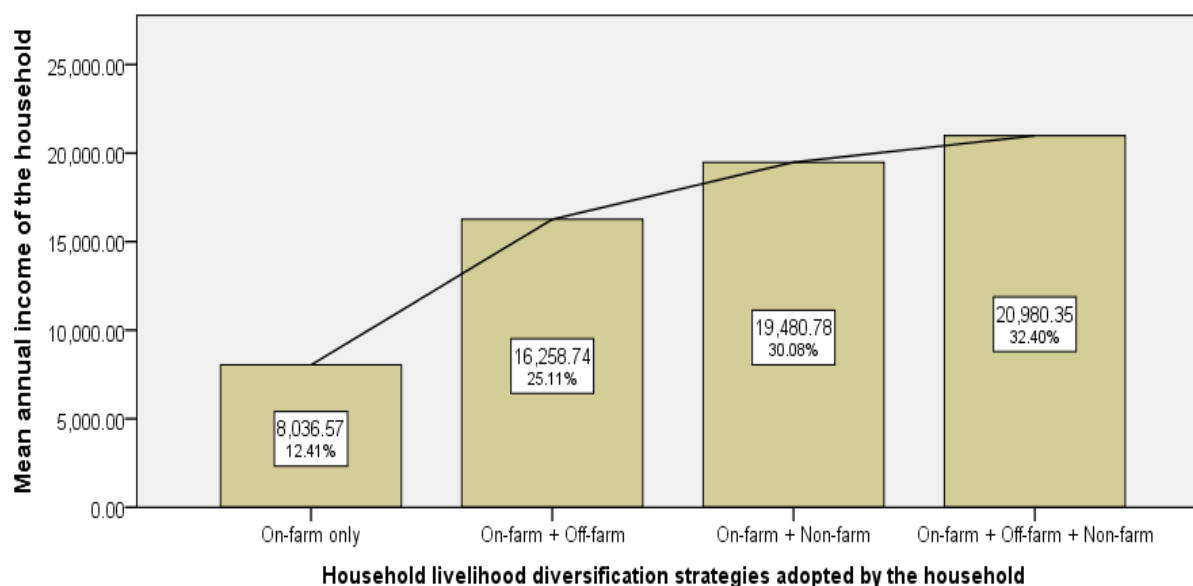


Figure 1. Household livelihood diversification and mean annual income.

people made by the community based wealth criterion to know household asset ownership and status. Otherwise, the majority of the households are poor, food insecure and dependent on external support for their survival and will continue being dependent unless sustainable measures are taken. Moreover, using the aforementioned community based relative wealth criterion, better off (n=130), less poor (n=177) and poor (n=178) sample households were selected for the purpose of this study.

Rural household livelihood diversification strategies

The study found out that about 1.5, 59.8 and 11.8% of the sample households were able to diversify into on-farm + off-farm, on-farm + non-farm and combination of on-farm + off-farm + non-farm income generating livelihood strategies, respectively (Table 1). Whereas 16.9% of the sample households were unable to diversify their livelihoods, often lacking the means to engage in any

form of income generating activity aside agriculture.

Consistent with this, households' livelihood diversification strategy has been strong bond with income. The sample households receive mean annual income of ETB 8036 from on-farm income alone, ETB 16258 from on-farm + off-farm income, ETB 19480 from on-farm + non-farm and ETB 20980 from combined usage of on-farm + off-farm + nonfarm income livelihood strategies (Figure 1).

The result confirmed that households who diversify their livelihood strategies into on-farm + off-farm + non-farm income sources get more than two fold of the households who are only dependent on agricultural income and 25% better than households who used on-farm + off-farm livelihood activities. This is an indication of the more you diversify out of farming the better income you again. Therefore, the aim of livelihood income diversification can be either a deliberate household strategy to smooth income or to manage risks, or it may be as a response to opportunity by the existence of

Table 2. Reasons for household livelihood diversification strategies.

