

Comparative Analysis of the Productivity and Efficiency of Cluster and Individual Farming in East Shewa Zones of Oromia

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Abstracts
The main objective of this study was to compare the productivity and efficiency of clustered and individual farming; to identify factors affecting clusters farming practice and to know the view/perception of farmers for clustered farming approach in East Shewa zone. To conduct the study, primary data was collected from 215 randomly selected household heads through semi-structured questionnaire. Secondary data were also collected from different sources including CSA, ZOANR, DOANR, and from published and unpublished sources to supplement primary data. In this study both descriptive statistics and econometric analysis were employed. The primary data was analyzed using descriptive statistics and stochastic efficiency decomposition method to decompose TE. Stochastic Frontier approach (SFA) was used for its ability to distinguish inefficiency from deviations that are caused by factors beyond the control of farmers. The productivity of Maize per hectare was 46.42 and 25.982 quintal for cluster and individual farming respectively which is statically significant at 1% level. The productivity of Teff per hectare was 16.076 and 11.043 quintal for cluster and individual farming respectively which is statically significant at 5% level. The study result revealed that the mean of TE was about 70.22% and 64.64% of for teff and maize production respectively for cluster farming and 58.22% and 53.58% for teff and maize production respectively for individual farming as the Cobb-Douglas functional form indicate that. As the result of research analysis indicates that, the cumulative sum of farmers' perception towards the compatibility of cluster farming with the socio-economic situational circumstances was 4.093 suggesting farmers perceive positively that it was compatibility with their socio-economic situational circumstances. The likelihood of farmers to practice cluster farming positively influenced by cultivated land, access to extension, participation on field visit and perception of farmers in the zone. The study suggested that farmer adoption decisions are affected by above mentioned factors and policies addressing each decision process and cross-cutting issues are required to improve farmer participation in cluster farming. In addition, the study suggested the need for policies to discourage land fragmentation and promote education, extension visits, participation in field visit, and strengthening social network of farmers, increase wealth of farmers and changing farmer's perception towards cluster farming to increase participation of farmers in cluster farming in both zones.
Keywords: Cluster and Individual farming, Productivity, Technical efficiency, Stochastic Frontier approach, and probit model.
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1. INTRODUCTION

1.1. Background and Justification

Ethiopia is one of the fastest growing non-oil economy countries in Africa. The country is heavily reliant on agriculture as a main source of employment, income and food security for a vast majority of its population. In GTP-II period, agriculture will remain the main driver of the rapid and inclusive economic growth and development. It is also expected to be the main source of growth for the modern productive sectors. Therefore, besides promoting the productivity and quality of staple food crops production, special attention will also be given to high value crops, industrial inputs and export commodities (NPC, 2016).

Agriculture is the foundation for Ethiopian economy, and the overall economic growth of the country is highly linked to the success of the agriculture sector. Agriculture accounts for about 36% of the country's Gross Domestic Product (GDP) in 2018.Our country has undertaken various measures to improve food security situation of the rural community. One of the strategies that the country has undertaken to reduce food insecurity and enhance rural development in the rural area is the establishment and strengthening agricultural clusters.

Agriculture is the backbone of Ethiopia's economy. It contributes 36.2 percent of the country's gross domestic product (GDP) and 72.7 percent of employment and 70 percent of export earnings (Getachew, *et al.*, 2018).

Vegetables are sources of vitamins, minerals and income for those involved in production and marketing (Reddy and Kanna, 2016). According to Degafe (2013), Ethiopia has a good potential for the production of high-value export vegetable product. The vegetable production ranges from home gardening, smallholder farming to commercial farms (ATA, 2014). Ethiopia has comparative advantage in vegetables production due to suitable and favorable climate and cheap labor (EIA, 2012). Vegetables are grown by commercial farms and small-scale farmers for food and market since vegetables have a huge domestic market in Ethiopia (EHDA, 2011 and Mebrat, 2014).

Along the same line, lately the Government of Ethiopia has started to implement a cluster-based approach to agricultural development, which holds an impressive potential for transformation. By providing an innovative contribution to the definition of the Ethiopian way to agrarian transformation, the analysis of the cluster-based initiatives provides insights into: the peasantry's changing role in fostering development and structural transformation, the leverage of historical legacies and international influences on the adoption and implementation of the strategy, the developmental state's practice and state-peasant relation (Marcell, 2018).

The country industrial strategy necessitates the establishment of industrial zones for agro-processing industries. Agro-industry can link up or integrate the agricultural sector which is the source of livelihood for the majority of Ethiopians. It can also create sustainable market link by establishing Rural Transformation Centers (RTC) that can improve production and productivity. One of the objectives of GTP-II is establishing Integrated Agro-industrial Parks (IAIPs) to link up the agricultural sector and add value to basic agricultural products (Abiy, 2016).

