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Research Article

Analysis of Factors Affecting Participation of Smallholder Farmers in Wheat Cluster Farming: The Case of Gasera District, Bale Zone, Oromia Region, Ethiopia

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Abstract

Agriculture is the main means of livelihood in Africa. Wheat is one of the globally produced and marketed cereal crops which cover 15% of the total sowing areas of cereal crops in the world. This study focused on the analysis of factors affecting smallholder farmer's participation in wheat cluster farming in Gasera District of Bale zone. A multi-stage sampling method was employed for this study. Simple random sampling technique was used to select 259 sample respondents in three selected Kebeles out of 24 total kebeles in the woreda. Primary data sources were generated using an interview schedule, five Focus Group Discussions, and eight key informant interviews. Besides, secondary data were obtained from literature and the Woreda Agricultural Office. Both descriptive statistics and econometric models were employed to analyze the collected data. The descriptive statistics results showed that from the total sampled households, 169 (65.3%) were participant and, 90 (34.7%) were non-participant smallholder farmers of wheat cluster farming technology. According to the probit regression model, education status, wheat land, livestock size, frequency of extension contact, credit access, availability of fair price, market information, agricultural input access, training access and membership in a cooperative had a positive influence on farmers' decisions to participate in wheat cluster farming. Therefore, the local community, Woreda Agriculture Office and research institutes need to expand cluster farming technology to increase wheat production and policies aiming at increasing farmers' awareness of producing wheat in cluster to increase yield of farmers.

Keywords

Gasera Woreda, Cluster Farming, Cluster, Probit Model, Wheat

1. Introduction

Agriculture is the main means of livelihood in Africa. Currently it employs 65–70 percent of the African workforce, supports the livelihoods of 90 percent of Africa's population, and accounts for about a quarter of the continent's Gross Domestic Product (GDP. [5, 14, 32].

Cereal crop production is the dominant sub-sector in Ethiopia. cereal crops are among the major crops produced by millions of smallholder farm households both for home food consumption and market income source Therefore, millions of smallholder households in Ethiopia rely on cereal produc-

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tion and marketing as a source of income [36]. It creates about 60% of the rural job opportunities for the Ethiopian economy. It is also a source of more than 60% of the total calorie intake of the country's population [6].

Wheat is one of the globally produced and marketed cereal crops which cover 15% of the total sowing areas of cereal crops in the world [23]. It is an important industrial and food grain which ranks second among the most important cereal crops in the world after rice and traded internationally [31].

According to [15] report Ethiopia is the leading producer of wheat in Sub-Saharan Africa. Unlike other countries, the study by [35] reported that Ethiopia is the only country where smallholders have a majority share in its wheat production with the exceptions of few government-owned and private large-scale and commercial farms.

In Ethiopia, wheat ranks fourth after teff, maize and sorghum in area coverage and third after maize and teff in total production [28]. As it has already been indicated, however, the production of wheat is rain fed based and tremendously of a subsistence smallholder farmers that cultivate more of wheat for consumption and less of it for the market Such subsistence smallholder production doesn't result in less marketable surplus but also low quality output may not be competitive to the world market quality standards [27].

In order to improve the production and productivity of agriculture, Ethiopia has developed different development policies that enhance agricultural production. In 1994/95, the country adopted Agricultural Development Led Industrialization (ADLI) development strategy [40].

Recently, the Ethiopian government targeting self-sufficiency in wheat in the coming few years increasing wheat yield in Ethiopia. As a result, cluster wheat production is increasingly seen as a critical instrument for addressing these issues and it is important to reduce the import dependency. Cluster farming is a farming practice that is growing crops on adjacent farmland with the aim of increasing productivity Cluster farming development programs have helped small-scale farmers to increase the productivity of wheat, barley and other type of food crops on the top of boosting food security [39].

In Ethiopia, cluster farming involves about 30–200 smallholder farmers with adjacent farm plots who voluntarily pool a portion of their land to benefit from targeted government support and cluster economic agglomeration [11].

Farm households participating in the clusters are required to contribute at least 0.25 ha of land, and the cumulative land per cluster must be at least 15 ha to harness the full benefits of participation. In these clusters, farmers commit to cultivating cluster priority crops and adhere to the best farm agronomic recommendations [24].

Oromia is one of the largest wheat regions in Ethiopia. Among zones in Oromia, Bale zone is particularly known for its extensive wheat production and sometimes called "wheat belt'' of Ethiopia. The same report, However, explained that, several problems hinder the performance of wheat production and productivity in Bale highlands, among which, Shortage of improved seed variety, low price of wheat products, high price of fertilizer, pesticides and seed, price instability problems for agricultural products, high costs of combine harvesting, reduced soil fertility, lack of sustainable market outlet, poor infrastructure, grass weed and disease are the major constraints of wheat production [40].

Cluster farming practice improve productivity by using improved seeds at the same time, using fertilizers that are suitable for the same agro-ecology, benefiting from the same technical advisory support, and harvesting their crops with the same machinery [39]

Bale Zone is one of the zones which practice wheat cluster farming introduced by the Ethiopian Agricultural Transformation Institute With the introduction of cluster farming, small-scale farmers in the various Districts of Bale Zone started to increase their crop productivity, which in turn helped them to extensively improve food security in the Zone starting from 2008 E.C but, the participation of smallholder farmers in the area was not sufficient. Therefore, this study was initiated to assess the factors affecting smallholder farmers' participation in wheat cluster farming production in Gasera district of Bale zone, Oromia regional state, where the practice has been newly introduced and implemented.

The objective of this study is to assess small holder farmers' participation in wheat cluster farming in Gasera District, Bale zone Oromia Regional state.