Livelihood diversification strategy	Frequency	Percentage
Limited agricultural income	170	35.1
Large family	14	2.9
Availability of non-farm income generating activities	33	6.8
Seasonable nature of agricultural produces	67	13.8
Favourable demand for goods and services	17	3.5
To live well/better life	19	3.9
Limited agricultural income and large family	59	12.2
Limited agricultural income, large family and availability of non-farm job opportunities	75	15.5
Availability of non-farm opportunities and seasonal nature of agricultural produces	31	6.4
Total (%)	485	100

Source: Own survey result (2017).

diversification options (FAO, 2015). However, household livelihood diversification is dependent on households' ownership of the particular asset and the value of assets they owned. It also depends on the prioritized objectives they need to achieve.

Reasons for household livelihood diversification

The survey result depicted that of the total sample households interviewed, limited agricultural income (35.1%), existence of large family size (2.9%), availability of non-farm income generating activities nearby (13.8%), seasonable nature of agricultural produces (12.2%), favourable demand for goods and services (6.8%), to live well (6.4%), limited agricultural income and large family (3.9%), limited agricultural income, large family and availability of non-farm opportunities (15.5%), and availability of non-farm opportunities and seasonal nature of agricultural products (2.9) were the major reasons for livelihood diversification strategies in the study area (Table 2). This clearly showed that some few households participate in different livelihood diversification strategies besides agriculture to get rich shortly and live well whereas the other majority households are forced to diversify to fulfil their basic human needs for their survival. As shown in Table 2, majority (35.1%) indicated that limited agricultural income as the key reason for livelihood diversification and of course the combined limited agricultural income, large family and availability of non-farm job opportunities with limited agricultural income and large family are the factors for diversification next to limited agricultural income.

This clearly shows that the main objective of diversification into off-farm and non-farm income livelihood diversification strategies in the study area is therefore primarily for survival, reducing climatic related risks like drought, looking for additional money to cover family expenditure like educational fee whereas the primary objective of the very few relatively wealthier

smallholder farmers is for wealth accumulation and better living. Therefore, smallholder farmer's livelihood diversification is a matter of life or death for many of the households in the study area. It is very difficult for them to live depending on agricultural income alone unless they can diversify into off-farm and non-farm income sources.

It was underlined that high illiteracy rate, lack of working capital, lack of entrepreneurship skill, poor social cooperatives, limited access to irrigation, water scarcity due to drought, and poor rural road expansion were mentioned as the bottlenecks of livelihood diversification strategies for the farm households (Table 2). For instance, access to irrigation can guarantee farmers livelihood income during bad season by increasing the cropping frequency from one to two or three times a year. Besides, it can also help farmers to switch from low to high value production and get more income and build good livelihood asset which is very important to attain sustainable livelihood and motivated to diversify into non-farm activities. However, farm households have limited access to small irrigation due to less effort made by the government on irrigation.

Rural households have many reasons for livelihood diversification. Some of the households need to diversify their livelihood strategies because manmade and natural factors push them to diversify for the purpose of their survival. On the other hand, some few farmers need to diversify into off-farm and non-farm livelihood activities basically for the purpose of more wealth accumulation.

Households income composition by relative community based wealth category

The household survey result revealed that 26.8, 36.5 and 36.7% of the sample households were found better off, less poor and poor, respectively (Table 3). Based on the relative community based wealth category, the better off households receive a mean annual income of Ethiopian Birr (ETB; equivalent to 22.4 USD) 14663.15 with a

Table 3. Households' annual income composition by community based wealth category.

