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Wheat Commercialization and Its Determinant Factors in Walmara, Central Ethiopia

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Abstract: In Ethiopia wheat is cultivated by more than 4.5 million farmers and covers more than 1.8 million hectares of the cultivated area of land. The objectives of the study were to identify factors affecting smallholders' wheat market participation and the level of commercialization in the walmara district, central Ethiopia. The study was conducted based on the data obtained from 200 randomly selected sample households. To analyze the collected data obtained from sample households' descriptive statistics and a Double hurdle econometric model was employed. The descriptive statistics results show that out of the total sample respondents 99 (49.5%) were wheat market participants and 101 (50.5%) were non-participants. The chi^2-test result and two-group mean-comparison test show the existence of a statistically significant difference between two groups in some explanatory variables. The mean commercialization level of wheat farmers in the study areas was 37.3%. The results from the probit regression model revealed that the education level of household heads, total livestock owned, total land owned, and access to credit positively and significantly influence the likelihood of wheat market participation whereas household size significantly and negatively affects the likelihood of wheat market participation in the study areas. The Truncated regression model result infers that household size and off/non-farm income negatively and significantly affect the intensity of wheat commercialization whereas the frequency of extension contacts positively and significantly affects the intensity of wheat commercialization. Thus, to enhance smallholder farmers' market-orientated production and to raise the intensity of wheat commercialization efforts of both Governmental and Non-governmental organizations aiming at availing improved wheat production technology and providing essential training on agricultural production and marketing are essential.

Keywords: Commercialization, Wheat, Double Hurdle, Walmara

1. Introduction

The Ethiopian economy majorly depends on the agriculture sector and is dominated by smallholder farmers. The sector contributed 33.3% to the national GDP, 87% to export earnings, and 72.7% to total employment [1, 2]. Ethiopia is the third largest wheat-producing country in Africa. Out of cereal crops, wheat is a strategic crop for household food security, import-substitution, supply of raw material for agro-industries, and means of generating income [3]. In Ethiopia, within the category of grain crop area cereals cover more than 10.5 million hectares and wheat took up more than 1.8 million hectares of the grain crop area. In terms of crop production cereals contributed 30.2 tons of grain production and wheat contributed 5.7 million tons of grain production [4]. The demand for wheat in Ethiopia is growing faster than for any other food crop, particularly in urban areas because of the rapidly increasing population, changing preferences toward wheat-based food items, and precarious wheat yield resulting from climate change.

The government of Ethiopia has identified ten key priority intervention areas in the agricultural sectors and the major one focused on increasing the productivity of small-scale farmers and expanding large-scale commercial production of wheat in rainfed agro-ecologies and production through irrigation. The agricultural commercialization clusters aim to develop integrated and agro-ecology-based value chains

supported by vibrant stakeholder alliances to enhance market-oriented output production and processing of high-value crops. Agricultural commercialization clusters have now been created in four regions. The four key commodities in the Oromia region are maize, wheat, tef, and barley [5]. According to CSA data, wheat covers 1,897,405 hectares of land and is grown by 4,579,491 farmers in Ethiopia, and it covers 996,364 hectares of land and grown by 1,832,546 farmers in the Oromia region, and it covers 35,352 hectares of the cultivated area of land and grown by 62,671 farmers in central Oromia which Walmara district is located in [4].

Smallholder farmers' market-oriented production is a key to the growth of the agricultural sector and a means of improving agrarian livelihoods but the majority of smallholders in developing countries face challenges to fully exploiting the existing potential of the markets due to different marketing constraints and elevating these challenges focusing on modernization and market-orientation of the smallholder's agriculture is indispensable [6]. There are two wheat marketing channels, the formal and informal channels. The informal channel is dominant among smallholders in rural areas and smallholders usually seek for selling their products to local collectors who gather wheat from rural producers to resell it to wholesalers due to fear of transaction costs. The formal sector includes primary cooperatives, unions, rural wholesalers, commercial farmers, and millers [7]. The constraints of the commercial orientation of wheat producers are lack of resources, knowledge of production technologies, and poor marketing linkages. To this effect, wheat producers receive less economic benefit from agricultural activities. Thus, considering the suitability of central Ethiopia for wheat production, this study aimed at identifying those factors determining wheat market participation and the intensity of wheat farmers' commercialization in the study areas to take evidence-based correction measures.