2. Materials and Methods

2.1. Description of the Study Area

Bale Zone is located in southwestern part of the Ethiopia. It is one of the 18 zones of Oromia Regional Administrations. It is 430 km far from Addis Ababa, the capital city of Ethiopia. Bale Zone has 18 Woreda and 3 sub city administrations. Of these Woredas, Gasera is one of them, which located at 60km from Bale-Robe to East. Gasera Woreda is bordered with Woredas like Sinana Woreda in South, Ginir Woreda in the southeast and in the northeast by Gololcha Woreda, in the north by Wabe Shebelle River, which separates it from Arsi Zone, on the east by Gololcha Woreda and west by Agarfa Woreda. The administrative center of Gasera Woreda is Gasera Town. Gasera Woreda has three climatic conditions known as Dega, Weyna Dega and Kola. It found at altitude of 1200—1800 and longitude of 4-8N22 with an elevation of above sea level [43].

2.2. Research Design

This study was carried out on selected farmers who practice cluster farming and who do not practice cluster farming at Gasera District. The study is designed as the cross-sectional design for the quantitative study which was used to gather the relevant information with regard to participation

of smallholder farmers in wheat cluster farming in Gasera woreda. Cross sectional design was selected because the design is used to study different groups at one time and can be used to describe the characteristics that exist in a group by gathering relevant information about the study participants.

2.3. Study Population, Sampling Technique and Sample Size

All the wheat producing smallholder farmers in the district constituted the population of this study. For this study multistage sampling techniques were carried out to select a representative sample. First Gasera District was purposefully selected from Bale Zone Districts due to its wheat potential agro-ecologic woreda and implemented wheat cluster farming. There are a total of 24 Kebeles in the woreda and 17 kebeles practicing cluster farming. In the second stage kebeles which practice wheat cluster farming selected based on purposive sampling. Third stage among 17 kebeles (potential kebeles which practice wheat cluster farming) 3 kebeles (Nake Negewo, Baneba Guranda and Danbel Amogisa) were selected randomly in the district. Sampling framework was established using household that constitute total of 3823 wheat producing households in all sample 3 kebeles. Finally, the sample size of 259 households (169 participant farmers and 90 non participant farmers) was determined using the formula of [41] and the study sample households were selected using simple random sampling technique.

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

$$n = \frac{3823}{1+3823(0.06)2} = 259$$

Where n is the sample of wheat producer that were taken from participant in wheat cluster farming & non participant in the kebeles, N is the total number of wheat producer in the study kebeles. e is the maximum variability or margin of error which is 0.06 in this study. 0.06% margin of error was used rather than 0.05% because the population under the study is known and less heterogeneous and considering the budget, accuracy and time utilization for the research. The maximum level of precision in this study is 10%.

Table 1. *Sample distributions of households in the study kebeles.*

Kebeles	*Total wheat producers	**Sampled household (259)	
		Participant	Non-participant
Nake-Negewo	1688	70	40
Baneba-Guranda	1180	55	30
Danbel Amogesa	955	44	20
Total	3823	169	90
		Total sample size=259	

Source:*Gasera District Agricultural Office, 2023; ** own computation proportion to the population

2.4. Methods of Data Collection

Data Collection Techniques

Household survey

Household survey was administered using semi-structured questionnaires on 259 sample household heads, which was the main source of the data collection tool in the research work. Before conducting household survey interview, the questionnaires were pre tested on 30 households from participant and 15 households from non-participant farmers. This led to a further revision of the questionnaire to make sure that important factors addressed well.

Focus group discussion

Focus group discussion was conducted to generate in-depth information on some of the survey findings. A total 3 FGDs was held with the cluster farming participant's farmers each containing 10 participants (8 females and 22 male attendants) and 2 FGDs were also held with the non-participant farmers, 1FGD containing 6 (all are males) participants in each and the other 1FGD contains 8 (2-females and 6 males) participants in each.

Key informant interview

Key informant interview was employed to collect primary qualitative data. Accordingly, an in-depth interview was made with total 8 key informants. Two experts from district agriculture and natural resource office (2-males), one development agent from each selected kebeles (2-males and 1

female) and one model farmer from each selected kebeles.

2.5. Method of Data Analysis

Data were analyzed and summarized using both descriptive statistics and econometric models and narrative.

2.5.1. Descriptive Statistical Analysis

When analyzing the explanatory variables and the dependent variable, descriptive statistics like percentages, means, standard deviations, minimums, and maximums were used. To determine whether households participating in cluster wheat production are significantly different among themselves in terms of continuous and categorical variables or to test the association of dependent and independent variables, the inferential statistics (t-test and $\chi 2$ -test) were applied. For qualitative data gathered from FGDs and KIIs, narrative and interpretation analyses were applied. To analyze the collected data both Statistical Package for Social Science (SPSS) version 20 (for data entry and cleaning) and STATA version 15.0 (for analysis) were used as tools for data entry and analysis.

2.5.2. Econometric Models

Probit regression model

A farmer's decision to participate in cluster farming of wheat is a dependent variable. It was explained by socio-economic, demographic, and institutional variables. It is a dichotomous (binary) variable that takes a value of one. the household is participant and zero if the household is non-participant. According to [17] the participation decisions of the households, can be determined using either logit or probit models, as the results of these two models are similar. So, a probit regression model was chosen in this research to assess factors affecting farmers' participation decisions in wheat cluster farming. The probit model includes the error term distribution as well as realistic probabilities [4]. Meanwhile, the probit model assumes that while 0 and 1 values for non-participants and participants, respectively, are only observed for the response variable Y, there is a latent, unobserved continuous variable Y* that determines the value of the response variable Y [34].