Income composition by wealth category		N	Mean	Std. Dev.	Min.	Max.	F-Value
On-farm total income	Better off	130	14663.15	22552.977	0.0	216880.0	9.351***
	Middle	177	9485.52	6562.047	0.0	33620.0	
	Poor	178	6783.44	6025.719	0.0	42400.0	
Off-farm total income	Better off	130	2615.59	4113.457	0.0	29880.0	5.502***
	Middle	177	1964.38	2667.309	0.0	9900.0	
	Poor	178	1552.30	2225.076	0.0	9900.0	
Non-farm total income	Better off	130	10297.92	28036.765	0.0	251000.0	9.655***
	Middle	177	4853.08	7467.809	0.0	76000.0	
	Poor	178	2586.74	4138.700	0.0	25000.0	
Total annual Income	Better off	130	26075.20	31055.447	1600.0	263500.0	2.623*
	Middle	177	17405.73	17942.088	2800.0	216880.0	
	Poor	178	10922.49	7888.357	800.0	45600.0	
	Total	485	17350.09	20796.912	800.0	263500.0	

* and ***Indicate significance at less than 10 and 1% probability level.
Source: Own Survey Result (2017).

minimum of no income and maximum of ETB 216880 from on-farm activities (Table 1). Similarly, the less poor households receive a mean annual income of ETB 9485.52 with a minimum of no income and a maximum income of ETB 33620 from on-farm activities while the poor households gain ETB 6783.44 with no minimum income and maximum of ETB 42400 (Table 3). The fact is that very few households were unable to get income from on-farm activities because they have no own farmland and livestock. The statistical analysis also showed the existence of significant income difference among the poor, less poor and better off households. For instance, the mean annual income of the better off households from on-farm activities is more than two fold of the poor household income.

On the other hand, the mean annual income of the better off households from off-farm activities was ETB 2615.59 with a minimum of no income and maximum of ETB 29880. Whereas the annual mean income of the less poor from off-farm was 1964.38 with a minimum of no income and maximum of ETB 990. Similarly, the poor household's annual mean income from off-farm was ETB 1552.30 with no minimum income and a maximum of ETB 990. The statistical analysis also confirms that there is a significant income difference among the poor, less poor and better of households. The better off households are the ones who get a better income. Furthermore, the non-farm mean annual income of the better off, less poor and poor households was ETB 10297.92, ETB 4853.08 and ETB 2586.74, respectively. The maximum non-farm income of the better off was ETB 251000, the less poor ETB 76000, and the poor ETB 25000 with a minimum of no income for all the three wealth categories (Table 3).

Moreover, the overall on-farm plus off-farm plus non-farm annual income of the better off, less poor and poor households were ETB 26075.20, ETB 17405.73 and ETB 10922.49, respectively. It was also clearly shown that the maximum total annual income of the better off was ETB 263500, the less poor ETB 216880 and the poor ETB 45600. Here, the survey result revealed that the overall mean annual income of the households was ETB 17350.09 with a total minimum annual income of ETB 800 and a maximum annual income of ETB 263500 (Table 3). The better off households were the most dominant relative wealth category of the households who receive the highest annual income from the three broad livelihood diversification strategies. Of note is that the better-off households have greater freedom to choose and combine diverse range of livelihood strategies and are able to earn better income than the poor and less poor households. It is also true that the poor smallholder farmers meanwhile has little choice but observed to diversify their income sources out of farming into temporary, low return and unskilled labour based off-farm and non-farm income activities in order to cope with drought associated risks, seasonality and other adverse factors in agriculture.

Implication of livelihood diversification strategies on smallholder farmer's income

Result of the survey depicted that the mean annual income per household head earned by the sample respondents from crop production was about Ethiopian Birr (ETB) 570. It also revealed that sample households

Table 4. Annual income composition of sample households by livelihood diversification strategies.

