International Journal of Agricultural Economics
2021; 6(6): 305-314
http://www.sciencepublishinggroup.com/j/ijae
doi: 10.11648/j.ijae.20210606.18
ISSN: 2575-3851 (Print); ISSN: 2575-3843 (Online)

Determinants of Onion Marketed Among Smallholder Producers in Gemechis District, West Hararghe Zone, Oromia National Regional State of Ethiopia

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To cite this article:

Ahmed Abrahim, Kumilachew Alamerie, Alelign Ademe. Determinants of Onion Marketed Among Smallholder Producers in Gemechis District, West Hararghe Zone, Oromia National Regional State of Ethiopia. *International Journal of Agricultural Economics.* Vol. 6, No. 6, 2021, pp. 305-314. doi: 10.11648/j.ijae.20210606.18

Received: September 27, 2021; **Accepted**: November 22, 2021; **Published**: November 27, 2021

Abstract: Onion plays a crucial role in enhancing food security and generates income for the smallholder farmers of Ethiopia. This paper was attempted to analyze the determinants of onion supplied to the market in Gemechis District, Oromia Region of Ethiopia. Data for the study were collected from both primary and secondary sources. The primary data were collected by household survey using a pre-tested structured questionnaire and key informant interview using checklists. The data were collected from 176 farmers. The collected data was analyzed using both descriptive statistics and econometric model. The descriptive statistics was used to analyze the socio-economic characteristics of smallholder farmers and econometric model was used to determine the factors affecting onion supplied to the market. The results of two-stage least square regression model showed that quantity of onion supplied to the market was significantly and positively influenced by the endogenous quantity of onion produced. In addition, distance from nearest market, non/off farming income, land allocated and lagged price significantly affect the onion marketed. The study findings suggest the need to improve rural road infrastructure, intensification of land to compensate through cash crop production and efficient utilization of the existing limited farm land and encourage investment on off/non-farm incomes as well as onion production.

Keywords: Gemechis, Onion, Quantity Marketed, Smallholder, 2SLS Regressions

1. Introduction

Agricultural sector in Ethiopia is the most important which accounts for 36% of GDP, 80% of export earning and about 70% of employment [18]. The sector still remains largely dominated by rain-fed subsistence farming by smallholders who cultivate on an average landholding of less than a hectare. Even though the sector has a long history in the country's economy, development of the agriculture has been hindered by many constrains which include soil erosion, shortage of agricultural inputs, weak organizational structure, and lack of efficient and effective agricultural policies and strategies [5].

Horticultural crops, especially vegetable production and marketing play a crucial purpose for countries like Ethiopia, in enhancing the producers' income and improving the nutritional status. Moreover, it supplies the opportunities of employment as the production of vegetable is labor intensive [6]. Vegetable are the most essential source of vitamins and minerals, and are important for a balanced and healthy diet. Diversifying and enhancing vegetable production helps to reduce malnutrition and poverty by increasing home consumption and create new market opportunities for farmers. Furthermore, vegetable marketing offers new income and job opportunities in trading and processing sectors [4].

Vegetable crops such as onion, tomato, potato, beetroot, carrot, cabbage, sweet potato and pepper are largely

produced in Ethiopia. Among these, onion is the most crucial vegetable cultivated on large scale in Ethiopia. The area of onion production is enhancing from time to time because of the onion profitability per unit area and ease of production and the increase in small-scale irrigation areas [28]. During the 2018/2019 production period, the total hectors of onion cultivation was estimated to be 28,185.11 hectares with an average product of about 9.31 tons per hectare and an estimated total production of greater than 262,478.3 tons [10].

Onion production and marketing has an important role in poverty reduction through employment generation and creating job opportunities for smallholders [3]. The demand for onion products is increasing while supply is lagging. Markets imperfection in and imbalanced market information hinder the potential profit that could have been achieved under the presence of business sectors with complete data [20]. Both farmers and traders do not have the same level and type of market information on the onion prices at the central market [8]. Improved information and marketing facilities enable smallholders to plan their production more in line with market demand, to schedule their harvests at the most profitable time, to decide which markets to send their produce to and negotiate on a more even footing with traders and also it enables traders to move produce profitably from surplus to deficit market and to make decisions about the economics of storage, where technically possible [22]. Enhancing smallholder farmers' income from onion production and marketing is a vital determinant of prosperity and advancement in Ethiopia. In rural areas, onion marketing plays a crucial role in generating better income and enhancing the welfare of smallholder farmers and thus contributes to their livelihoods. Successful market chain developments for onion products with a relatively large demand may lead to the adding up effect with market potential being exaggerated by the strong interest from the side of market participants [12].