Then the Probit model is described as follows:

$$Yi^*=Xi\beta+\varepsilon i,\ \varepsilon i\sim [0, 1],$$

Yi=1, if y*i>0, otherwise Yi=0, (3) Where; Yi* is a latent variable representing farmers' decisions to participate in cluster farming, Xi is a vector of explanatory variables, βa vector of parameters associated with explanatory variables, εi is the independently and normally distributed error term assumed to be normal as εi~[0, 1].

The probability of farmers' participation in cluster wheat production and expressed as:

$$Pi=Prob\ [yi=1 \mid Xi] =\Phi\ (X'i\beta)$$

Where; Φ represents the cumulative distribution of standard normal random. The marginal effect estimation was employed to measure the expected change in probabilities of farmers' in cluster farming participation resulting from a unit change in the explanatory variables at the average mean effect.

Testing the problem of multi-collinearity

The situation where the independent variables are highly inter-correlated is referred to as multi-collinearity [25]. Problem of multicollinearity detected using variance of inflation Factor (VIF) and contingency coefficient (C.C) continuous and discrete variable respectively. According to [18] VIF (Xi) can be defined as

$$\mathrm{VIF}(x_i) = \frac{1}{(1-R_i^2)}$$

Where: R_i^2 is the multiple correlation coefficients between Xi and other independent variables.

For continuous variables, as a rule of thumb, value of VIF greater than 10, are often taken as a signal for the existence of Multicollinearity problem in the model (if the value of Ri^2 is 1, it would result in higher VIF (∞) and cause perfect Multicollinearity between the variables) The VIF for each independent variable is less than the critical value of 10 indicating non-existence of multi-collinearity [18] In the same line, the contingency coefficient (CC) was computed for dummy variable from chi-square ($\chi 2$) value to detect the problem of multicollinearity (the degree of association between dummy variables). Dummy variables are said to be collinear if the value of contingency is greater than 0.75.

$$c.c = \sqrt{\frac{x2}{n+x2}}$$

Where: C.C is contingency coefficient, n is sample size, $\chi 2$ is chi-square values.

2.6. Variable Definition, Measurement and Working Hypothesis

Dependent Variable

Cluster farming participation (CLFP): The dependent variable in this model is a dummy (binary) variable representing farmers 'cluster farming participation; taking a value of 1 if farmers are participant in wheat cluster farming and 0 if not (non-participant) in wheat cluster farming.

Table 2. Summary of variables and their hypothesized signs.

Dependent variable	Description of variables		
	Types of variables	Measurement	Expected sign
Decision to participate in cluster wheat production	Dummy	"1"for participant and "0" for non-participant	
Explanatory variables			
Sex	Dummy	1=male, 0=female	+/-
Age	Continuous	Age of household in years	+/-
Education	Dummy	0=unable to read and write 1=able to read and write	+
Family size	Continuous	Number of family members	+/-
Livestock holding	Continuous	TLU	+
Total land size	Continuous	Total Land in hect.	+
Size of Wheat land	Continuous	Wheat land in hect.	+
Off-farm income participation	Dummy	1=Yes, 0=No	+/-
Credit utilization	Dummy	1=yes, 0=N0	+
Distance to nearest market	Continuous	In kilometre	+
Cooperative member	Dummy	1=Yes, 0=No	+
Getting training	Dummy	1=Yes, 0=No	+
Number of extension contact	Continuous	number of extension contact in a month	+
Getting agricultural inputs	Dummy	1=Yes, 0=No	+
Utilization of Market information access	Dummy	1=Yes, 0=No	+
Availability of fair price	Dummy	1=Yes, 0=No	+

3. Result and Discussion

3.1. Demographic and Socio-economic Characteristics of Sample Households

Table below shows the distribution of farm households based on wheat cluster farming participation. About 65.3% of the sample households were participant and the remaining 34.7% were non participant sample households.

Table 3. Participation in wheat cluster farming of sample farm households.

Description	Number	%
Participant	169	65.3
Non-participant	90	34.7

Source: Own computation of household survey data, 2023

3.2. Descriptive Results of Independent Dummy Variables and Their Association with Participation in Cluster Farming

The results of the descriptive statistics indicates that cluster farming participants and non-participants are statistically different in terms of sex, education status, access to agricultural inputs, availability of fair market price, market information, training access, credit access, cooperative membership, participating in off-farm activities.

Sex of HH: As indicated in Table 4 below, out of 259 the total sample households, 69.88% (n = 181) were male, whereas 30.12% (n = 78) were female. Regarding participation in wheat cluster farming sample households, 34.7% (n = 90) and 65.3% (n = 169) were non-participants and participants, in wheat cluster farming respectively. The majority of households in the sample are headed by males. Among female headed households, 26.63% and 36.67% are cluster farming participant and non-participant respectively, while 73.37% and 63.33% male are cluster farming participant and non-participant respectively. The result shows there is significant difference between the two variables in terms of sex. Concerning the association between participation in wheat cluster farming and sex of HHs, the values of Pearson chi2 = 2.81 and Pr = 0.094 (pr <α) This shows that at a 5% significance level, there is relationship (association) between sex and participation of farmers in wheat cluster farming. This implies that the maleness or femaleness of the household head is determining the participation of farmers in wheat cluster farming.

Status of education: In terms of educational status of household head among the total sample households 33.6% were unable to read and write and 66.4% were able to read and write. Of this 21.89% and 55.56% are illiterate (unable to read and write) of cluster farming participant and non-participant respectively. While, 78.11% and 44.44% of literate (able to read and write) are cluster farming participant and non-participant respectively. This shows that the majority of non-participant households are illiterate (unable to read and write). As the Chi^2-test statistics result ($chi^2(2) = 29.83$, Pr = 0.000 (Pr<α)) reveals at 1% significance level, there is statistically significant relation between educational status of sample HH and participation of the households' cluster farming participants are relatively better in education level. This implies that there is strong association between education level and farmers participation in cluster farming participants.