Annual income composition of sample households	Y=1, n=82	Y=2, n=56	Y=3, n=290	Y= 4, n=57	Total, N=485	Min.	Max.	F-value (Sig.)
	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)			
Crop farm	4071.04 (3175.989)	5407.59 (6121.742)	6523.55 (14388.404)	4568.07 (3030.931)	570.23 (11473.477)	0.0	39500.0	1.245 ^{ns}
Irrigation	445.12 (1567.427)	1680.36 (4016.621)	1032.30 (4046.682)	615.79 (1419.858)	958.90 (3518.209)	0.0	48250.0	1.597 ^{ns}
Selling ripped fruit of Cactus	408.54 (1864.430)	775.00 (1574.946)	259.17 (1671.408)	332.14 (1040.298)	352.80 (1639.036)	0.0	25000.0	1.593 ^{ns}
Livestock live sale	2084.02 (3981.763)	3255.00 (3922.113)	3539.22 (4567.330)	2154.91 (2621.320)	3097.68 (4248.625)	0.0	37000.0	3.619 ^{**}
Livestock product sale	356.34 (730.372)	1363.04 (2596.475)	1027.57 (2014.350)	1716.09 (3715.852)	1033.74 (2240.740)	0.0	27040.0	4.773 ^{***}
On-farm Subtotal	6511.40 (5946.40)	10025.63 (10202.89)	11090.35 (15824.54)	8439.07 (5814.74)	9881.64 (13199.68)	0.0	216880.0	2.854 ^{**}
Overall on-farm share (%)	-	-	-	-	56.95%	-	-	-
Sales of fire wood/charcoal	0.00 (0.00)	3.57 (26.726)	116.89 (1766.642)	35.09 (264.907)	74.39 (1369.148)	0.0	8000.0	.238 ^{ns}
Rent of land & pack animals	38.83 (264.020)	177.86 (717.447)	202.76 (894.404)	21.05 (158.944)	150.81 (746.023)	0.0	2184.0	1.691 ^{ns}
Agri. Wage labour	401.71 (2123.157)	1368.79 (2529.469)	19.31 (241.477)	341.81 (1055.436)	277.68 (1351.220)	0.0	16800.0	17.623 ^{***}
Project (Emergency) food aid	0.00 (0.00)	796.16 (1692.158)	622.39 (1584.139)	1011.93 (2074.429)	584.13 (1552.814)	0.0	8800.0	5.840 ^{***}
Programme (PSNP) food aid	122.68 (974.994)	1707.81 (2883.419)	493.31 (1425.707)	3158.60 (3420.761)	884.12 (2132.832)	0.0	12320.0	38.320 ^{***}
Selling local brewery (Sewa)	0.00 (0.00)	64.29 (481.070)	0.00 (0.00)	98.25 (741.738)	18.97 (302.009)	0.0	5600.0	2.236 [*]
Off-farm Subtotal	563.22 (2321.02)	4118.47 (3096.02)	1452.45 (2694.83)	4666.72 (2742.53)	1987.70 (3013.85)	0.0	29880.0	42.014 ^{***}
Overall off-farm share (%)	-	-	-	-	11.46%	-	-	-
Hand crafting	0.00 (0.00)	0.00 (0.00)	637.59 (6054.327)	562.28 (1677.857)	447.32 (4721.539)	0.0	100000.0	0.580 ^{ns}
Petty trading	365.85 (3312.946)	409.09 (1367.923)	1829.24 (16388.312)	766.32 (2556.077)	1294.75 (12804.25)	0.0	39500.0	0.431 ^{ns}
Remittance	502.44 (2863.175)	889.29 (3307.330)	2013.51 (5350.253)	3892.98 (4507.726)	1848.77 (4792.552)	0.0	40000.0	6.705 ^{***}
Construction work	93.6 (595.99)	384.29 (1436.945)	2334.241 (5680.172)	2040.00 (5054.189)	1695.69 (4838.083)	0.0	72000.0	6.353 ^{***}
Salary payment	0.00 (0.00)	139.29 (1042.319)	130.80 (1053.130)	612.98 (2314.681)	166.41 (1198.040)	0.0	12000.0	3.309 ^{**}
Non-farm Subtotal	961.95(4370.99)	2114.64 (4112.79)	6937.98 (19616.28)	7874.56 (5809.46)	5480.75 (15668.70)	0.0	100000.0	4.511 ^{***}
Overall non-farm share (%)	-	-	-	-	31.59%	-	-	-
Grand total	8036.57 (7663.03)	16258.74 (11199.49)	19480.78 (25196.75)	20980.35 (9405.62)	17350.09 (20796.91)	800.0	263500.0	7.410 ^{***}

*, **, ***Indicates significant at less than 10, 5 and 1% probability level while ^{ns} indicates insignificant, Y=1, Y=2, Y=3 and Y=4 represent on-farm income alone, on-farm + off-farm income, on-farm + non-farm income and on-farm + off-farm + non-farm income, respectively.