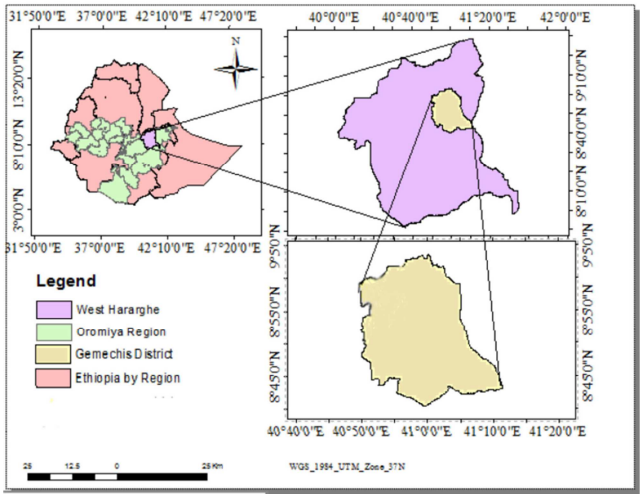
In West Hararghe, smallholder farmers producing onion both for home consumption as well as for market demand under rain fed agriculture in *meher* season and using irrigation during dry season. In 2019/2020 production period, the total land of onion cultivation was estimated to be 13,492 hectares and the estimated total production was greater than 1,186,306 quintals [29]. Gemechis district is one of the major vegetable producers in West Hararghe Zone in which onion is the dominant one. This District is endowed with available resources that offer high potential for development and has suitable agro ecology for onion production. So far, however, in Gemechis District, there are no significant studies that were conducted and documented on the determinants of the onion marketed. In the absence of such type of studies, the onion productivity and ultimately to ensure food security in the area could be the major problem. Therefore, in this study, the major determinants of the onion marketed would be conducted.

2. Methodology

2.1. Description of the Study Area

Gemechis *woreda* is one of the 15 *woredas* of West Hararghe Zone which situated at a distance 343 km east of Addis Ababa and 16 km south of Chiro town. It shares borders with Chiro *woreda* in the north, Oda Bultum *woreda* in the west and Shanan Dhugo *woreda* in the east [13]. The *woreda* covers an area of 77,785 hectares and has 34 *kebeles*. The total population of the *woreda* is 235,638 of which 119,485 are males and 116,153 are females [9]. The number of agricultural households in the district is estimated to 38,500 with 32,308 male headed and 6,192 female headed [13]. The average family size is estimated to be 4 and 6 per household in rural and urban areas respectively. The district is the first most densely populated district in the zone.

Gemechis *woreda* is suitable for onion cultivation because of its convenient agro-ecology and availability of underground irrigation water. In 2018/19 cultivation period the total yield of onion in Gemechis *woreda* is estimated to be 26,124 quintals on 1,088 areas of land. Whereas, in 2019/20 production period, about 34,816 quintals were produced on 1,324 areas of land. This shows that the yield and area coverage of onion in Gemechis *woreda* has increased even if there is a shortage of water during the off season [13].



Source: Manipulated from Ethiopian map, 2020

Figure 1. *Location map of the study area.*

2.2. Sources of Data and Methods of Collection

The survey was conducted in February 2020 using semi-structured questionnaires to collect primary data from 176 onion producers. In addition to formal questionnaire survey, focus group discussions at village level were applied in three groups based on the planned checklists and field observation on some randomly selected farmers were conducted. Moreover, key informant interviews were also employed. The main purpose of the focus group discussion is to validate information obtained from the survey and to generate in-

depth information on some of the survey findings and perceptions of the farmers that may not have been adequately captured by the questionnaire survey.

To generate information at the field level, six enumerators who are familiar to the study area and believed to have sufficient exposure to rural life was selected and trained on data collection tools and interview handling. Field supervision was responsible to carry out field level verification and initial approval of the works of the respective enumerators.