Getting agricultural inputs: Among the total sample of household (n=259), 80.3% were not getting agricultural inputs timely while, 19.7% were getting agricultural inputs timely. Among those who have access to agricultural inputs 10% & 24.85% are non-participant and participant in cluster farming respectively. Out of respondents who have not getting agricultural inputs timely were 90% &75.85% are non-participant and participant in cluster farming respectively. As the Chi2-test statistics results chi2=8.19, Pr = 0.004 reveal that, there is a strong association between HH participation in wheat cluster farming and accessibility of agricultural inputs timely. This assertion is also supported by FGD and KII; improved farm inputs utilization is a factor for enhancing agricultural productivity. The utilization of optimum level of inputs (seed, fertilizer) per hectare i.e., they are a prerequisite for better production and productivity.

Availability of fair market price: the result of the study indicated that in terms of fair market price, among the total sample of households 68% of the respondents feel there is no fair market price available for wheat production. Among these majority are 81.11% and 60.95% are non-participant in wheat cluster farming and participant respectively. Only 32% of the respondents feel there is fair market price available for wheat 39.05% and 18.89% accounted for CLFP and NP respectively. Concerning the association between participation in wheat cluster farming and availability of fair market price, the values of Pearson chi2 = 10.96 and Pr = 0.001 (pr <α) This shows that at 1% significance level, there is relationship (association) between fair market price and participation of farmers in wheat cluster farming.

Utilization of market information access: among the total sample of household (n=259), 77.2% and 22.8% had access to market information and were not have access to market information respectively. Out of household who had access to market information 94.08%, 45.56% are cluster farming participants (CLFPs) and NPs respectively. On the other hand out of household who had no access to market information 5.92% and 54.44% are CLFPs and NPs respectively. As the chi2 (P=0.000) test result reveal, at 1% significance level there is strong association between participation in wheat cluster farming and market information. More participated in cluster farming were have access to market information. Households with better information access are more likely to participate in cash crop production.

Getting training: the results of the study also indicated that in terms of training access, among the total respondents 32% had access to training. About 43.2% and 11.11% of those who have training access were CLFP (cluster farming participant) and NP (non-participant), respectively. In addition among respondents who had no access to training 56.80% and 88.89% are among CLFP and NP, showing CLFP are more accessed with training. The result indicated there were 1% (p=0.000) statistically significant differences between CLFP and NP in terms of training access. Therefore, those farmers who got training are more willing to apply improved productive technologies than those who didn't get training and hence will be interested to participate in cluster farming.

Credit utilization among the total respondents, 36.3% had access to credit and the rest 63.7% had no access to credit. Of those accessed with credit, 47.93% and 14.44% were CLFP (cluster farming participant) and NP (non-participant), respectively. In addition, about 52.07% and 85.56% of those who do not have access to credit were CLFP and non-

participants, respectively. The result indicates significant difference in terms of access to credit at 1% (p=0.000) significant level. These shows that there is strong association and significant difference between the two variables in terms of credit access and NP were constrained by credit access by than CLFP.

Cooperative membership: about 63.7% of the farmers are members in cooperation while 36.3% are not participant in farmer's cooperation. Table 4 indicated 79.3% and 34.4% of the sampled household heads are members of farmers 'cooperatives which are wheat cluster farming participant and non-participant respectively. On the other hand, from non-member of cooperatives 65.56% and 20.7% are non-participant and participant in wheat cluster farming respectively, indicating majority of non- participant. The results revealed that, there was a highly significant relationship between participation in cluster farming and cooperative membership at 1% significant level (p = 0.000). Information from FGD and KII also support the above idea. These households' participants in cooperative to have access of improved agricultural inputs like improved seed, and also access to credit, training, information and experience sharing among them. Thus, they encourage to participate in new agricultural technologies. Participation at cooperatives enhances the information exchange and experience sharing among farm households on the use of improved agricultural technologies and agronomic practices.

Off-farm income participation: About 24.7% of the respondents are engaged in off-farm activities. Among this 28.99% and 16.67% are cluster farming participant and non-participant respectively. Of those from 75.3% non-participant in off-farm income 71.01% cluster farming participant and 83.33% are non-participant in cluster farming. The result shows more participant in cluster farming participated in off-farm activities and there is a 5% level (p=0.029) of significant difference between cluster farming participant and non-participant. This assertion is also supported by FGD and KII; the farmers who were engaged in off-farm activities and had additional income to purchase improved agricultural inputs were more likely to participate in cluster farming. Carpentry, trading, and daily laborer were some of off-farm activities the farmers engaged in the study area. Participation in off-farm activity promotes the capacity to invest in new agricultural technologies.

Table 4. *Characteristics of the sample respondents (Dummy variables).*

Variables	Non-participant (n=90)		Participant (n=169)		Total household (%)	X^2 test	P-value
	N	(%)	N	(%)			
Sex of HH							
Female (n=78)	33	36.67	45	26.63	30.12	2.81	0.094*
Male (n=181)	57	63.33	124	73.37	69.88		
Status of education							
Unable to read and write	50	55.56	37	21.89	33.59	29.83	0.000***
Able to read and write	40	44.44	132	78.11	66.41		
Getting Agricultural inputs							
No (n=208)	81	90	127	75.85	80.31	8.192	0.004***
Yes (n=51)	9	10	42	24.85	19.69		
Fair price availability							
No (n=176)	73	81.11	103	60.95	67.95	10.96	0.001***
Yes (n=83)	17	18.89	66	39.05	32.05		
Market information							
No (n=59)	49	54.44	10	5.92	22.78	78.62	0.000***
Yes (n=200)	41	45.56	159	94.08	77.22		
Getting training							
No (n=176)	80	88.89	96	56.80	67.95	27.76	0.000***
Yes (n=83)	10	11.11	73	43.2	32.05		