Source: Own Survey (2017).

earn an average annual in-come of ETB 612, ETB 332, ETB 2155, and ETB 1716 from irrigation, cactus fruit, livestock live sale, and livestock product sales, respectively. In the entire on-farm share mean annual income of the sample households their minimum income was zero and the maximums were ETB 39500, ETB 48250, ETB 25000, ETB37000 and ETB27040 from crop

production, irrigation, cactus, and livestock live sale and livestock product sale, respectively (Table 4). In addition to this, the annual mean income of households by income share of the broad on-farm livelihood strategies was ETB 9882.

It also indicated that households who participated in different on-farm income generating activities got much more income than those who

did not diversify. This is statistically significant at 5% level of significance and shows that even within farming diversification of income is an essential component of smallholder farmers' livelihood in the study area (Table 4).

Furthermore, except 82 (16.9%) of the sample households, all of them participated in diversified income generating livelihood strategies. The

particular off-farm income sources of sample household's were sales of fire wood/charcoal, rent of land and pack animals (e.g. Donkey and camel), agricultural wage labour, project (emergency food aid), programme (PSNP) food aid, and selling locally made drink like 'Sewa'. The survey data revealed that the mean annual income of the households across the four livelihood strategies from sales of fire wood/charcoal, rent of land and pack animals, agricultural wage labour, project (emergency food aid), productive safety net programme (PSNP) food aid, and selling local brewery like 'Sewa' off-farm livelihood strategies is ETB 74.39, ETB 151, ETB 278, ETB 584, ETB 884 and ETB 19, respectively (Table 4). Besides this, the annual mean income of households by income share of the broad off-farm livelihood strategies was ETB 1988. The results of the descriptive statistical analysis depicted that there is high income difference at less than 1% significance level among the sample households who participate in different off-farm livelihood strategies (Table 4). This clearly indicates existence of huge income variation among the households that emanates from livelihood diversification and its practices. It seems surprising to see some rural households who are exclusively dependent on on-farm income without getting any income from sale of fire wood and charcoal. Of the different off-farm income sources, sample households in the area get relatively the highest share of mean annual income from PSNP and project food aid than agricultural wage labour, sale of fire wood, rent of land and pack animals and sale of locally made drink 'sewa' and factory produced drinks beer.

In fact, agricultural households use non-farm income to diversify risk, minimize seasonal income fluctuation and finance agricultural input purchases and then to improve their livelihood. Result of the survey depicted that sample households get a mean annual income of ETB 447, ETB 1295, ETB 1849 and ETB 166 from hand crafting, petty trading, remittance, construction work and salary payment, respectively (Table 4). Of the non-farm income sources, the mean annual income shares from remittance, construction work and petty trading are relatively higher than the income share received from hand crafting and salary. The statistical analysis showed that there is a positive and significant income difference among the sample households who diversify their income to non-farm income at less than 1% significance level. The sample households also received a total mean annual income of ETB 5488 from non-farm income with a minimum income of zero and maximum income ETB 100000 (Table 4).

In line with this, the average total annual income of sample households rely their livelihood on on-farm, on-farm plus off-farm, and combination of on-farm plus off-farm plus non-farm comprises ETB 8036, ETB 16258, ETB 19480, and ETB 20980, respectively. And the total mean annual income of the sample households per one household head is ETB 17350 with a minimum of ETB

800 and maximum of ETB 263500. It means one household member of the sample respondents earns an approximate mean annual income of ETB 2892 per year since the average household size is 6. The standard deviation (20796.91) clearly indicated that there is high income difference among the households who diversify their means of livelihood income strategies and even between those who did not diversify (Table 4). Moreover, the mean annual income of the sample households by income share of the broad on-farm, off-farm and non-farm livelihood diversification strategies comprise ETB 9881.64 (56.95%), ETB 1987.70 (11.46%) and ETB 5480 (31.59%) of income from on-farm, off-farm and non-farm, respectively.