Secondary data sources were taken from Gemechis District Agriculture and Natural Resource office, Gemechis District Marketing Development Office, West Hararghe Zone Agriculture and Natural Resource office, West Hararghe Zone Marketing Development Office and published and unpublished reports, Central Statistical Authority (CSA), bulletins, and websites.

2.3. Sampling Procedure and Sample Size

The samples for this study were obtained from the chain actors participated in the onion marketing. For the primary data collection, two-stage sampling technique was employed to draw sample household heads. In the first stage, with the consultation of the District Agriculture and Natural Resource office, the three highly potential onion producer villages namely, *Sagariya*, *Walenso harabafana* and *Sororo* were purposively selected. In the second stage, a total of 176 household heads were selected from 2884 onion producers of Gemechis *Woreda*.

There are many approaches to determine the sample size. These include using census for small populations, using published tables, applying formulas and using rule of thumb [16]. In this study rule of thumb [16] was used to determine sample size. Accordingly, the sample size was determined by $n \geq 30 + 10k$, where n=sample size and k=number of explanatory variables included in the model. Then the study has k=13, $n \geq 30 + 10*13 \geq 160$. But in this study the sample size was inflated to176 to check non-respondents.

To decide the number of households to be interviewed from each kebele, probability proportional to size was used. The probability proportional to sample size allocation formula [21] given by; $ni = \frac{nNi}{N}$, where, n_i=sample household from i^{th} *kebele*, n=total sample size, N_i=total household in i^{th} *kebele* and N=total households in selected *kebeles* of the *woreda*.

Table 1. *Sample distribution of onion producers in selected kebeles.*

No.	*Kebeles*	Total number of onion producers	Number of sampled households
1	Sagariya	464	114
2	Walenso harabafana	146	36
3	Sororo	102	26
Total		712	176

Source: Gemechis District Agriculture and Natural Resource Office, 2020

2.4. Methods of Data Analysis

In this study, descriptive statistics and econometric analyses were used for analyzing the data.

2.4.1. Descriptive Statistics

The descriptive statistics was used to describe the demographic, socio economic and institutional characteristics of sampled onion producer in the study area.

2.4.2. Econometric Analyses

Multiple linear regression model (OLS) was used to analyze the determinants of onion marketed due to all sampled smallholder farmers were participated in onion marketing. However, when some of the assumptions of the Classical Linear Regression model are violated, the parameter estimates of the above model may not be Best Linear Unbiased Estimator (BLUE). Thus, it is important to check the availability of heteroskedasticity, multicollinearity and endogeneity problem before fitting important variables into the regression models for analysis.

Both Hausman test and Durbin-Wu-Hausman (DWH) test were used to check the availability of endogeneity. In case of this study, there is a potentially endogenous variable, which is the quantity of onion produced included in the explanatory variables that could cause endogeneity bias if OLS is applied. Therefore, in identifying the determinants of farm level marketed surplus of onion a two-stage least square (2SLS) model was used. Two-stage least square is similar to OLS except that uses two completely separate stages during the analysis phase in order to avoid problems of endogeneity [29]. Econometric model specification of supply function in matrix notation is as follows:

$$\text{Structural equations: } Y = \delta Y_1 + \beta_0 + X'\beta_1 + U \quad (1)$$

where; Y is a vector of quantity of onion supplied to market, X is exogenous variable that is assumed to affect onion marketed surplus, Y_1 is a vector of endogenous variables which is the quantity of onion produced, δ, β0 and β1 are a vector of parameters to be estimated and U is a vector of disturbance terms.

As the name suggests 2SLS involves using OLS regression in two stages. In the first stage a reduced form of the structural equations is estimated where the endogenous variable quantity of onion produced is regressed on all the exogenous variables in the system separately.

$$\text{Reduced form: } Y_{1i} = \alpha_o + \alpha_1 X_i + \alpha_2 Z_i + v, \quad (2)$$