Agricultural transformation in Ethiopia is deeply embedded in these global trends: the government-led process is mainly outward-oriented and aimed at integrating agro-industrial value chains to spur the conversion of the country into a global leader in manufacturing goods by 2025.One of the most significant strategies designed to achieve this goal is the agglomeration of agricultural and industrial producers into poles, hubs, or clusters, in order to benefit from the service-delivery concentration. The main importance of clustered farming is to transform substance agricultural production in to commercialized and mechanized farming.

The term "cluster farming" usually refers to agglomeration of producer farmers engaged in similar and/or related activities. The production of small scale or individual farming was mainly not demand driven, commercial and mechanized but it was based on producers need for consumption only which is low productivity. Productivity is the output produced per unit of resource used, and it is accordingly a measure of the efficiency with which producers use available resources. Productivity measures are at the core of the discussion of the impact of *reforms* in transition countries, as efficiency improvement was the main motivation for the transformation of agriculture.

National Framework for Agriculture Commercialization Clusters in Ethiopia announced that 21 clusters and 12 commodity types had been chosen, and this information was confirmed by Zegeye Teklu in July 2016. Each cluster is expected to have one primary commodity, and one or two additional rotation crops. The 2011-15 progress report announced the designation of 31 and that an additional 16 were in the works for interventions during 2015 (ATA 2016). The most recent official paper reported that 26 clusters and 10 commodities had been selected, but since a federal strategy has been issued for only 7 commodities, just 14 clusters are being implemented (ATA 2017).

Nine clusters over 114 woreda and 10 commodities have been picked out in the Oromia Region, amounting to a targeted total of 4.6 million hectares and 1.3 million farmers. In 2015-16, five clusters and commodities were given top priority: the maize cluster in the Horro Guduru Wellega, East Wellega, and West Shewa areas; Malt barley cluster in the Arsi and West Arsi areas; Bread wheat cluster in the Arsi, West Arsi and Bale areas; Durum wheat cluster in the Bale area; Teff cluster in the West Shewa, East Shewa (where the Bulbula Park is located), South West Shewa areas (ATA 2017). Out of a total of 739,727 ha of land that had been allocated to these five clusters, 134, 235 ha is the actual surface that they occupy, as reported by the MoANR in August 2016. Oromia apparently reported the highest results for the period: the clusters supplied around;700,000 qt of crops (durum wheat and malt barley) to agro-industries such as the Asela Malt Factory; 800,000 qt of bread wheat have been channeled to the EGTE through unions; five unions delivered 130,000 qt of maize grain to the WFP, the Mama Injera and Consumer Association in Addis Ababa, and other buyers through contractual agreements (ATA 2017).

In general clustered farming or medium farming has the advantage over small scale farming or individual farming on; *economies of scale* of crop cultivation, generate better marketable surplus, release of workers for industries because of since its mechanized farming nature, credit worthiness, administrative convenience, social arguments and technological transfer. Meanwhile the report of ATA indicates only the clustered farming returns greater productivity than individual farming but their efficiency of comparative advantage and partial analysis for each individual input (i.e. output/land and output/labor) was not done suggesting as there is dearth of current information. In addition factors that influence farmers' decision to practice cluster farming, and their needs were not conducted.

Agricultural commercialization clusters (ACC) strategies predominantly featured by; top-down, output-oriented and control-biased characters of the political practice carried out by the numerous local administration structures, and may lead to capital expropriation, a bad attitude towards work, vulnerability, dependence, offfarm activity reduction, and other negative consequences.

There are no previous studies conducted in the area regarding the importance of cluster farming and factors affecting its practice by farmers and its comparative advantage over individual farming. This study, therefore, aims at identifying factors affecting cluster farming practice by farmers and its importance over individual farming. So, the study aimed to fill the above knowledge gap.

1.2. Objective of the Study

- ✓ To compare the productivity and efficiency of clustered and individual farming
- ✓ To know the perception of farmers for clustered farming approach in the study area.
- ✓ To identify factors affecting clusters farming practice in East Shoa zones

1.3. Expected Output

- ✓ The productivity and efficiency of clustered and individual farming identified;
- ✓ Farmers perception towards clustered farming approach identified
- ✓ Factors affecting clusters farming practice in the study area identified

2. Research Methodology

2.1. Description of the Study Area

These studies were conducted in selected districts of East Shewa Zone. East Shewa Zone lies between 60 00' N to 70 35'N and 380 00'E to 400 00'E. This zone is bordered on the South by the West Arsi Zone, on the Southwest by the Southern Nations, Nationalities and Peoples Region, on the West by South west Shewa Zone, on the Northwest by North Shewa, and on the Southeast by Arsi Zone. Adama city is the capital city of East Shewa Zone and located at 100 km from Addis Ababa/Finfinne towards South–East direction.