Variables	Non-participant (n=90)		Participant (n=169)		Total household (%)	X^2 test	P-value
	N	(%)	N	(%)			
Credit utilization							
No (n= 165)	77	85.56	88	52.07	63.71	28.45	0.000***
Yes (n=94)	13	14.44	81	47.93	36.29		
Cooperative membership							
No (n=94)	59	65.56	35	20.7	36.29	51.08	0.000***
Yes (n=165)	31	34.44	134	79.3	63.71		
Off-farm income participation							
No (n=195)	75	83.33	120	71.01	75.2	4.79	0.029**
Yes (n=64)	15	16.67	49	28.99	24.71		

***, **and* are significance at 1%, 5% and 10% respectively. Source: Own survey, 2023

3.3. Descriptive Results of Independent Continuous Variables and Their Association with Participation in Wheat Cluster Farming

The mean value of continuous variables regarding sample HH socioeconomic characteristics to test whether there was statistical significance in the mean difference of sample households who are participant in cluster farming & non-participant focus on age, family size, wheat land, total land-holding, TLU, and extension contact per month was presented in the table below. All variables have significant mean differences between participant and non-participant in wheat cluster farming.

Age: The combined mean age of the sample HH of both cluster farming participant (CLFP) and non- participant (NP) was 42.51 years. Regarding the mean age difference between cluster farming participants and non-participants in sample HH, the average age of the sample households that are CLFPs and NPs was 41.91 and 43.64 years, respectively. The t-test result of their mean age difference at a 10% significance level is statistically significant (mean difference = 1.733 and P = 0.083).

Family size: The average family size of overall sample households was 5.77. Accordingly, the average family size for CLFPs and NPs was 5.64 and 6.01, respectively. Family size plays an important role in the available labor force in terms of enhancing households' probabilities of participating in wheat cluster farming. The T-test result shows that there is a statistically significant mean difference in terms of household size between participants and non-participants of wheat cluster farming at 10% (mean difference=0.366, P = 0.078) significance level. The result indicate that participants and non -participants were statistically different in terms of family size.

Total land size: Land is one of the most important resources for any economic activity, especially in the rural and agricultural sectors. Farm size influences households' decisions to participate in cluster farming. The mean land holding in the overall sample households was 2.71ha. Similarly, the average land size for CLFPs and NPs was 3.03 ha and 2.12 ha, respectively. The average land holding by cluster farming participant (CLFP) is slightly higher than non-participant (NP). As the t-test result shows at 1% significance level, there is a statistically significant mean difference in land holding size between cluster farming participants and non-participants (mean difference =0.912 and P =0.000). Also, this assertion is supported by FGD and KII; farmers who have a larger land size are more likely to participate in wheat cluster farming than those with smaller land size.

Size of wheat land: The average land allocated to wheat production in sample HH was 1.93ha. Whereas the average land size for wheat production of the sample household of cluster farming participants (CLFPs) was 2.34 hectares and that of non-participants (NP) was 1.16 hectares. As the T-test shows (mean difference =1.17 and P = 0.000) at 1% significance level, there is statistically significant mean difference in the land given to wheat growth between participant and non-participant HHs.

Tropical livestock unit (TLU): The TLU (tropical livestock unit) was used to compare livestock ownership among sample households. The livestock species found in the study area are cattle, goats, sheep, donkeys, horses, and poultry. Farm animals have a key role in rural economy. They are source of draught power, food, such as, milk and meat, animal dung for organic fertilizer and fuel and means of transport. Beside this, livestock are important sources of cash in rural areas to

allow purchase of farm inputs. The average TLU of the sample HH was 10.27. In a comparison of each source's mean TLU, the mean numbers of livestock owned by CLFPs and NP sample HH were 10.77 and 9.34, respectively. As a result of the T-test result (mean difference =1.43 and P =0.0000) showing at the 1% significance level, there is a statistically significant mean difference in TLU between cluster farming participant and non-participant sample households.

Distance to the market: distance of farmers' village from the nearest market, on average was 16.24 minutes of walk for the total sample respondents. However, for the farmers who participated in wheat cluster farming, it was 13.86 minutes which is less than average of 20.72 minutes for non-participants. Thus, there is a mean difference between participants and non-participants in terms of distance from the nearest market at a 1% significant level (p = 0.0000) as indicated in table 5 below. Information from FGD and KII also supports the above declaration, as these households that are nearest to the market have a benefit from using farm inputs and employing improved agricultural inputs. This helps to access the nearest input market which is useful for participation and employing improved agricultural inputs.

Number of extension contacts: the average extension contact number per month of the sample HH was 1.46. Whereas comparing the mean extension contact number per month between participant and non-participants, the average number of extension contacts between participant and non-participant sample HH was 1.68 and 1.066, respectively. The mean difference is 0.613 and P =0.0000, which shows that at 1% significance level, there is a statistically significant mean extension contact number difference among participants and non-participants.