Where, Y_{1i} is endogenous variable (quantity of onion produced), X_i is vector of exogenous variables, Z_i is a vector of excluded instruments (amount of fertilizer applied for onion and improved seed), αis the coefficients to be

estimated and ν is the errors terms, symmetrically distributed around zero. In order to obtain consistent estimators in this case, we need some additional information. These instruments (in this case Z) must satisfy two conditions; uncorrelated with U, also called orthogonal to the error process (exogeneity condition i.e. Cov (Z, U)=0) and correlated with Y_1 the endogenous variable (relevance condition i.e. Cov (Y1, Z) ≠ 0) [30]. Furthers, multicollinearity problem among explanatory variables have been checked using the Variance Inflation Factor (VIF). As a rule of thumb, if the VIF is greater than 10, the variable is said to be highly collinear [14]. A measure of multicollinearity associated with the variance inflation factors is computed as:

$$VIF\ (X) = \frac{1}{1-Rj^2} \quad (3)$$

Where; R_j^2 represents a coefficient for determining the subsidiary or auxiliary regression of each independent continuous variable X. Conversely, test for heteroscedasticity was undertaken for this study. To detect heteroscedasticity problem, Robust method was employed for correcting the problem.

2.5. Definition of Variables and Working Hypothesis

Dependent variables

Quantity Supplied to Market: A continuous variable that represents the actual supply of onion by individual farm households to the market during the survey year, measured in quintals (100kg).

Independent Variables

Quantity Produced: It is an economic factor and continuous variable that can affect the household level volume sales and measured in quintals. Quantity of onion produced when instrumented by improved seed and fertilizer is assumed to affect the volume supply positively, because a farmer that obtains high yield can supply more to the market than a producer who had fewer yields. [1] Illustrated an increase of vegetable production by farming households has augmented marketed output of the commodities significantly. [2] found that quantity of vegetable produced has positively and significantly influence on vegetable quantity supplied to market. Therefore, quantity of onion produced is hypothesized to have a positive effect on onion market supply.

Sex of the Household Head: This is a dummy variable (takes a value of 1 if the household head is male and 0 otherwise). The variable is expected to have either a positive or negative relation with volume of onion marketed. [2] found that sex of the household head positively and significantly influence leafy vegetable and potato marketed supply. Therefore, in this study, sex of the household head is expected to influence volume supply positively.

Family size: Family size of a respondent is a continuous variable measured in adult equivalent. Since onion production is the function of labor, the availability of labor is assumed to have positive relation with volume of onion supply. [25] Reported that the number of adult equivalent in household members had a positive effect on vegetable market supply. [17] Also showed that families with more number of active labour forces increase vegetable production and then increase vegetable marketable surplus. However, number of adult equivalent in household members is expected to have positive impact on volume of sales of onion.

Education Level of the Household Head: Education level of the household head is a categorical variable measured using the level of formal schooling of the household head. Education of the household head has a positive effect on the onion supplied to the market. [2] found out that, farmers who attended formal education have better skills and access to information to supply more vegetable to the market. [18] reported that education is believed to improve the knowledge of the household to increase the quantity of production and supply to the market. Therefore, education of household head is hypothesized to affect onion supplied the market positively.

Distance from Nearest Market: Distance to the nearest market is a continuous variable measured in walking minutes from the household residence to the nearest market. The closer the market, the lesser would be the transportation charges, reduced walking time, and reduced other marketing costs, better access to market information and facilities. Study conducted by [1] revealed that distance from the nearest market affects cabbage marketable surplus negatively and significantly. Because, as the distance to the market center increases transportation cost also increases; since cabbage is highly perishable and bulky product its loss and other marketing costs increased. In this study, distance from nearest market is expected to influence volume supply negatively.

Farming Experience: This is a continuous variable measured in number of years of onion production. A household with better experience in onion farming is assumed to produce more amounts of onion and, as a result, assumed to supply more amounts of onion to market. [1] implied as farmers have high potato production experience the amount of potato supplied to the market increased through its effect on potato production. [27] found that experience in papaya production had a positive and significant effect on papaya volume marketed. Therefore, it is expected that farm experience have positive effect on onion quantity supplied to the market.

Non/Off Farm Income: It is a continuous variable measured in amount of birr the farmer earned other than farming. Farmers engaged in off-farm income were expected to generate more income. [2] Found that the amount of potato supplied to the market increases as potato producer have engaged in non-farm income. Therefore, in this study off/non-farm income has expected to influence the volume of onion supply to market positively.