East Shewa Zone has different agro-ecologies which categorized as highland, midland and lowland agro-ecologies. In the Zone, 18.70% of the agro-ecology is high land, 27.50% is midland and 53.80% is lowland. The total population in the Zone was1,275,645 of which 53.26% are male and 46.74% are female. It receives 350mm-1150 mm annual rain fall and has uni-modal nature of rain fall pattern. This Zone also receives 12^{o}C-39^{o}C annual temperature per year (ZoARD, 2016).

The Zone has a total of 971,159.21 hectare of land. From the total land, 12.57% is arable land, 47.31% is cultivated land, 4.18% forest land, 14.58% grazing land, 4.89% is used for construction and 12.82% is used for other purposes (ZoARD, 2016).

2.2. Data types, sources and methods of data collection

Both primary and secondary data were used for this study. Primary data generated through cross-sectional survey during 2020/21 production season using semi-structured questionnaire, key informant interviews, and focus-group discussions. The questionnaire were designed and pre-tested in the field for its validity and content, and to make overall improvement of the same and in line with the objectives of the study. To complement the primary data, secondary data were collected from both government and Non-Government Organizations (NGOs). The major sources of secondary data was from both published materials and online resources such as CSA, ATA, FAO data base and East shoa zone agriculture office.

2.3. Sampling procedure and sample size

Another criteria required of the households is that they have to grow similar crop i.e. maize and Teff in the zone at least once during the last five years. This is crucial since member homogeneity is the prerequisite for successful cooperation (Hansmann, 2000). The respondents sample selection was focuses on households who have expressed willingness to be part of an agricultural clustered farming without any government intervention.
Two-stage sampling techniques were employed for this study.
1st households stratified into members and non-members of clustered agricultural farming and
2nd from each stratum equal proportion of sample respondents were selected by using simple random sampling techniques. In general a total of **215** sample respondents were selected from the zones.

2.4. Methods of Data Analysis

Both descriptive and inferential statistics was used to analyze the data. Descriptive statistical tools such as average, ratios, percentages, frequencies, etc. were applied to describe household and farming characteristics of the study areas. While inferential statistical such as $\chi 2$, and t-tests will be used to compare households in the two groups in terms of household farming characteristics. Both partial and total factor productivity was used, in addition technical efficiency which is often used to evaluate farm performance was also applied. Factors affecting clustered farming practice and the view of farmers for clustered farming approach was modeled using a two-limit probit model.

Selection of Production Function

The limitation of SFM is to pre-determine a functional form and assume the distribution for technical inefficiency (half-normal, gamma, truncated and exponential) for the evaluation of technical inefficiency. Among the possible algebraic forms of production function, Cobb-Douglas and trans log functions have been the most popularly used models in the most empirical studies of agricultural production analysis. A number of researcher stated that Cobb-Douglas functional form has advantages over the other functional forms in that it provides a comparison between adequate fit of the data and computational feasibility. It is also convenient in interpreting elasticity of production and it solves problems with respect to degrees of freedom. According to Coelli (1995), the Cobb-Douglas functional form has most attractive feature which is its simplicity. But, the Cobb-Douglas functional form imposes severe restriction on the technology by restricting the production elasticity to be constant and the elasticity of input substitution to be unity. Likewise, translog production function imposes no restrictions upon returns to scale or substitution possibilities. However, the function is more complicated to estimate having serious estimation problems. A among these estimation problems, if number of variable inputs adding, the number of parameters to be estimated raise rapidly and also additional terms require cross products of input variables, thus, making a serious multicolinearity and degrees of freedom problems. Even through, Cobb-Douglas production function assumes unitary elasticity of substitution and constant production elasticity; it has adequate representation of technology and insignificant impact on measurement of efficiency (Coelli et al., 2005).

3. Results and Discussion

3.1. Descriptive Analysis for East Shewa Zone

The most dominant crop produced by farmer in East Shewa zone was maize and teff which accounts for 60 and 42.86% respectively by cluster. Analysis of the member of cluster farming practice result showed that from the total 215 sampled households head, 49.30% were member of cluster farming with 3.23 year experience.

Table 1: Member of cluster farming in East Shewa zone

Are you member of cluster farming?	Freq.	Percent	**Remark**
No	109	50.70	
Yes	106	49.30	
Total	215	100	

Source: Survey result of 2020/21

3.2. Demographic characteristics of sampled households for East Shewa zone

Average age of the overall sampled respondent was found to be 41.82 years. Average age of sample respondents of member of cluster and non-cluster farming was 43.13 and 40.55 years old respectively. The average age of the sample households during the survey period, was about 41.82 years having farming experience 23.15 years which was less than 65.97 year of average life expectancy for both sex in Ethiopia (WPP, 2017). Based on Strock et al., 1991 (as cited in Ermiyas ,2013) this average value of age included in the most economically active age group of 17-50 year. Independent sample t test result shows that no statistically significant mean difference between two group farmers in terms of age indicating absence of association of membership decision of cluster farming and age of sampled respondent households.