2. Research Methodology

2.1. Study Areas

Walmara district is geographically situated between 8°50'-9°15' N and 38°25'-38°45' E. The total area coverage of the district is 65,605 hectares. The altitude of the district is ranging from 2060 to 3380masl with an average of 2400masl. About 61 percent of the district is highland and 39 percent is mid-highland. The mean annual rainfall of the district is 1,144 mm, ranging from 795 to 1300 mm. The annual temperature ranges from 6°C to 24°C, with an average of 14°C. Walmara district is bordered on the south by Sebeta Hawas, on the west by Ejere, on the north by Adeaberga, and on the east by Kolobo. According to the CSA population projection report, the population of the district was 112,498 (56,200 male and 56,298 female) in 2019. The farming system of the district is characterized by both crop and livestock production. Cereal major crops grown in the district includes wheat, barley, and tef. While pulses crops, oilseed, potatoes, and other vegetables are also grown in the district.

2.2. Data Types, Sources, and Collection Methods

In this study, both primary and secondary data sources were used. The structured and semi-structured questionnaires were used to collect the primary data from sample respondents. Secondary data on socio-economic information was taken by reviewing published journals articles, unpublished documents of the districts and websites were visited.

2.3. Sampling Procedure and Sample Size Determination

To select the required sample respondents a purposive and two-stage sampling procedure was followed. Walmara district was selected purposively for this study by classifying into highland and mid-highland agro-ecology. First, four representative sample peasant associations, two from each ecology were randomly selected. In the second stage, from the total of 1995 households, 200 sample household heads were selected using systematic random sampling. To decide the required sample size of (n=200) the rule of thumb was followed. The sample size from each kebele was selected based on the proportional sampling method using the formula:

$$ni = \frac{(Ni)\,(n)}{\sum Ni} \quad (1)$$

Where ni - the sample to be selected from ith kebele.

Ni - the total population living in ith kebele.

ΣNi - the summation of the population living in selected four kebeles.

n - total sample size for the district.

2.4. Methods of Data Analysis

In this study, descriptive statistics tools and econometric models were employed to examine the collected data from sample households.

2.4.1. Descriptive Analysis

Descriptive statistical tools such as mean, proportions, percentages, standard deviations, t-test, and chi^2 test were used to describe the demographic and socio-economic characteristics of sample respondents. In addition, the household commercialization index (HCI) defined as the ratio of the gross value of wheat sold to the gross value of wheat produced was used to measure the intensity of commercialization. Mathematically, the HCI adopted from [8] is expressed as:

$$HCI = \frac{\text{The gross value of wheat sold}}{\text{The gross value of wheat produced}} \text{ x } 100 \quad (2)$$

HCI_i = Commercialization index of i^{th} household in whet marketing expressed as a percentage.

2.4.2. Econometric Analysis

To identify the factors affecting wheat market participation and the intensity of wheat commercialization a Double hurdle model which interprets the zero observation as a corner

solution and addresses the intensity of marketed surplus was used. The Double hurdle model was first introduced as a class of models by [9]. The modeling approach assumes a two-step decision process, the first step was the decision either to participate or not participate in the wheat market, and secondly, is the quantity of wheat marketed. The Double hurdle model estimation involves a probit regression to identify factors affecting the decision to participate in the wheat market in the first stage, and a truncated regression model to identify the determinants of the quantity of wheat marketed among participating households, in the second stage.