Frequency of Extension Contact: This is continuous variable which is the number of days that farmer had contact with extension agent for agricultural work supervision in a year. The objective of the extension service is introducing farmers to improved agricultural inputs and to better methods of production. [7] found that if fruit producer gets extension,

the amount of fruits supplied to the market increases. Farmers that have frequent contact with extension agent have better access to information and could adopt better technology that would increase their marketed supply of vegetables. Therefore, extension is assumed to have positive contribution to farm level volume supply of onion.

Land Allocated for onion: This variable is assumed to have a positive relation with the dependent variable and is continuous variable measured in hectare. Onion is cash crop having a direct relation with volume supplied. Increase in the area of land covered by the onion can directly increase the marketed supply of onion. [15] Found that land allocated to sesame production influenced marketable supply of sesame positively. Hence, area allocated for onion is hypothesized to influence positively volume supply to market.

Access to Market Information: This is a dummy variable taking value of 1 if the producer had access to market information and zero otherwise. The better market information farmers have the more likely they supply onion to the market. [1] Stated that availability of market information reduces farmers risk aversion behavior of getting a market and decreases marketing costs of farmers that affects the marketable surplus. Obtaining and verifying of market information helps smallholders to supply more quantity of vegetables. Poor access to market information results in information-related problem, namely moral hazard and adverse selection which in turn increase transaction costs and hence discourages participation in the market by some farmers [23]. Therefore, it is expected that market information has positive effect on onion quantity supplied to the market.

Credit Utilization: This is a dummy variable, which assumes a value of one if the farmer has utilized credit and zero otherwise. Utilization of credit would enhance the financial capacity of the farmer to purchase the necessary inputs and increases the onion production. [19] Found that utilization of credit had positive and significant influence on volume of wheat supply. Therefore, for this study, it is hypothesized that utilization of credit has positively influence on volume of sales onion.

Livestock Ownership: This is a continuous variable measured in terms of tropical livestock unit (TLU). It was assumed that households who have a number of livestock have better economic strength and financial position to purchase sufficient amount of inputs and also used their manure as an input for the production of onion. [18] Found out that households with large numbers of livestock produce and supply more potato. For this study TLU was hypothesized to influences Quantity of onion supplied to the market positively and significantly.

Lagged price of onion: is the price of onion in 2018/19 (one year lagged price). It is a continuous variable and measured in birr per quintal. There exists a direct relationship between the price of onion in the past and supply of onion in the current. This is because if price of onion was high in the past, it would be motivating the farmers to supply more onion in the present. Study by [6] lagged market price affect marketable supply of red paper positively. Therefore, it is hypothesized to affect the volume of onion supply positively.

Irrigation Access: This is a dummy variable which takes a value of 1 if the household have access to irrigation and 0 otherwise. Having access to irrigation was hypothesized to have positive influence on quantity of onion sold. A study by [25] found that households having irrigation access tend to sale more volume of vegetables than households who have no irrigation access. [18] revealed that farmers who have irrigation access can produce potato more two times a year and supply more potato to the market. Therefore, in this study, irrigation access has a positive effect on volume of onion supply.

3. Results and Discussion

3.1. Descriptive Statistics Results

The socio- demographic attributes of the farm households (sex, family size, age, education, farming experience, land size and income) play a very crucial role in onion production and marketing. As indicated in Table 2, the majorities of the households are male headed (with nearly 85 percent) and the mean age of respondents is 38.6 years. Education level of household heads varies among the sample *kebeles* of the district. The survey result shows that about 21.88% of the sampled household heads were illiterate, 56.88% attended primary school, 18.75% attended secondary school and 2.5% attended higher education. The mean family size of the total sample households was 4.29 ranging from 2 to 6 and this can be considered as a proxy for labor availability. The average farming experience of sample respondents were 12.18 years with a standard deviation of 5.6 years.

Land is one of the most important factors of onion production. It is the main sources of income and enhances the status of smallholder in the community. A sample smallholder farmer owned 0.96 hectares on average, which ranges from 0.75 to 1.5 hectares and this indicates that there is the scarcity of land in the study area. On the other hand, the average land allocated for onion production was 0.46 hectares and the average onion produced per household was 19.62 quintals. Farm households under study generate their income from crop sales, livestock sales, and off-farm and non-farm activities. It has been observed that sales of cereal crops and *khat* were the main source of income in the study area. The average income of the sampled households participating in off-farm and non-farm activities was 2988 Birr per annum. Moreover, a household under study owns 3.63 TLU on average.