It was not surprising to see farm households in the study area forced to diversify their livelihood income sources beyond agricultural income. Because agriculture in the particular study area is subsistence in nature, land is fragmented, highly degraded and rain fed dependent and unable to absorb the growing population pressure. In addition, farm income was unable to provide sufficient means of survival in rural areas due to climatic variability and change associated risks such as drought coupled with limited farm-land and high population growth in the area. Accordingly, rural households in the area are forced to use off-farm and non-farm livelihood diversification strategies as survival option, earn better income and to improve their living standards from diverse allocation of their natural, physical, financial and human livelihood assets.

Despite the negligence of the non-farm sector by the government, its role on the livelihood of the majority of the rural farm household's income is enormous. For instance, the overall income contribution of household livelihood diversification strategies into off-farm + non-farm activities on the annual income of the household is 43%. This is consistent with findings of Bezabih et al. (2010) and Haggblade et al. (2010) who found that rural residents across the developing world earn 35 to 50% of their income from non-farm activities. Similar to this, empirical studies conducted in Ethiopia also found non-farm income accounts for as much as 40 to 45% of average household income (Bezabih et al., 2010; Kassie, 2017). The fact is that depending on the event and the wealth in capitals, the family may be able to build only agricultural portfolio or a combination of on-farm, off-farm and non-farm activities during times of stress and even at good seasons.

CONCLUSIONS AND RECOMMENDATIONS

The study concludes that smallholder farmers in the study district use diverse livelihood diversification strategies to achieve their prioritized livelihood objectives depending on their wealth status. The objective of the poor and less poor household's livelihood diversification

was primarily for survival, reducing drought associated risks, and to cover all family running costs. Whereas the objective of the few better off households was for wealth accumulation and better life. On the other hand, limited agricultural income due to severe drought and small farm size coupled with high population growth were found the most prioritized reasons for the smallholder farmers to diversify their livelihood income sources.

Furthermore, it was found that households in the study area have unevenly diversified sources of income. For instance, the overall on-farm + off-farm + non-farm annual income of the better off, less poor and poor households was ETB 26075.20, ETB 17405.73 and ETB 10922.49, respectively. In addition to this, all but 16.9% of the sample households were unable to diversify their livelihoods, often lacking the means to engage in any form of income generating activity aside from agriculture mainly livestock husbandry and crop production. Similarly, the mean annual income of the sample households by income share of the broad livelihood diversification strategies covers 56.95% on-farm income, 11.46% off-farm income and 31.59% non-farm income. It means off-farm + non-farm income contributes 43% to the total annual income share of the households. It should be noted that the relatively better off households have greater freedom to choose and combine among the diverse range of livelihood strategies and are able to earn better income than the poor and less poor households. It is also true of the sample households that the poor smallholder farmers meanwhile has little choice but observed to diversify their income sources out of farming into temporary, low return and unskilled labour based on off-farm and non-farm income activities in order to cope with drought associated risks, seasonality and other adverse factors in agriculture.

Moreover, despite the negligence of the non-farm sector by the government its role on the livelihood of the majority of the rural farm household's income is enormous. It helps them to build livelihood capitals and become less vulnerable to risks associated with climate changes than those who do not diversify their livelihood strategies. Hence, this paper concludes that in the context of unstable, drought prone, and poor agricultural income, limited farm-land, and high population growth environment, diversification of household livelihood strategies is a must and has positive implication on smallholder farmer's income and in minimizing risks and getting better livelihood. It is also difficult for smallholder farmers to live without external support depending on agricultural income alone unless they can diversify their income sources into off-farm and/or non-farm income activities. In fact, in the context of the study area, livelihood diversification is a matter of life and death for many of the smallholder farmers.