The general form of Cragg's Double hurdle model (probit and truncated models) that was used for this study is specified as follows.

$$D_i^* = W_i'\alpha + U_i \text{ (participation decisison)} \quad (3)$$

$D_i = 1, if\ D_i^* > 0, D_i = 0, Otherwise$

Where, D* is the latent variable describing the household's decision of whether or not to adopt improved *tef* varieties that take the value 1 if the household adopted and 0 otherwise, D_i is the observed variable that represents the household's participation decision, W_i is a vector of explanatory variables, α is a vector of parameters to be estimated and U_i is the error term.

$$Y_i = X_i^*\beta + V_i \text{ (Commercialization decision)} \quad (4)$$

$Y_i = Y_i^* = X_i\beta + V_i$ if $Y_i^* > 0$ and $D_i^* > 0, Y_i$=0, Otherwise

Where, Y_i^* is the latent variable describing the intensity of the market. Y_i is the quantity of wheat marketed and X_i indicates the vector of explanatory variables influencing how much the household participates in wheat selling, β is a vector of parameters to be estimated and whereas V_i is the error term? If both decisions are made by the individual farmers independently, the error term is assumed to be independently and normally distributed as: U_i~N (0, 1) and V_i~N (0, δ2).

The log-likelihood from the Cragg type double-hurdle model is the sum of the log-likelihood from probit and a truncated regression. Hence, the double-hurdle model is given by:

$$\text{Log } 1 = \Sigma_0 \ln\left(1 - \phi\left(W_i'\alpha\left(\frac{X_i^*\beta}{\sigma}\right)\right)\right) + \Sigma_+ \ln\left(\phi(W_i'\alpha)\frac{1}{\sigma}\emptyset\left(\frac{Y_i - X_i^*\beta}{\sigma}\right)\right) \quad (5)$$

Where Φ and ∅ are standard normal cumulative distribution function and density function respectively.

To fix the appropriate models for the study a test for the double-hurdle model against the Tobit model was made. The Akaike information criterion (AIC) is a mathematical method used for evaluating how a selected model fits the data to compare different possible models and determine which one is the best fit. The Akaike information criterion (AIC) is calculated from the maximum log-likelihood of the model and the number of parameters used to reach that likelihood. Mathematically:

$$AIC = 2K - 2\ln(L) \quad (6)$$

K is the number of explanatory variables used and L is the log-likelihood estimate (the likelihood that the model could have produced your observed y-values). According to AIC, the best-fit model is the one that explains the greatest amount of variation using the fewest possible explanatory variables, and models with lower AIC values are a best-fit.

3. Results and Discussions

3.1. Descriptive Analysis Result

3.1.1. Households Demographic and Socio-economic Characteristics

Group comparisons of wheat market participants and non-participants were computed using a *t*-test for continuous variables and a chi^2-test for dummy variables, and the results from the analysis were presented in consecutive tables. As shown in Table 1 below, out of the total sample households 171 (85.5%) were male-headed and 29 (14.5%) of them were female-headed. The chi^2-test result among wheat market participants and non-participants shows that there is a significant difference between the two groups in terms of access to credit and the existence of crop disease market participants are more in number than non-participants.

Table 1. *Test statistics of wheat market participants and non-participants (chi^2 -test).*

Variables		Participants		Non-participants		chi^2-value
		(n=99)	49.5%	(n=101)	50.5%	
Sex of household head	Male	85	85.9	86	85.1	0.07
	Female	14	14.1	15	14.9	
Access to credit	Yes	93	93.9	87	86.1	3.38*
	No	6	6.1	14	13.9	
Extension contacts	Yes	89	89.9	85	84.2	1.46
	No	10	10.1	16	15.8	
Crop diseases	Yes	44	44.4	58	57.4	3.37*
	No	55	55.6	43	42.6	

Symbols: * indicates significance at 5% levels
Source: Own household survey result.

The results of the two-group mean-comparison test of continuous variables indicate that there is a significant mean difference among wheat market participants and non-participants by four explanatory variables (Table 2). The mean value of household size, years of formal schooling, and total land size among wheat market participants and non-participants is statistically significant at 1%. The average household size of sample respondents was 4.74 with a standard deviation of 1.904. Concerning the educational level of sample household heads the mean difference among wheat market participants and non-participants is statistically significant at 1% in favor of the former, and the average years of formal schooling completed were 4.24 years with a standard deviation of 3.88.