Accesses to institutional services (distance to nearest market, extension contact, credit utilization, irrigation access and access to market information) are important determinants that affect onion market supply. Even though extension contact is the most important element for the production of onion, only about 50.63% had access to extension contact. Moreover, the absence of interest free credit service institution in the study area hinders smallholder farmers to utilize credit since the

majority of the district residents are Muslims. In Gemechis district, the majority of onion was produced under irrigation system in dry season. The sample onion producers travels average walking minutes of 12.32 to access development center and travel average walking minutes of 37.59 to access the nearest market place for their onion.

Table 2. *Summary statistics of the characteristics of sample farm households.*

Variable	Indicators	No of producers		Percentage
Sex	Male	136		85
	Female	24		15
Education	Illiterate	35		21.87
	Primary school	91		56.88
	Secondary school	30		18.75
	Certificate and above	4		2.5
Cereal crop		98		61.25
Chat		54		33.75
Oxen fattening		18		11.25
Petty trade (small shops)		12		7.5
Bee keeping		16		10
Others		10		6.25
No extension contact		79		49.38
Contact weekly		19		11.88
Contact once within two weeks		23		14.38
Contact monthly		14		8.75
Contact any time I ask		25		15.63
Credit utilization		35		21.87
Access to market information		51		31.87
Access to irrigation		123		76.87
Variable	Mean	SD	Min	Max
Age	38.61	8.39	23	61
Family size	4.29	1.15	2	6
Farming Experience	12.18	5.60	4	30
Farm size (ha)	0.96	0.23	0. 75	1.5
Land allocated for onion (ha)	0.46	0. 23	0.25	0.50
Average quantity of onion produced (qtl)	19.62	9.95	10.75	43
Distance from development center (minute)	12.32	8.70	3.50	35
Distance from nearest market (minute)	37.59	13.02	20	70
Off/non-farm income (Birr)	2987.94	1561.24	1200	6998

Note: SD=standard deviation, ha=hectare and qtl=quintal
Source: Survey results, 2020

3.2. Econometrics Model Results

The survey result revealed that all smallholder farmers producing onion have supplied their onion to the market. Accordingly, multiple linear regressions model was employed to determine the factors influencing onion supplied to the market. The variables included in the model were quantity of onion produced, sex of the household head, family size, education level of the household head, distance to the nearest market, farming experience, non/off-farm income, frequency of extension contact, land allocated for onion, access to market information, credit utilization, livestock owned, lagged price of onion and irrigation access. Prior to fitting multiple linear regressions, these variables were checked for the existence of multicolliniarity, heteroscedasticity and endogeniety problem.

Test for Multicollinearity: The degree of multicollinearity among the explanatory variables has been tested using VIF. The results for all VIF were ranging between 1.02 and 1.82. Therefore, since the values of all VIF were less than 10, there was no serious multicollinearity problem among independent variables.

Test of heteroscedasticity: Since there is heteroscedasticity problem in the data set, the parameter estimates of the coefficients of the independent variables cannot be BLUE. Therefore, to overcome the problem, Robust OLS analysis with heteroscedasticity consistent covariance matrix was estimated.

Test of endogeneity: When a variable is endogenous, it will be correlated with the disturbance term, hence violating the OLS assumptions and making the OLS estimates biased. Testing for endogeneity of quantity of onion produced was carried out in the model using both Hausman test and Durbin-Wu-Hausman (DWH) test and endogeneity problem was found in quantity of onion produced. Hausman test result indicated that, the predicted quantity of onion produced was statistically significant at (p=0.014) when included as additional explanatory variable in structural model which implies the hypothesized quantity of onion produced was endogenous due to correlated with error term. Durbin Wu-Hausman test results also shows that the null hypothesis of exogeneity of the quantity of onion produced was rejected at 5% probability level ($\chi^{2=}$6.031 and P=0.014) using estat endogenous STATA command after ivregress. Therefore, two stages least square (2SLS) method was used to address the

endogeneity problem.