The average education level of literate sample household heads during survey period was about 6.4 years with the minimum of zero years (illiterate) and maximum of 12 years. Family size plays an important role in crop production and most farmers depend mainly on family labor. The average family size of the sample households was 6 persons per household (table 2) which is greater than 4.6 persons per household as Ethiopia, based on household size and composition around the world in 2017.

Cultivated farmland was calculated as a sum of owned land, rented-in and shared-in farm land less shared-out farm. It is an effective farm land amount used by sample households to undertake agricultural production. Sample households were found to hold a mean of 1.44 ha of cultivated land in the survey year from total land holding of 1.92ha. Member of cluster and non-cluster farmers held a mean of 1.725 and 1.167 ha respectively. An independent sample t-test comparison also showed that member of cluster farming farmers have superior to non-cluster in terms of their cultivated land holding at 1% probability level. This finding is in line with other study results such as (Ermias, 2013).

On average, sample household owned livestock of 6.345 TLU. This indicates that the farming system in Ethiopia is mainly based on plough by animal draught power that has created complementarity between crop and livestock production (Table 11).

In general independent sample t test result indicates that there were no significant difference between member of cluster and non-cluster farmers of farming practice in terms age, farm experience and educational level in study area (Table 2), implying the absence of significant relationship of above listed variables with membership decision of cluster farming.

Table 2: Socio-demographic characteristics for East Shewa zone

Demographic characteristics	Cluster member (n=106)		Individual (n=109)		Total Sample (n=215)		t-value
	Mean	Std. Dev	Mean	Std. Dev.	Mean	Std. Dev	
Age of HH head	43.132	13.22	40.5505	11.29	41.823	12.3215	-1.5409
Farm Experience	24.198	12.902	22.1376	11.587	23.1535	12.268	-1.2327
Family size	7	3.21	6	2.7185	6**	2.9988	-2.2253
TLU	7.189	3.5107	5.5312	3.023	6.3488***	3.369	-3.7152
Grade level	6.536	2.6489	6.3151	2.8523	6.4323	2.7398	-0.5012
Land cultivated	1.725	0.9958	1.166	.8314	1.442***	.9559	-4.4726
Total land holding	2.251	1.3386	1.6058	1.0915	1.924***	1.2590	-3.8802

Source: Survey result of 2020/21

3.3. Productivity of Maize and Teff in cluster and individual farming in East Shewa zone

There was variability in technical inputs and output among maize and teff producing farmers (Table 3). Land, fertilizer, labor, seed, and chemical were included in production function to produce maize and teff output. This is economic process of producing output from these inputs or uses resources to create output that are suitable for users. The productivity of Maize per hectare was 46.42 and 25.982 quintal for cluster and individual farming respectively which is statically significant at 1% level. The productivity of Teff per hectare was 16.076 and 11.043 quintal for cluster and individual farming respectively which is statically significant at 5% level.

Table 3: Productivity of maize and teff in cluster and individual farming in east Shewa zone

Commodity Productivity/ha	Cluster	Individual	t-value
Productivity-Maize/quintal	46.422	25.982	10.73***
Productivity-Teff/quintal	16.076	11.0431	-2.2719**

Source: Survey result of 2020/21

3.4. Estimated Teff stochastic production function for cluster and individual farming

The appropriateness of the stochastic frontier model over the convectional production function can be tested using the statistical significance of the Stochastic Production Frontier Ordinary Least Square parameter gamma, Ý. The estimated value of gamma is equal to 0.98 for individual farming which is statistically significant at 1% level of significance suggesting that 98% of the variation in output is due to the variation in technical inefficiency among the farmers whereas the remaining 2% of variation in output is due to the random shocks.

The coefficients of the production function are interpreted as elasticity. The highest coefficient of output to seed (0.30) following fertilizer (0.24) in cluster farming whereas its 0.6 and 0.44 for fertilizer and seed in individual farming suggesting that seed and fertilizer are the main determinants of teff production in the study area. If there is a one percent increase in the amount of fertilizer would increase teff production by 0.24%, 0.60%, in cluster and individual farming respectively. The increase of these inputs were increase output of teff production significantly which similar to the returns to scale analysis can serve as a measure of total factor productivity and indicated that there is decreasing returns to scale. This implied that there was a potential for teff producer to continue to expand their production. In other words, a percent increase in all inputs proportionally would increase the total production by 0.62 in cluster farming whereas its 0.036 in individual farming.