Table 2. *Test statistics of wheat market participants and non-participants (t-test).*

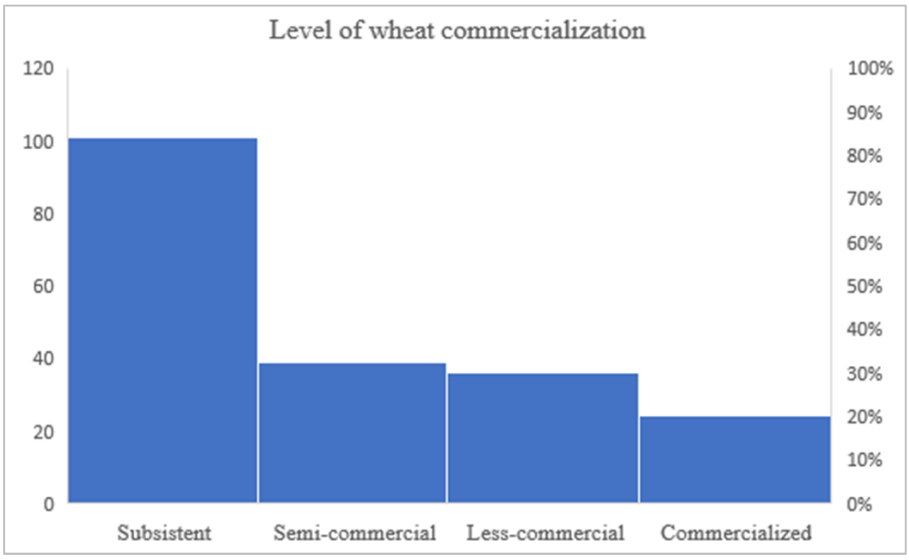
Variables	Mean			Std. Dev.	*t*-value
	Participants (n=99)	Non- participants (n=101)	Total (n=200)		
Age of household head (years)	42.727	44.971	43.86	9.924	1.6
Household size (adult equivalent)	4.271	5.21	4.74	1.904	3.6***
Education level (formal schooling)	5.01	3.485	4.24	3.880	-2.85***
Livestock owned (TLU)	7.848	6.756	7.29	3.965	-1.95*
Total land owned (hectare)	1.815	1.313	1.56	1.209	-3***
Non/off-farm income (ET Birr)	7192.9	7818.6	7508.9	10043.7	.45
Distance to nearest market	5.091	5.406	5.25	2.211	1

Symbols: *** and * indicates significant at 1% and 10% levels, respectively
Source: Own household survey result.

The mean difference in livestock owned among wheat market participants and non-participants is statistically significant at 10% in favor of the participants and the mean livestock owned of sample respondents was 7.29 TLU with a standard deviation of 3.965 (Table 2), whereas the mean difference in total land owned among wheat market participants and non-participants is statistically significant at 1% in favor of the participants and the average total land owned by sample households was 1.56 with a standard deviation of 1.209.

3.1.2. Level of Wheat Commercialization of Sample Respondents

The survey result Figure 1 below specifies the level of wheat commercialization of sample respondents in the study areas. The average level of wheat commercialization of sample respondents is 37.3% and most of the households in the study area are a subsistent wheat producers. This average value of wheat commercialization shows that the study area is categorized at a semi-commercial level.



Source: Own household survey result

Figure 1. *Level wheat commercialization of sample households.*

3.2. Econometric Model Results

Essential tests were made before econometric analysis to verify the hypothesized explanatory variables and the existence of econometric problems using appropriate test statistics. The AIC results revealed that the value of the Tobit model is 986.22 and that of the Double-hurdle model is 497.14 implies that for identifying the factors affecting market participation

and intensity of commercialization in wheat a Double-hurdle model feat the data. The estimated coefficients of the Probit regression model and Truncated regression model were presented in the following consecutive sections.