Table 5. *Characteristics of the sample respondents (continuous variables).*

Variables	Participation in wheat cluster farming				Combined mean	Mean difference	T-test	P-value
	Non-participant (n=90)		Participant (n=169)					
	Mean	std. Err	Mean	std. Err				
Age	43.64	0.5906	41.91	0.6555	42.51	1.733	1.738	0.083*
Family size	6.01	0.1391	5.64	0.1317	5.77	0.366	1.767	0.078*
Total land size	2.12	0.0798	3.03	0.0888	2.71	0.912	6.758	0.000***
Size of wheat land	1.16	0.0606	2.34	0.089	1.93	1.17	9.014	0.000***
Total livestock (TLU)	9.34	0.162	10.77	0.216	10.27	1.43	4.47	0.000***
Distance to the market	20.72	0.812	13.86	0.510	16.24	6.858	7.48	0.000***
Extension contact	1.066	0.064	1.68	0.059	1.46	0.613	6.505	0.000***

*** and* are significance at 1% and 10% respectively. Source: Own survey, 2023

3.4. Factors Affecting Participation of Farmers in Wheat Cluster Farming

In this study, a probit regression model was employed to identify factors influencing the sampled households' participation in wheat cluster framing using hypothesized independent variables and the results are presented in Table 6 below. Before running probit model, the existence of multicollinearity among independent variables was tested using contingency coefficient (CC) and Variance Inflation Factor (VIF) between discrete and continuous variables respectively. The result of both tests revealed that, there was no serious multicollinearity problem. As a result, no any variables were dropped from the model. the problem of multi-collinearity exists when the value of VIF is greater than or equal to ten. According to the result, there was no problem of multicollinearity in this case since the mean VIF was 2.88, so all the variables were included in the model to estimate factors affecting households' decisions to participate in wheat cluster farming in the study area. The Pseudo R2 is 0.8069, indicating the variables included in the model explain 80.7% of the variation in the decision participation of households in wheat cluster farming.

In this part, a probit model was employed to identify factors that affected participation decisions of wheat cluster farming. The dependent variable for the probit model is the probability of participation in wheat cluster farming. A total of sixteen variables, nine dummy and seven continuous explanatory variables were included in the model. From the total independent variables, ten variables significantly affect the participation decisions of wheat cluster farming. These

are education level of household, wheat land, total livestock, agricultural input access, availability of fair price, frequency of extension contact, market information, training access, credit access and cooperative membership.

The remaining six variables, namely age, sex, family size, total land holding, distance to nearest market and participation in off-farm activities were have no significant effect on participation decision in wheat cluster framing at households' level. The marginal effects presented how a given variable affects participation decision of wheat cluster farming.

Table 6. *Determinates of participation decision in wheat cluster farming probit model result.*

Variable	Coefficient	Std. error	P>|z|	Marginal effect (dy/dx)
Age of household	0.066	0.052	0.210	0.006
Sex of household	-0.111	0.473	0.814	-0.009
Education status	1.015	0.461	0.028**	0.126
Family size	-0.389	0.285	0.172	-0.035
Total land size	-0.0901	0.439	0.837	-0.008
Size of wheat land	1.672	0.561	0.003***	0.148
Tropical livestock	0.285	0.148	0.054**	0.025
Distance to the nearest market	-0.043	0.029	0.147	-0.004
Getting agricultural inputs	2.222	0.829	0.007***	0.097
Availability of fair price	2.139	0.666	0.001***	0.146
Number of extension contact	0.836	0.317	0.008***	0.074
Market information	2.447	0.677	0.000***	0.551
Getting Training	2.105	0.679	0.002***	0.145
Credit utilization	1.806	0.604	0.003***	0.138
Participation in Off-farm income	-0.237	0.465	0.609	-0.023
Cooperative membership	1.208	0.465	0.009***	0.153
Constant -10.90719 LR chi2 (16)= 269.97 Prob >chi2= 0.0000 Pseudo R2= 0.8069		3.009	0.000	

Source: Model output, 2023*** p<0.01 (1%) and ** p<0.05 (5%) significance level.

Details of significant variables are presented as follow:

Education status of Household Head:-Education status of household was expected to affect the decision of the household to participate in cluster farming. It was hypothesized that if the household head becomes literate (able to read and write) the probability of participation in wheat cluster farming will increase. As it was hypothesized Participation in wheat cluster farming is positively and significantly influenced by the educational status of the household head at 5% significance level (0.028). Keeping other variables constant, ability to read and write may increase the probability of participation in wheat cluster farming by 12.5% or as household become literate, the probability of participation in wheat cluster farming increased by 12.5%. This indicates that the farmers which able to read and write are more likely to participate in wheat cluster farming than those with unable to read and write in the study area. The reason may be that more educated farmers may have relatively more access to information and become aware of new technology and this awareness may enhance the participation in wheat cluster farming. This is consistent with the results of [2, 37, 7, 8].

Land allocated for wheat: Another socio-economic characteristic that affects households' participation in wheat cluster framing is size of land allocated for wheat production. The model result showed a positive and significant relationship between land allocated for wheat and probability participation in wheat cluster farm at the 1% significance level (0.003). Other variables held constant, an increase wheat

land by 1 ha would result in an increase the probability of participation in wheat cluster farming by 14%. This is because, as the size of land allocated for wheat crop increases, the production of wheat increases which in turn increase farmers' probability of being participant in wheat cluster farm. According to the information from FGDs farmers who have better land have greater chance of participating in wheat cluster farming and allocate greater land for wheat production.

This result is in consistent with the findings of [38] a positive and statistically significant (1%) relationship exists between decision to participate in improved wheat seed market and total land allocated for wheat production [37, 10] land size allocated for wheat significantly affect the smallholder wheat farmers' market participation [12, 16].

Livestock holding size (TLU): As it was hypothesized Participation in wheat cluster farming is positively and significantly influenced by livestock holding size of the household head at 5% significance level (0.054). The result implies that for each additional tropical livestock unit, the households would be 0.2% more likely to participate in wheat cluster farming, keeping other factors constant. This could be due to the fact that households with a large number of livestock decrease the constraint of capital to purchase agricultural inputs as well as their risk taking behavior to use technologies like, improved varieties. On the other hand, it used as organic fertilizer for the crop, which reduce the price of inorganic fertilizer because these farmers who had relatively more livestock participate in wheat cluster farming than others. This result is line with the findings of [13] livestock owned positively affect farmers participation decision in potato market [42] livestock holding size positively affect farmers participation and the level of participation in degraded forest rehabilitation practices [9] livestock ownership were statistically significant in affecting youth's to participate in major vegetable production and [29].