The sum of the partial elasticity of all inputs for cluster and individual farming equals to 0.62 and 0.036% respectively. This means an increase in all inputs at the sample mean by one percent will increase teff output by 0.62% in cluster farming whereas it's by 0.036% in individual farming in the study area. This result was in line with Beyene, 2004 and Hussein, 2007, they argue that larger farmer is more likely to employ improved agricultural technologies, used as a capital base and enhances the risk bearing ability of farmers and hence could be more efficient than small farms due to its advantage of the economic scale and scope associated with larger sizes.

Table 4: Estimated Teff stochastic production function for cluster and individual farming

Variables	Cluster farming frontier		Variables	Individual farming frontier	
	ML estimate			ML estimate	
	Coefficient	Std.Err		Coefficient	Std.Err
Intercept	0.9538**	0.46555	**Intercept**	4.8496***	0.71353
Ln (land)	-0.03119	0.10891	***Ln (land)***	0.146035	0.3085
Ln (labour)	0.114345	0.10629	***Ln (labour)***	-0.2743*	0.1582
Ln (seed)	0.30083***	0.09092	***Ln (seed)***	-0.4375***	0.15736
Ln (fertilizer)	0.24207**	0.1008	***Ln (fertilizer)***	0.60037*	0.32155
	∑β= 0.62				**∑β= 0.036**
γ (gamma)	0.98***				
Log likelihood	-22.9078			***Log likelihood***	-44.567
LR test	0.7			***LR Test 0.34***	

Source: Survey result of 2020/21

3.5. Estimated Maize stochastic production function for cluster and individual farming

The appropriateness of the stochastic frontier model over the convectional production function can be tested using the statistical significance of the Stochastic Production Frontier Ordinary Least Square parameter gamma, Ý. The estimated value of gamma is equal to 0.97 for individual farming which is statistically significant at 1% level of significance suggesting that 97% of the variation in output is due to the variation in technical inefficiency among the farmers whereas the remaining 3% of variation in output is due to the random shocks.

The coefficients of the production function are interpreted as elasticity. The highest coefficient of output to fertilizer (0.63) following seed (0.092) in cluster farming whereas its 0.39 for land in individual farming suggesting that fertilizer, seed and land are the main determinants of maize production in the study area. If there is a one percent increase in the amount of fertilizer would increase maize production by 0.63%, in cluster farming whereas if there is one percent increase in the size of the land maize production would increase by 0.39 in individual farming. The increase of these inputs were increase output of maize production significantly which similar to the returns to scale analysis can serve as a measure of total factor productivity and indicated that there is increasing returns to scale. This implied that there was a potential for maize producer to continue to expand their production. In other words, a percent increase in all inputs proportionally would increase the total production by 0.767 in cluster farming whereas its 0.689 in individual farming.

The sum of the partial elasticity of all inputs for cluster and individual farming equals to 0.767 and 0.689% respectively. This means an increase in all inputs at the sample mean by one percent will increase maize output by 0.767 % in cluster farming whereas it's by 0.689 % in individual farming in the study area. This result was in line with Beyene, 2004 and Hussein, 2007, they argue that larger farmer is more likely to employ improved agricultural technologies, used as a capital base and enhances the risk bearing ability of farmers and hence could be more efficient than small farms due to its advantage of the economic scale and scope associated with larger sizes.

Table 5: Estimated Maize stochastic production function for cluster and individual farming

Variables	Cluster farming frontier		Variables	Individual farming frontier	
	ML estimate			ML estimate	
	Coefficient	Std.Err		Coefficient	Std.Err
Intercept	4.0782***	0.23229	**Intercept**	3.9189***	0.00016
Ln (land)	0.23414	0.21227	***Ln (land)***	0.3902***	0.00005
Ln (seed)	-0.09269**	0.04139	***Ln (seed)***	-1.13e-08	0.00005
Ln (fertilizer)	0.6341***	0.00936	***Ln (fertilizer)***	0.2999003	7.11e-06
	∑β= 0.767			**∑β= 0.689**	
γ (gamma)	0.99***				0.97***
Log likelihood	-15.20919				-28.8072
					8.83***
LR test	18.14***				

Source: Survey result of 2020/21

3.6. Estimation of Teff technical efficiencies of Cluster and individual farming smallholder farmers

The results of the efficiency scores indicate that there were wide ranges of differences in TE among teff and maize producer households. The result indicated that farmers in the study were relatively good TE in cluster farming than individual farming as presented in table below.