Two-stage least square is a poor strategy for estimation and hypothesis testing when instruments are weak and the model is over identified. To overcome the endogeneity issue that two stage least technique requires valid instrumentals variables. Therefore, for this study relevance tests of excluded variables were made using F statistic from the first stage regression summery statistics using estat first stage STATA command. The F test result of the quantity of onion produced was 26.15 (as a general rule of thumb suggested by [24], if F test is less than 10 there is a cause for concern). So we should reject the null hypothesis of the presence of weak instruments and hence our statistics greatly exceeded the critical values. The over identifying restrictions test was also performed using Sargan score test and Basmann test. The result of Sargan score test and Basmann tests of over-identifying restrictions of 0.48 (p=0.5) and 0.42 (p=0.511), respectively shows that the model was correctly specified and the instruments were valid.

The 2SLS estimation results revealed that the quantity of onion produced, when instrumented by improved seed and fertilizer applied, significantly and positively influenced the amount of onion supplied to the market. This indicates that farmers who produce more quintals of onion are found to supply more onion to the market. It is known that the effect of instrumental variables on the amount of onion supplied to the market is expressed through quantity of onion produced. Result of first-stage indicated that increasing of the farm level quantity of onion produced through improved seed and fertilizer applied enhances the smallholder farmers' volume sales of onion. Furthermore, additional four variables were also found to influence the quantity of onion produced. These factors include distance form nearest market, extension contact frequency, land allocated for onion and access to credit.

As depicted in Table 3, in second stage of 2SLS, fourteen explanatory variables were used to run the model. Among these, five variables namely, quantity of onion produced, distance from nearest market, non/off farming income, lagged price and area of land allocated for onion were affected the quantity of onion supplied to market significantly. The result shows that the model was statistically significant level at 1% indicating the goodness of fit of the model to explain the relationships of the hypothesized variables. Coefficient of multiple determinations (R^2) was used to check goodness of fit for the regression model. Hence, R^2 indicates that 93.25% of the variation in the quantity of onion supplied to the market was explained by the explanatory variables included in the model.

Table 3. *Determinants of farm level volume sales of onion (2SLS estimates).*

Variables	Coefficient	Robust Std. Error	t-value
Constant	-0.67***	0.24	-2.79
Quantity produced	0.95***	0.37	2.57
Sex	0.78	0.65	1.20
Family size	-0.12	0.15	-0.80
Education	4.24	2.78	1.53
Distance from nearest market	-0.25*	0.15	-1.67
Farming Experience	0.02	0.07	0.29
Non/Off Farm income	2.21**	1.12	1.97
Frequency of Extension contact	0.03	0.26	0.12
Land allocated for onion	40.75***	5.23	7.79
Credit Utilization	0.06	0.45	0.13
Livestock owned	0.14	0.11	1.27
Lagged price (log)	2.25**	0.98	2.30
Irrigation Access	0.25	0.19	1.32
Market information	0.04	0.39	0.10
Number of observations		160	
Wald χ^2 (14)		1825.62	
Prob > χ^2		0.0000***	
R-Squared		0.9325	
Root MSE		0.8992	

Note: Dependent variable is quantity of onion supplied to market in quintal in 2019/20.
***, **and * Significant at 1%, 5% and 10% level of probability, respectively.
Source: Computed from survey result, 2020.

Quantity of Onion Produced: As hypothesized, the regression result shows that the quantity of onion produced positively and significantly affected the quantity of onion supplied to the market at 1% significance level. The result implies that, a quintal increase in onion production will cause an increase in the supply of onion by 0.95 quintal. This indicates that households who produce more quantity of onion will supply more to the market than those who produce less due to insignificant consumption of onion at home. This result is in line with the work of [11] who found out that an increase of the quantity of potato harvested by farming households has affected marketable supply positively and significantly.

Distance from the Nearest Market: It affects onion supply negatively and significantly at 10% significance level as expected. The result shows that as the distance from the

nearest market increased by one walking minute, the quantity of onion supplied to the market decreases by 0.25 quintals. This may be due to the reason that as the distance to the market center increases, transportation cost and other marketing costs increases which leads to decrease quantity of onion supply. This finding is in line with [26] who indicated that an increase of distance from nearest market caused marketable surplus of onion to decline.