Getting Agricultural inputs: - Agricultural input access was found statistically significant at less than 1% (0.007) probability level which associated positively with the participation in wheat cluster framing. The result of model confirms the expected hypothesis which is smallholder farmer with high agricultural input (improved seed and fertilizer) access is more likely to participate in wheat cluster framing than households with low access. Keeping other variables constant, getting agricultural inputs on time increase the probability of participation in wheat cluster farming by 0.9%. This is because of farm inputs utilization is a factor for enhancing agricultural productivity and a prerequisite for better production and productivity. Data from key informant interview indicate that input supply was very important for wheat production to increase quality and quantity of production but if it not accesses on time for producer and quality of improved seed has its own problem. This finding is in conformity with the findings of [9] access to input supply positively and significantly (at 5% significance level) hindering rural youth participation in major vegetable production.

Availability of fair price: As expected, availability of fair price was positively related to farmers‟ participation in wheat cluster farming at less than 1% (0.001) level of significance. Keeping other variables constant, getting fair market price for wheat increase the probability of participation in wheat cluster farming by 14%. This is because, households form their expectations based on the lagged price of wheat and allocates available resources according to their expectations. Alternatively, the higher the lagged price of wheat they perceive, the more quantity of wheat they produce and the higher the probability they participate in market as seller. This result is in consistent with the findings of [16] perception of farmers toward wheat market price were affected the smallholders' probability of wheat market participation significantly. [37] Households' perception on lagged market price of wheat affected probability of market participation positively and significantly at 1% significance level and intensity of wheat sale at 10% significance level.

Extension contact: - In study area, extension contacts were considered commissions of the organizational network. The variable was positively and significantly affects participation in wheat cluster farming at 1% probability level (0.008). Other variables held constant, for each additional one day contact with an extension agent, the probability of farmer's participation in wheat cluster farm increase by 0.7%. This may indicate that farmers who have more contact with extension agents having a higher probability of participating in cluster farm compared to those who have less contact. Moreover, farmers who frequent contact with extension agents are more likely to participate in wheat cluster farm. This justification, verified by FGD and KII, they explain that the supervision of extension agents plays a vital role in wheat cluster farming. This result is consistent with [20]. The frequency of extension contact significantly and positively affecting the level of input purchase particularly herbicides at 1% probability level. [30, 8, 42, 26, 21].

Market information: Access to market information has a positive and significant impact on the households' participation decision in wheat cluster farming. The variable was positively and significantly affects participation in wheat cluster farming at 1% probability level (0.000). Other variables held constant, having access to market information may increase, the probability of farmers participation in wheat cluster farm increase by 55%. Therefore, effort should be made to deliver proper and adequate market information through strengthening market information delivery network and also link farmers' cooperatives/groups with proper sources of market information to enhance wheat farmers' regular access to information on market dynamics. The result was in consistent with the findings of [10, 13, 33] Access to market information has significantly and positively affecting market participation at 1%probability level. The more information the household has on marketing, the less transaction costs will be thus increasing market participation.

Getting Training: Access to training positively influenced participation in wheat cluster farming at 1% (0.002) level of significance. The result of probit model shows that, if the household participated in training, the probabilities of participation in wheat cluster farm increase by 14% other variables held constant. Therefore, probit result shows that, farmers who participate in trainings will be more probable to participate in wheat cluster farming than not participated in training. This indicated that, participation in training is imperative to convince farmers and to provide knowledge and skill on the practical experience of wheat production in cluster and Training can be theoretical and practical demonstration, on input use (fertilizer seed and chemical application), weeding and are found to most important by the farmers. The finding of this research is similar with findings of [3, 8, 22] participation in training found to be highly important variable influencing adoption of wheat row planting. This justification, verified by FGD and KII, they explain that getting training on how to apply inputs like seed, fertilizer and agronomic practice on crop production plays a vital role in wheat cluster farming.

Credit utilization: As expected, access to credit positively and significantly influence the farmer's decision to participate in wheat cluster farming at 1% (p=0.003) significance level. This indicates that farmers who utilize credit increases the probability of participating in wheat cluster farming by 13%, all other factors held constant. This suggests that access to credit improves the financial capacity of farmers to buy improved inputs and credit makes the household to purchase more amounts of improved wheat seed, fertilizer and agrochemicals from different agricultural input supplying actors. This finding is in line with [29] who found that credit access had positive and significance influence on farmers' decision to participate in teff marketing, [26, 19, 38].

Cooperative membership: Membership in a cooperative had positive and significant influence on participation in wheat cluster farming at 1% significance level (p = 0.009). Keeping other variables constant, being a member of an institution increased the probability of participation in wheat cluster farming by 15%. Farmers' membership in a cooperative is `essential for accessing and disseminating new information and new technologies. The possible reason for this might be that membership of household heads in social organizations increases their awareness level of technologies as they are easily exposed to information and creates good network that leads them to easily access credit and essential agricultural inputs such as improved seeds. This result is in consistent with the findings of [38, 20, 26].

4. Conclusions and Recommendations

The objectives of the study were to identify and describe the factors influencing farmer's participation in wheat cluster farming. The study used binary probit model to evaluate the determinants of farmers' participation in wheat cluster farming. The descriptive results of the study revealed that, there exists significant variation among participants and non-participants in terms of age, sex, family size, household education status, off-farm participation, livestock holding, extension contact, land size, distance to nearest market, fair price availability and agricultural input access. Moreover, significant difference between participant and non-participant categories in relation to credit access, wheat land, training access, market information and cooperative membership. On the other hand about 65.3% of the sample households were participant in wheat cluster farming and the remaining 34.7% were non participant sample households. However, probit model results revealed that, households' decision to participate in wheat cluster farming positively and significantly affected by households education status, livestock holding, land allocated for wheat, credit access, training access, market information access, availability of fair price for wheat, agricultural input access, cooperative membership, and frequency of extension contact while, the remaining six variables: age, sex, family size, total land holding, distance to nearest market and participation in off-farm activities were have no significant effect on participation decision in wheat cluster framing at households' level. Based on the findings of this study, the following recommendations are made.