The study indicated that 70.32% and 58.22% were the mean levels of Technical Efficiency of cluster and individual farming respectively. This in turn implies that farmers can increase their cluster and individual farming productivity on average by 29.68% and 41.78% respectively at the existing level of inputs and current technology by operating at full technical efficient level. This result was in line with Beyene, 2004 and Hussein, 2007, they argue that larger farmer is more likely to employ improved agricultural technologies, used as a capital base and enhances the risk bearing ability of farmers and hence could be more efficient than small farms due to its advantage of the economic scale and scope associated with larger sizes.

Table 6: Estimation of Teff technical efficiencies of Cluster and individual farming smallholder farmers

Types of farming	Efficiency	Mean	St.dev.	Minimum	Maximum
Cluster	Technical Efficiency	0.7032	0.10388	0.3948	0.87514
Individual	Technical Efficiency	0.5822	0.18772	0.1800	0.860477

Source: Survey data, 2021

3.7. Estimation of Maize technical efficiencies of Cluster and individual farming smallholder farmers

The study indicated that 64.64% and 53.58% were the mean levels of Technical Efficiency of cluster and individual farming respectively. This in turn implies that farmers can increase their cluster and individual farming productivity on average by 35.36% and 46.42% respectively at the existing level of inputs and current technology by operating at full technical efficient level. There is huge gap among farmers in sample study which ranges 43.59% to 92.49% for cluster farming and 24.30% to 94.79% individual farming. This result needs to extension intervention by arrange experience sharing between farmers to reduce the efficiency gap. This result was in line with Beyene, 2004 and Hussein, 2007, they argue that larger farmer is more likely to employ improved agricultural technologies, used as a capital base and enhances the risk bearing ability of farmers and hence could be more efficient than small farms due to its advantage of the economic scale and scope associated with larger sizes.

Table 7: Estimation of Maize technical efficiencies of Cluster and individual farming smallholder farmers

Types of farming	Efficiency	Mean	St.dev.	Minimum	Maximum
Cluster	Technical Efficiency	0.64637	0.23327	0.139036	0.9999
Individual	Technical Efficiency	0.5358	0.2389	0.1324	0.9999

Source: Survey data, 2021

3.8. Analysis of maize and teff yield gap of cluster and individual farming

In the table 8 and 9, it was observed that the mean cluster and individual yield difference between sample farmer due to technical efficiency variation was 16.43 qt per ha and 12.056 qt per ha respectively for maize, whereas its 4.77 and 4.626 qt per ha for teff.

Table 8: Maize yield gap due to technical inefficiency of cluster and individual farming

Type of farming	Variable	Mean
Cluster	Actual qt per hectare	46.42
	TE (%)	0.646
	Potential qt per ha	62.85
	Yield gap (qt per ha)	16.43
Individual	Actual qt per hectare	25.982
	TE (%)	0.536
	Potential qt per ha	38.036
	Yield gap (qt per ha)	12.056

Survey Result, 2021

Table 9: Teff yield gap due to technical inefficiency of cluster and individual farming

Type of farming	Variable	Mean
Cluster	Actual qt per hectare	16.076
	TE (%)	0.703
	Potential qt per ha	20.85
	Yield gap (qt per ha)	4.77
Individual	Actual qt per hectare	11.043
	TE (%)	0.582
	Potential qt per ha	15.659
	Yield gap (qt per ha)	4.626

Source: Survey result of 2020/21

3.9. Perception of farmers regarding to compatibility of cluster farming in line with socio-economics circumstances and its advantage

Positive attitude towards compatibility of cluster farming is one of the factors that can speed up the change process. Positive attitude formation is also a prerequisite for behavioral change to occur. Therefore, it was hypothesized that favorable attitude towards compatibility of cluster farming positively influences the likelihood of farmers to practice cluster farming. This was measured using a summated rating (Likert) scale.

(Düvel, 1991) associates perceptions with the way the attributes of innovations are perceived and he distinguishes between (a) awareness of relative advantages, (b) awareness or concern of disadvantages, (c) the overall prominence or relative advantage of innovation (practice), and (d) the compatibility with situational circumstances. In this study, weighted average of individual positive (advantages) was calculated. As the result of research analysis indicate that, the cumulative sum of farmers perception towards the compatibility of cluster farming with the socio-economic situational circumstances was 4.093 suggesting farmers perceive farmers in cluster approach uses improved verities, working tougher, that result in productivity improvement and skill and knowledge improvement.

Table 10: Perception of farmers regarding to compatibility of cluster farming in line with socio-economics circumstances

Compatibility with your socio-economic circumstances	Freq.	Percent	Remark
Less compatible	6	2.79	The cumulative sum is 4.093 suggesting positive perception of cluster farming
Undecided	6	2.79	
Compatible	165	76.74	
Highly compatible	38	17.67	
Total	**215**	**100.00**	

3.10. Result of econometric model (Factors affecting farmers participation in cluster farming practice in East Shewa zone)

The VIF results for access to agricultural credit (Appendix Table 1) indicate that, there is no serious multicolinearity problem among the explanatory variables included in the model. In the model estimation, a robust estimation technique was used to correct for minor heteroscedasticity problems.