Non/Off-Farm Income: This variable significantly and positively influenced the volume sales of onion at 5% significant level. The result shows that onion producers who earn income from non/off-farm activity will sell 2.21 quintals more onion than those who did not, by holding other factors constant. This may due to the fact that farmers who generate cash from these sources use as additional income to purchase inputs like improved seed, fertilizers, chemicals and farm implements for onion production and thus supplied more onion to the market than those who have not. This result agrees with [1] who found out that earning cash from non/off farm income influenced volume of cabbage supplied to market positively and significantly.

Land Allocated for onion: The result shows that land allocated for onion has positive and significant effect on volume of sales of onion at 1% significant level as expected. The result of the finding shows that, as the cultivated land for onion increases by one hectare, supply of onion increases by 40.75 quintals, keeping other factors constant. This shows that, the larger land size allocated for onion production, the larger the quantity of onion produce and thereby increasing the quantity of onion available for sale. Therefore, the size of land allocated has a positive relationship with the volume of onion market supply. This is in line with [2] indicated that the area of land allocated for potato production affected farm level marketed supply significantly and positively.

Lagged market price: As it was expected, it affected quantity of onion supplied to the market positively and significantly at 5% significance level. This relationship indicates that when the lagged price increases by one birr per kilogram, the current year supply of onion will increase by 2.25 quintals. Therefore, as the last year price of onion in the market rises, farmers are highly motivated to produce and supply more to the market and hence the onion market supply is directly related to the previous year market price. The finding agrees with [17] who indicated that one year lagged price affected potato marketable supply positively and significantly.

4. Conclusion and Recommendations

The aim of the study was to identify the determinants of quantity of onion supplied to the market. Econometric result of the two stage least (2SLS) regression model indicated that quantity of onion produced, non/off farming income, lagged price and area of land allocated for onion affect the amount of onion supplied to market positively and significantly while distance from nearest market affects the volume of onion supplied to market negatively and significantly.

The findings of this study draw the following recommendations and policy implications. The quantity of onion produced at the farm level affected marketable supply positively and significantly. However, farmers are working under limited plots of land by natural as well as socio-economic factors without improved seed and other necessary inputs. Hence, increasing production and productivity of onion per unit area of land is the better alternative to increase marketable supply of onion. Therefore, it is recommended that introduction of improved seed varieties, application of chemical fertilizers, controlling disease and pest practices should be promoted to enhance the production of onion.

The marketable onion supply is significantly and negatively influenced by distance to nearest market. Therefore, improving rural road infrastructure would assist poor farmers for faster delivery of onion produce.

Land allocated for onion have a positive influence on market supplied of onion. So, the concerned bodies should focus on intensification of land to compensate through cash crop production and efficient utilization of the existing limited farm land is the dominant strategies pursued by farming communities by using irrigation water wisely. The smallholders' off/non-farm income affects the market supply positively and significantly. Thus, the onion producers should be encouraged to invest on off/non-farm incomes as well as onion production.

Appendix

Table 4. *First-stage regressions result expressing factors affecting quantity of onion produced.*

Variables	Coefficient	Robust Std. Err.	t-value
Sex	0.35	0.55	0.64
Family size	0.13	0.16	0.81
Education	0.25	0.23	1.09
Distance form nearest market	-0.32**	0.13	-2.46
Farming experience	0.02	0.13	0.15
Non/ Off Farm income	0.19	0.21	0.90
Extension contact frequency	0.25	0.22	1.14
Land allocated for onion	1.93**	0.95	2.03
Credit utilized	0.65**	0.36	1.81
Livestock owned	0.25	0.45	0.56
Lagged price	0.03	0.59	0.05

Variables	Coefficient	Robust Std. Err.	t-value
Access to irrigation	0.23	0.33	0.70
Access to market information	0.35	0.32	1.09
Fertilizer applied [IV]	2.97***	1.27	2.34
Improved seed used [IV]	0.75***	0.19	3.95
_cons	-22.32	2.81	-7.94

IV indicates instrumental variable; Number of observation=160; F (15,144)=10.58; Probability>F=0.000; R-squared=0.4430; Adjusted-R-squared=0.3741, Root MSE=8.4386. ***, **and * Significant at 1%, 5% and 10 level of probability, respectively.
Source: Own computation from survey result, 2020.

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