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RESEARCH PAPER

Analysis of Vegetable Seed Supply Chain of Smallholder Farmers: The Case of Ada'a District, East Shewa Zone, Oromia National Regional State, Ethiopia

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Abstract

The vegetable sub-sector is one of the important sub-sectors of the Ethiopian economy. Consequently, the return from vegetables per unit area is several times higher than from major cereals. Hence, this research attempted to analyze factors affecting the vegetable seed supply chain system in Adea district, East Shoa zone, Oromia Region of Ethiopia, focusing on onion crop. A household survey with a pre-tested structured questionnaire and a key informant interview with checklists were used to collect primary data. The data was collected from 150 farmers and analyzed using STATA software. To address these objectives, multiple linear regression models were adopted. Ordinary Least Square (OLS) estimation shows that education level, sex of the household head, age of the household head, farm experience of the household, oxen ownership of the household head, area of vegetable and income of the vegetable significantly affect the vegetable seed supply chain system. The regression result indicated that the price of onion seed was negatively related to the quantity of onion seed used. Similar to the case of onions, the area allocated to tomatoes also had a positive impact on the quantity of tomato seed used by the sample households. However, unlike their significant impact on onions, both age and education had an insignificant impact on the quantity of tomato seeds used by the sample households. There is a special need to develop vegetable sector-specific guidelines for the development of the seed supply chain in Ethiopia. This calls for the transformation of the seed supply system from an informal to a more formal one through system establishment and capacity development..

Keywords: seed supply chain system analysis, vegetables, tomato, onion, multiple linear regression

Introduction

Ethiopia's agricultural sector is a powerhouse, contributing significantly to the country's economy. It makes up nearly half (46%) of the GDP, fuels most exports (80%), and employs a staggering 73% of the workforce. However, rain-fed subsistence farming remains the dominant practice, with smallholder farmers typically managing plots of less than a hectare (Aklilu, 2015). Vegetables offer an exciting opportunity for growth within agriculture. Compared to grains and other annual crops, they boast higher productivity and shorter growing seasons, allowing for multiple harvests per year (up to three). This labor-intensive sector also holds promise for job creation (Ayana *et. al*. 2014; Ketema and Tadesse *et al*., 2019).

Vegetable production is becoming an increasingly important activity in the agricultural sector of Ethiopia (CSA, 2015). The return from vegetables per unit area is several folds higher than major cereals. Vegetable production also plays a great role in reducing unemployment as it is labor-intensive and needs special skills (*A. cepavar. aggregatum*), carrot and beetroot (Aklilu, 2000; EHDA, 2011, 2012).

The most significant issues that vegetable crop production companies and traders face are a lack of sufficient improved varieties, a lack of quality planting materials and supply systems, a lack of appropriate production technology, biotic factors such as disease and insect pests, abiotic factors such as drought, and a lack of improved harvesting, post-harvest handling, and storage facilities (Ketema and Tadesse, 2019).

Ethiopia's onion production is much lower than other African countries and the world average. During the 2013/2014 cropping season, the total area under onion production was estimated to be 24, 375.7 hectares with an average yield of about 9.02 tons per hectare (Lemma and Shimelis, 2003). In comparison to the global average of 19.7 tons per hectare, this is an extremely low output (Weldemariam, et al, 2015). Onions are a nutritious, versatile, and economical agricultural product with a long shelf life, making them suitable for various regions and reducing food west. They are affordable to grow, creating jobs in farming, transportation, and storage. Onions can be grown responsibly using practices like crop rotation and integrated pest management, contributing to the agricultural landscape and protecting the environment (Bassim and Hayat, 2022). Because onion is the most grown species in the East Shoa zone Adea district, where the research was conducted, the focus of this study is on it.

In Ethiopia, the seed industry is still in its infancy. One of the key reasons for the correct growth of the seed industry is a lack of seed production technology. It is challenging for public universities and research organizations to multiply and distribute high-quality seeds on their own. The seed industry, particularly in the private sector, has the potential to be improved and developed. Currently, Ethiopian Seed Enterprise is projected to play a larger role in reducing seed shortages in the medium future, if not immediately (Fasikaw, 2019).

Horticulture is one of the main research programs in the Ethiopian Agricultural Research System. The horticulture research program, with a focus on tomato, pepper, onion, snap bean, has been coordinated by the Melkasa Agricultural Research Center. Regional research centers focus more on root and tuber crops such as potato, sweet potato, enset, taro, yam, and cassava (ISSD, 2013; MoA, 2012; Emana *et al*., 2014). Ethiopia's (vegetables) seed marketing remains one of the weakest links in the seed supply chain. Remote area farmers or those furthest from cities are faced with the inaccessibility of seed market information and infrastructure. In this respect development and promotion of different seed systems is a potential solution to this problem (Fasikaw, 2019; Emana *et al*, 2014; Getachew, 2010).