The probit regression model was used to analyze the smallholder farmers' cluster farming practices. The model chi square test indicates that the overall goodness-of-fit of the probit model was statistically significant at 1% probability level which in turn indicates the usefulness of the model to explain the relationship between the dependent and at least one independent variable. The result of probit model estimation shows that the factors affecting farmers cluster farming practices significantly influenced by cultivated land, access to extension, participation in field visit, and farmer's perception.

Table 11: Result of econometric model (Factors affecting farmers participation in cluster farming practice in East Shewa zone)

		Number of observation	= 215	
		LR $chi^2(13)$	= 52.45	
		Prob > chi2	= 0.0000	
Log likelihood = -122.78		Pseudo R2	= 0.1760	
Variables	**Coefficient**	**Std. Err.**	**P>z**	**Marginal effect**
Farm experience	0.0115	0.01246	0.358	0.0046
TLU	0.0419	0.03116	0.179	0.0167
Sex of HH	-0.4161	0.46967	0.376	-0.1659
Age of HH	0.0037	0.01237	0.765	0.00148
Cultivated land	0.8074**	0.35746	0.024	0.32186
Total land owned	-0.3023	0.27366	0.269	-0.12051
FTC distance	-0.0391	0.06579	0.553	-0.01557
Access to credit	0.10715	0.28212	0.704	0.04272
Access to extension	0.48819**	0.23553	0.038	0.19120
Market information	-0.0479	0.21176	0.821	-0.01908
cellphone	-0.1774	0.3100	0.567	-0.0707
participation on field visit	0.3495*	0.2137	0.100	0.1387
Perception of farmers	1.27625***	0.4241	0.003	0.4151
Constant	-1.7595	0.8431	0.037	

***, **,*: implies statistical significance at 1%, 5%, and 10% levels, Log pseudo likelihood = -122.781, Pseudo R^2 = 0.1760, Wald chi^2 (13) =52.45, Prob> chi^2 = 0.0000, Predicted probability = 0.485, N = 215.

Land cultivated: Consistent with *priori* expectation, the model result showed a positive and significant relationship between land cultivated and decision to practice cluster farming at less than 5% level of probability. This result implies that as the respondent's cultivated land increase by one hectare, their likelihood of practicing cluster farming would increase by 32.19%, keeping other factors constant. This result implies that as farmers focus more on crop production, s/he gives more attention for cluster farming than individual farming. The result would tell us status of cluster farming practicing among different sizes of land cultivated for crop production. It implies that larger farmers practice cluster farming more than small farmers land cultivated households. The result enhances the validity of an argument which states that larger area cultivated farmers are commercialized producers indicating cluster farming practice are more market demanded than individual farmers while small are subsistent producer. A possible explanation might be an increased commercial behavior of farmers' with an increase area of land cultivated. This is in line with the findings of (Mignouna *et al.,* 2011).

Access to extension service: Access to extension service was found to have a positive and significant influenced on farmers cluster farming practice at 5% level. This significance indicates that those farmers who have access to extension service practice cluster farming than individual farming producer. The result implies that access to extension service would increase farmers' cluster farming practice by 19.12% than others, keeping all other factors constant. They farmers who got the chance to more frequently visit by extension professionals are more efficient than their counter parts. Because it improves the technical knowhow and skill of the farmers thereby exchange of experience will improve the efficiency. This is in line with the findings of Abdulkadir (2015).

Participation in Field visit: As the model result revealed that, participation in different field visit had a positive impact on household's cluster farming practices at 10% level of statistical significance. This implies that the respondent's participation in field visit would increase the probability of household's cluster farming practices by about 13.87%, keeping other factors constant. The probable reason was that the respondent participation in field visit increase their awareness about technologies and create good network which increase practices of cluster farming. Participation in field visit assumes that farmers who have participated in different field visit are more likely to be aware of new practices as they are easily exposed to information. This implies those only participant farmers in different field visit exposure were more likely to practices cluster farming than non-participant farmers.

Perception of farmers: Perception of farmers on compatibility/advantage of cluster farming has positive and spastically significant at 1% level on probability of farmers cluster farming practice. Those farmers who have positive perception on compatibility of cluster farming practice practice cluster farming by 41.51% than others. (Düvel, 1991) associates perceptions with the way the attributes of innovations are perceived and he distinguishes between (a) awareness of relative advantages, (b) awareness or concern of disadvantages, (c) the overall prominence or relative advantage of innovation (practice), and (d) the compatibility with situational circumstances. In this study, weighted average of individual positive (advantages) and negative (disadvantages) were calculated and total advantage and disadvantage were calculated.