3.2.1. Factors Affecting the Probability of Wheat Market Participation

The Probit regression model results shown in Table 3 below revealed that out of eleven explanatory variables used in the model five of them the education level of household head; household size; the number of Livestock owned; total land owned; and access to credit were found statistically significant to influence the probability of whet market participation in the study area.

The educational level of the household head was found to have a positive and significant effect on the probability of wheat market participation at 5% level of significance. The positive association implies that the level of formal education of the household head increased by one grade the probability of wheat market participation increased by 2%. This result indicates that attending formal education improves wheat producers' knowledge of using production inputs and the amount of wheat marketed. Hence, availing access to formal education for farmers in the study areas is required to enhance wheat production and improve market participation. This result is similar to the findings of [10] who get the level of household head education of the increased intensity of wheat commercialization.

The size of household members measured as adult equivalent was found to have a negative and significant effect on the probability of wheat market participation at 1% significance level. This result displays that as the household size increased by one adult equivalent the probability of wheat market participation decreased by 7%. This result is because of households with more household sizes tend to consume more of the wheat output produced and less is available for the market. This result is supported by the findings of [11] who showed that the larger households are expected to have lower market orientation and market participation.

The number of livestock owned has a significant and positive effect on the likelihood of market participation at 10% probability level. The result implies that an increase in the number of livestock owned by a unit rises the likelihood of wheat market participation by 1.8%. This is due to the positive effect of livestock resources on wheat cultivation as a source of traction power and the income from the sale of livestock used to purchase wheat production inputs. This outcome is in line with the previous studies [12] that households who have a greater number of draft oxen meet the standard cultivation of wheat production and also enhance the purchasing power of smallholder farmers to the best agricultural practices.

Table 3. *Probit model estimates the probability of wheat market participation.*

Variables	Coefficient	Robust Std. Err.	p-value	Marginal effect
Sex of household head	-0.382	0.289	0.186	-0.150
Age of household head (years)	0.000	0.011	0.996	0.000
Education level of hh head	0.049*	0.026	0.058	0.020
Household size (adult equivalent)	-0.176***	0.059	0.003	-0.070
Livestock owned (TLU)	0.045*	0.027	0.088	0.018
Total land owned (hectare)	0.182**	0.085	0.032	0.073
Non/off-farm income	0.000	0.000	0.960	-0.000
Frequency of extension	0.296	0.289	0.305	0.117
Distance to nearest market	-0.021	0.043	0.632	-0.008
Access to credit	0.559*	0.322	0.083	0.214
Crop disease	0.017	0.204	0.932	0.007
Constant	0.336	0.746	0.652	
Wald chi2 (11)	33.45			
Prob > chi2	0.0004			
Log-likelihood	-121.611			

Symbols: ****, ** and * indicates significant at 1%, 5% and 10% levels, respectively
Source: Own household survey result.

The total land size of the household head was found to be a statically significant and positive effect on the probability of participating in the wheat market at 5% level of significance. The result implies that an increase in the areas of land owned by one hectare raises the likelihood of wheat market participation by 7.3%. The positive association implies that households having large hectares of cultivable land allocate more areas for wheat production and produce surplus output to participate in the market. This result is in line with the findings of [12] that an increased in the land size allocated to wheat production rises the volume of wheat supplied to the market.

Access to credit services has a significant and positive effect on the probability of market participation at 10% significance level. The result implies that sample households having access to credit services enhances the likelihood of wheat market participation by 2.1%. This is due to the positive effect of credit services on wheat production and productivity by purchasing improved seed and inorganic fertilizers. This outcome is supported by findings of [10] that credit services play a vital role in elevating cash constraints of farmers required in production which in turn has a positive effect on marketable surplus.

3.2.2. Factors Affecting the Intensity of Wheat Commercialization

The likelihood function of the Truncated regression model for the intensity of wheat commercialization is significant (LR 2 (11) =20.51 with Prob > Chi2 = 0.038) indicating the explanatory power of the explanatory variables (Table 4). The result of the Truncated regression model showed that out of eleven explanatory variables used in the model three variables, namely the size of household members (adult equivalent), frequency of extension service, and off/non-farm income were found to significantly influence the commercialization of wheat producers in the study area. The size of household members was found to have a positive and statistically significant at 10% significance level. An increase of household members by one adult equivalent decreases the wheat commercialization level by 4.23%. This result is expected because households with more household members tend to consume more of the wheat output produced and less is available for sales. This result is supported by the findings of [10, 13] who find that a large family size increases the quantity for home consumption thereby reducing the marketed surplus.