The imported seeds are distributed by local traders, farmers' cooperatives/unions, bureaus of agriculture, and NGOs. Such seeds are rarely checked for quarantine and quality by the seed regulatory department of the Ministry of Agriculture and the regional bureaus of agriculture. Access to quality seed sources is limited in case farmers use any available seeds they access which increases seed-borne diseases and subsequent seed damage (Fasikaw, 2019).

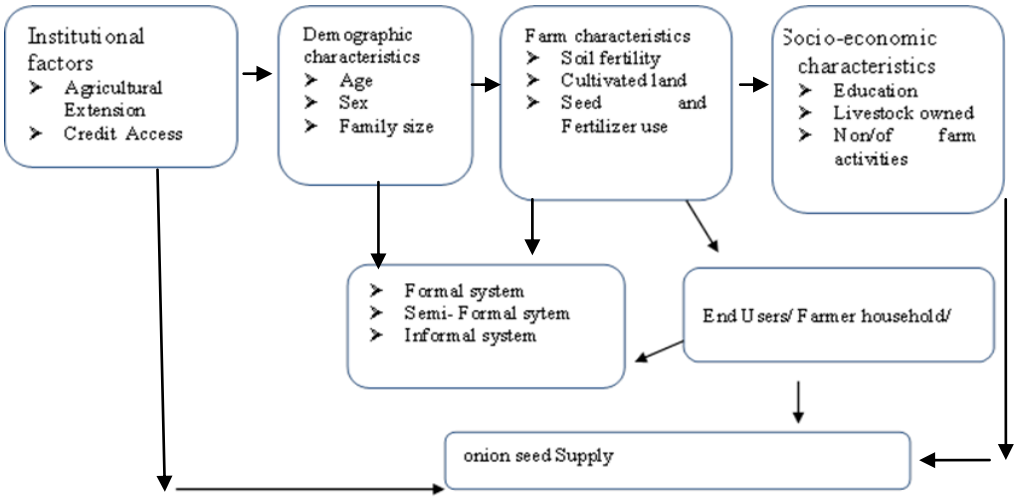
Most farmers and even some extension agents do not know the types of imported varieties used by the farmers. The varietal replacement period is very long as older varieties are still in production due to the weak variety development program and slow promotion of newly released varieties by the extension system. Whenever there is chance varieties are chosen or replaced for their yielding potential, taste, color, long shelf life, market demand and largely availability of seed Emana et al., 2014). Ethiopia's informal seed system has mostly gone unacknowledged, unappreciated, and unreported. Farmers' requirements have not been met by the formal seed sector (Fasikaw, 2019; Getachew, 2010). According to Emana et al., (2014), the overall vegetable seed system of a country is in the infant stage.

Ethiopia's seed industry faces a number of hurdles. The country lacks the expertise and infrastructure to run efficient seed businesses,

and there's a constant threat of new diseases and pests due to weak border controls. Furthermore, a clear national seed strategy is absent, and current extension services aren't providing adequate support to farmers. Limited collaboration within the seed sector, private companies focusing on profitable crops, and a general lack of knowledge and resources are further roadblocks. These challenges all contribute to an inadequate seed system in Ethiopia. As a result, this work aims to fill a research gap and contribute to the development of evidence for policymakers about the onion seed supply chain system and its problem analysis in Adea district of East Shewa zone, Oromia regional state.

Conceptual Framework

Ethiopia's seed system has undergone a tremendous change during the past three decades. But, still, the sector is unable to guarantee farmers' access to seeds of improved varieties. This is mainly because of the highly centralized seed distribution system and the absence of seed marketing. Based on the literature research, it is expected that onion seed supply is influenced by a variety of factors presented in Figure 1.



Materials and methods

Adea district was located in Oromia Regional State, East Shoa Zone, with the capital located 47 km Southeast of Addis Ababa. Most of the land (90%) is plain highland ranging between 1540 to 3100 meters above sea level. The district has a total of 26 kebeles of which 22 are rural-based kebeles administration areas and 4 are town kebeles. The total human population of the district is estimated by CSA is 131,162. The district has two agroecologies which are Dega and Weina Dega. Black clay and vertisol are the dominant soil types, with good soil fertility but with water logging problems The total land of the district is estimated to be 96,680 ha, Bishoftu Town and surrounding cover 19,543 ha and 77,137 ha is covered by rural areas, out of which 61,709 (80 %), ha is cultivated land, 2,603 (3.4%) ha is grazing land, 6,011 (7.8 %), ha is forest and 6,814 (8.8 %) ha is covered with others. Black clay and vertisol are the dominant soil types, with good soil fertility but water logging problems in those areas where the land slope is below 8%. Household average farm size varies from 1 to 2.5 ha and the major farm operation is done by oxen power. The farming system is a mixed crop-livestock production system. Major crops grown are teff, wheat (mainly bread variety), vegetable crops (mainly Onion, Tomato, kale, cabbage, etc.) and pulses. Chickpea is the main

pulse crop grown in the district and used as a crop rotation to wheat and teff crops. Irrigated horticultural crops are the most emerging business in areas where small-scale irrigation has been identified as a potential venture. Livestock farming under smallholder management consists of cattle/oxen, poultry and small ruminants. Apiculture is emerging in some pocket areas like Yerer Mountain (ADAO, 2020).