4. Summary, Conclusions and Recommendations

This chapter summarizes the whole findings of the study and makes conclusions based on the results of the descriptive and econometric model. It also highlights some important policy recommendations to enhance farmers' productivity and efficiency in cluster and individual farming practice.

4.1. Summary and Conclusions

The overall objective of this study was to compare the productivity and efficiency of clustered and individual farming and to identify factors affecting clusters farming practice in East Shoa zone. In the meantime knowing the view/perception of farmers for clustered farming approach in the study area was also the objective of this study. To conduct the study, primary data was collected from 215 randomly selected household heads through semi-structured questionnaire. Secondary data were also collected from different sources including CSA, ZOANR, DOANR, and from published and unpublished sources to supplement primary data. In this study both descriptive statistics and econometric analysis were employed. The primary data was analyzed using descriptive statistics and stochastic efficiency decomposition method to decompose TE. Stochastic Frontier approach (SFA) was used for its ability to distinguish inefficiency from deviations that are caused by factors beyond the control of farmers.

The descriptive analysis frequency and mean was used to analysis demographic characteristics of sample households.

The productivity of Maize per hectare was 46.42 and 25.982 quintal for cluster and individual farming respectively which is statically significant at 1% level. The productivity of Teff per hectare was 16.076 and 11.043 quintal for cluster and individual farming respectively which is statically significant at 5% level.

The study result revealed that the mean of TE was about 70.22% and 64.64% of for teff and maize production respectively for cluster farming and 58.22% and 53.58% for teff and maize production respectively for individual farming. The mean technical efficiency scores were quite high for Cluster farmers for all three commodities than individual farming, however, the results Show that there is still some considerable level of inefficiencies in the use of inputs for the corresponding output levels. The relatively high levels of technical efficiencies among the small scale farmers/individual defies the notion that maize and teff production in the zone can only be efficiently produced by the Cluster/large scale farmers. The relationship between farm size and efficiency is one of the more persistent puzzles in development economics, even more so as many potential determinants have been put forward and tested without being able to provide a fully satisfying explanation.

In general the findings from this study suggest that gains from improving technical efficiency exist in all farm categories but they appear to be much higher on large/cluster than on small farms/individual.

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The result of probit model revealed that, out of total 13 explanatory variables included in the model 4 (cultivated land, access to extension, participation on field visit and perception of farmers) variables was statically significant that influence the likelihood of farmers to practice cluster farming positively.

4.2. Recommendations

The findings of this study point to the need for implementing differential policies that separately target each factor which affect the zone, in order to address the specific determinants of farmers' decision to practice cluster farming. Therefore, to promote and improve farmers' participation in cluster farming, the following policy options are suggested to be addressed by various stakeholders including governments at all levels, research centers, executive bodies of cooperatives and concerned NGOs.

Productivity and efficiency of maize and teff greater when produced by cluster, so shifting farmers from individual/small scale to large scale/cluster farming is the only option to boost the production.

Cultivated land affects significantly and positively participation decision of farmers in cluster farming. Therefore, the result could reinforce the reason suggested for increaseing land for cultivation through the use of rent-in and share-in where the situation of economies of scale could operate. On the other hand, creating opportunities of providing access to credit used to rent in and shared in land is also another better option to increase household's land cultivated for crops, which has been discovered to be one of the contributing factors to low level of participation in cluster farming.

Respondent's participation in social organization has significant and positive impact on participation of farmers in cluster farming. The probable reason was that the respondent participation in any social organization increase their awareness about technologies and create good network which increase access to input used for crop production. Hence, we need to encourage establishment and strengthening of participation in any kinds of social organization to enhance farmer's participation in cluster farming through providing different kinds of incentive to farmers and use other suitable mechanism which increase producer farmer in participating of any community/social organization.

In general the following policy implication was recommended to increase participation of farmers in cluster farming in the zone;

- Improve farmers access to extension service
- Improve farmers participation in field visit
- Improve farmers perception on advantage of cluster farming

APPEDICIES

Appendix Table 1: VIF for East Shewa Zone

Variable	VIF	1/VIF
Farm experience	8.95	0.111682
TLU	8.92	0.112152
Sex of HH	2.71	0.368696
Age of HH	2.68	0.373273
Cultivated land	1.39	0.718380
Total land owned	1.38	0.725702
FTC distance	1.34	0.744915
Access to credit	1.32	0.758604
Access to extension	1.20	0.834139
Market information	1.19	0.839634
Cellphone	1.17	0.851780
Participation on field visit	1.15	0.868310
Perception of farmers	1.14	0.880405
Mean VIF	**2.66**	

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