Household incomes obtained from non/off-farm activities affect the level of wheat commercialization negatively and significantly at 1% significant level. This result indicated that an increase in the amount of off/non-farm income by one ET birr decrease the commercialization intensity by 0.001%. This is because of households that gained income from non/off-farm activities were not encouraged to take part in modern agriculture by employing full production packages and they used the produced wheat for household consumption. This result is supported by the findings [14] who found that the farmers getting more off/non-farm activities to consider wheat production as part-time activity.

Table 4. *Truncated regression estimates on the intensity of wheat commercialization.*

Variables	Coefficient	Robust Std. Err.	p-value
Sex of household head	-7.728	10.828	0.475
Age of household head (years)	0.133	0.347	0.701
Education level of hh head	0.913	0.958	0.340
Household size (adult equivalent)	-4.231*	2.199	0.054
Livestock owned (TLU)	-0.802	0.758	0.290
Total land owned (hectare)	1.151	2.776	0.678
Non/off-farm income	-0.001***	0.000	0.005
Frequency of extension contact	21.270*	11.915	0.074
Distance to nearest market	0.247	1.350	0.855
Access to credit	8.476	11.029	0.442
Crop disease	-3.374	7.394	0.648
Constant	30.177	34.715	0.385
Sigma	23.014***	1.845	0.000
Wald chi2 (11)	20.51		
Prob > chi2	0.0388		
Log-likelihood	-350.532		

Symbols: *** and * indicates significant at 1%, 5% and 10% levels, respectively
Source: Own household survey result.

As revealed in Table 4 above, extension contact has a positive and statistically significant effect on the intensity of commercialization at 10% significant level. The result shows that an increase in extension contact of farmers with the development agents by one day would increase the commercialization level of wheat by 21%. This result was because of getting technical advice on the production and marketing of wheat enables farmers to cultivate wheat by applying full production and package and enhance the quantity of wheat marketed to improve their family's livelihood. This finding is similar to the results of [12] who found that access to extension service providers on commercial farming would increase their wheat commercialization.

4. Conclusions and Recommendations

Wheat is cultivated by more than 4.5 million farmers and contributed to 5.7 million tons of grain production in Ethiopia. Wheat is among the ten key priority commodities of commercialization clusters in Ethiopia. This study aimed to identify the factors affecting wheat market participation and the commercialization level of wheat producer farmers in the walmara district, central Ethiopia. The data analysis employed both descriptive statistics tools and a Double hurdle econometric model. The descriptive statistics results show that out of the total sample respondents 99 (49.5%) were wheat market participants and 101 (50.5%) were non-participants. The chi^2-test result indicates the existence of a significant difference between market participants and non-participants in terms of access to credit and the existence of crop disease. The two-group mean-comparison test of continuous variables shows the existence of a statistically significant mean difference between two groups by four explanatory variables. The average commercialization level of wheat farmers in the study areas was 37.3%, this displays that the study area is categorized as a semi-commercial level. The DH model estimation involves a probit and a truncated regression model to identify factors affecting wheat market participation and the intensity of commercialization, respectively.

The probit model result indicated that education level,

livestock owned, total land owned, and access to credit were statistically significant and positive to influence the likelihood of wheat market participation whereas household size was negative and statistically significant to affect wheat market participation of sample respondents. As to the intensity of wheat commercialization, the Truncated regression model result infers that household size and off/non-farm income determine the commercialization level negatively and significantly whereas the frequency of extension contact moves the level of commercialization positively and significantly. Therefore, to increase wheat market participants and enhance the commercial orientation farmers' efforts focus on improving production technology, modern production, and marketing training are crucial.

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