1. Education has affected extent of participation positively and significantly. So government stakeholders in the study area need to give emphasis in strengthening formal and informal education.
2. Livestock ownership has a positive impact on households' participation decision in wheat cluster farm. Therefore, an intervention that improves the livestock assets of households are better recommended.
3. Access to market information has a positive and significant impact on the households 'participation in wheat cluster farm. Therefore, Government, DAs, and rural institutions should promote an effective market research and information network to disseminate the right information to the people in need, at the right place, at the right time, and in the right form.
4. Total land allocated for wheat production has affected participation decision positively and significantly. Hence, increasing productivity of wheat per unit area of land is also better alternative to increase participation in wheat cluster farm through introducing improved varieties, application of chemical fertilizers and controlling disease at a right time with a right quantity with strengthen existing extension service provision.
5. Price of wheat found to be positively related to participation in wheat cluster farming. Government and other NGOs must stand besides farmers to safeguard them by offering fair price.
6. On time availability of agricultural inputs like fertilizer and seeds are positively and significantly affect participation in wheat cluster farming. Ontime availability of these services at an acceptable quality level is crucial

as the success of farming activity highly depends on it. Providing quality of the above inputs on time is very important Government and other stakeholder must focus on these issues.

7. Extension contact affected participation decision positively in the study woreda. Extension contact and its frequency have significant impact on giving valuable information on wheat cluster farming. Therefore, DAs who work in the study Woreda should frequently visit the work of farmers, should moralize good performers and support the weak farmers.
8. Training found to be positively and significantly affect cluster farming participation. Therefore agricultural office and other stakeholders such as ATI, NGO and Agricultural Research centers strengthen their effort to address the training demand and interest of the farmers. The farmer training should be designed and focused on method of sowing, improved input use and agronomic practices, marketing and post - harvest technology and management.
9. Financial institutions in the Woreda such as Micro-Finance and Commercial Bank of Ethiopia need to facilitate credit access and agents Micro-Finance and DAs of agricultural office need to give awareness for farmers to use credit at kebele level so as to capacitate farmers financially to enable them to participate in wheat cluster farm.
10. The model result revealed that membership to cooperative has affected participation decision positively and significantly. So woreda cooperative office experts need to give awareness for household to be the member of cooperatives so as to make them benefited from the service.

Abbreviations

ADLI	Agricultural Development Lead Industrialization
ATI	Agricultural Transformation Institute
CC	Contingency Coefficient
CLFP	Cluster Farming Participant
DA	Development Agent
E.C	Ethiopian Calendar
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Statistics
FGD	Focus Group Discussion
GDP	Gross Domestic Product
KII	Key Informant Interview
NGO	Non-Governmental Organization
NP	Non Participant
TLU	Total Livestock Unit
OECD	Organization for Economic Co-operation and Development

Conflicts of Interest

The author declares no conflicts of interest.

Appendix

Table A1. Conversion Factor Used to Estimate TLU.

Animal category	A unit category in TLU
Cow/Oxen	1.00
Weaned calf	0.34
Heifers	0.75
Calves	0.25
Bulls	0.75
Young sheep/goat	0.06
Adult Goats/goat	0.13
Horse/mule	1.10
Young donkey	0.35
Adult donkey	0.70
Poultry	0.01

Source: [38]

Table A2. Test for multicollinarity VIF for continuous variables.

Variables	VIF	1/VIF
Total land	5.60	0.178693
Wheat land	5.50	0.181766
Total livestock	1.17	0.857266
Distance to the nearest market	1.08	0.925743
Family size	1.04	0.965948
Mean VIF	2.88	

```
Probit regression                               Number of obs     =        259
                                                LR chi2(16)       =     269.97
                                                Prob > chi2       =     0.0000
Log likelihood = -32.295239                     Pseudo R2         =     0.8069
```

participation	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Age	.0656916	.0523804	1.25	0.210	-.0369722	.1683553
sex	-.1111052	.4724718	-0.24	0.814	-1.037133	.8149224
Education	1.015165	.4609881	2.20	0.028	.111645	1.918685
Fam_size	-.3899877	.2854662	-1.37	0.172	-.9494912	.1695157
tot_land	-.0901148	.4385228	-0.21	0.837	-.9496037	.769374
WheatLand	1.672011	.5609691	2.98	0.003	.5725317	2.77149
totLivstock	.2847349	.1480361	1.92	0.054	-.0054105	.5748802
timtmarkt	-.0427696	.0295055	-1.45	0.147	-.1005993	.0150601
agri_inputaccess	2.222054	.8293981	2.68	0.007	.596464	3.847645
availfaiprice	2.139136	.6665648	3.21	0.001	.8326925	3.445579
Extncontact	.8363488	.3174617	2.63	0.008	.2141353	1.458562
mrktinfo	2.447528	.676803	3.62	0.000	1.121019	3.774038
training	2.105428	.6798403	3.10	0.002	.7729658	3.437891
credacc	1.805796	.6042694	2.99	0.003	.6214502	2.990143
offfarm	-.2377427	.4648661	-0.51	0.609	-1.148864	.6733781
coopmemb	1.208857	.4649141	2.60	0.009	.2976425	2.120072
_cons	-10.90719	3.009463	-3.62	0.000	-16.80563	-5.008749

Figure A1. *Probit model output result.*

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