Therefore, more efforts are required from the government on facilitating and supporting livelihood diversification into off-farm and non-farm options via

providing enough credit and working place for petty traders and handcraft men and linking them with market rather than sticking on the drought vulnerable agricultural income alone. Moreover, much investment is needed on labour intensive factories that can attract more job opportunities for the landless and jobless youths as part of mitigation option to break illegal out-migration as a response to drought.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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REFERENCES

- Barrett BC, Reardon T, Webb P (2001). Non-farm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications. *Food Policy* 26:315-331.
- Bezabih M, Gebreegziabher Z, Gebremedhin L, Kohlin G (2010). Participation in Off-Farm Employment, Rainfall Patterns, and Rate of Time Preferences: The case of Ethiopia. *Environment for Development Discussion Paper Series, Efd DP 10-21*.
- Challinor AJ, Simelton ES, Fraser ED, Hemming D, Collins M (2010). Increased crop failure due to climate change: Assessing adaptation options using models and socio-economic data for wheat in China. *Environmental Research Letters* 5:1-8.
- CSA, Central Statistical Agency (2013). Central Statistical Agency Population Projection of Ethiopia for All Regions At Wereda Level from 2014-2017. Federal Democratic Republic of Ethiopia, Addis Ababa. <https://doi.org/10.1007/s13398-014-0173-7-2>
- Ellis F (2000). The Determinants of Rural Livelihood Diversification in Developing Countries. *Journal of Agricultural Economics* 51:289-302.
- Eshetu F, Mekonnen E (2016). Determinants of off-farm income diversification and its effect on rural household poverty in Gamo Gofa Zone , Southern Ethiopia. *Journal of Development and Agricultural Economics* 8:215-227.
- FAO, Food and Agriculture Organization (2015). Livelihood diversification and vulnerability to poverty in rural Malawi. In: (eds.), Asfaw S., McCarthy N., Paolantonio A., Cavatassi R., Amare M. and Lipper. *ESA Working Paper No. 15-02*. Rome.
- FDRE, Federal Democratic Republic of Ethiopia (2011). Federal Democratic Republic of Ethiopia Ministry of Agriculture: Agriculture Sector Programme of Plan on Adaptation to Climate Change, Addis Ababa.
- Gebru GW, Beyene F (2012). Rural household livelihood strategies in drought-prone areas: A case of Gulomekeda District, eastern zone of Tigray National Regional State, Ethiopia. *Journal of Development and Agricultural Economics* 4:158-168.
- Haggblade S, Hazell PBR, Reardon T (2010). Transforming the Rural Non-farm Economy: Opportunities and Threats in the Developing World. *American Journal of Agricultural Economics* 92:288-290.
- International Fund for Agricultural Development (IFAD) (2010). Rural Poverty 2011. New realities, new challenges: new opportunities for tomorrow's generation. International Fund for Agricultural Development (IFAD) 317 p. Rome, Italy.

Intergovernmental Panel on Climate Change (IPCC) (2012). Managing the risks of extreme events and disasters to advance climate change adaptation. A special report of Working Groups I and II of the Intergovernmental panel on climate change. Cambridge University Press, Cambridge, UK. 30(11):7575-7613.

Intergovernmental Panel on Climate Change (IPCC) (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II And III To The Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland 151 p.

Kassie WG (2017). The Nexus between livelihood diversification and farmland management strategies in rural Ethiopia. *Cogent Economics and Finance* 5:1-16.

Khatun D, Roy BC (2016). Rural Livelihood Diversification in West Bengal: Nature and Extent. *Agricultural Economics Research Review* 29:115-124.

Loison SA (2015). Rural Livelihood Diversification in Sub-Saharan Africa: A Literature Review. *Journal of Development Studies* 51:1125-1138.

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