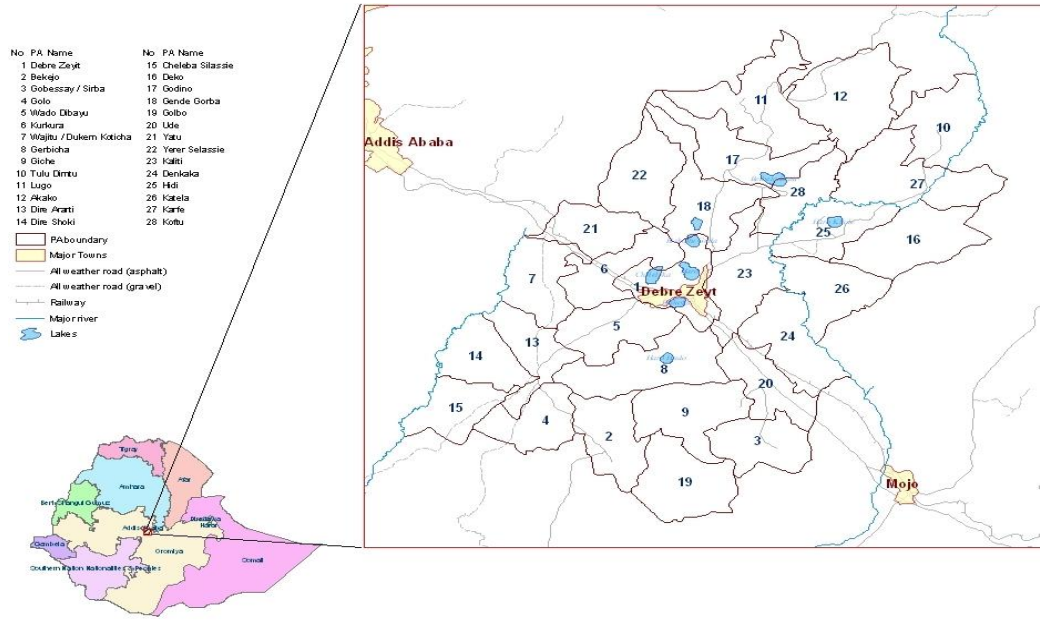


Figure 1 Map of Adea District (Study area)

Source: Adea District Agriculture and Natural Resource Office

Data Types and Sources

Primary and secondary data were used in the analysis of the vegetable seed supply chain. The primary data were collected through face-to-face interviews using a standardized and pre-tested questionnaire, which was filled out by trained enumerators working under tight supervision. Four Agricultural Office development agents and one district expert of seed supply and utilization analyzer gathered data.

Method of Data Collection

The primary data from onion producers was collected using a structured questionnaire that was pre-tested before the actual survey. Along with the formal survey, rapid appraisal using group discussion, key informant discussions and direct observation were undertaken along the vegetable seed supply chain system. The primary data was supplemented with secondary data.

Sampling Technique and Sample Size Determination

In this study, a two-stage sampling method was used. First, out of 26 kebeles in the district four potential vegetable-producing kebeles; namely, Denkeka, Hidi, Godino and Ouda were randomly selected. In the second stage, 150 farm households were selected randomly from those kebeles who are producing vegetables (Onion) taking into account probability proportional to the size of onion producers in each sample kebeles.

The study used a sample determination formula developed by Yemane (1967) presented as equation 1.

n=N/(1+N(e)2)…….....(1)

Where n is the sample size, N is the total target population of the area or households and e is the level of precession (sampling error). In this study, using an e value of 8 % and 4100 total population of vegetable-producing households, the sample size of 150 was obtained as follows:-

n=4100/(1+4100(〖0.08)〗 ^2)= 150. …… (2)

In general, using the above formula sample size of 150 vegetable producers (Onion and Tomato) was selected from four kebeles (Table 1).

Table 1. Sample distributions of vegetable (Onion) producers in selected kebeles

No.	**Name** of Kebele's	Total number of Vegetable producers	Number of sampled households
1	Denkeka	1367	50
2	Hidi	1093	40
3	Godino	957	35
4	Udea	683	25
Total		4100	150

Source: Adea District Agriculture and Natural Resource Office

Methods of Data Analysis

Descriptive statistics such as mean, minimum, maximum, percentages, frequencies and standard deviation were applied to describe the demographic, socio-economic, farm and institutional characteristics, supply and distribution of onion seed for producers in the study area. The econometric model was also used depending on the objective of the study and the nature of the data at hand. In this study, the dependent variable is the quantity of seed used by the sample household. Among the vegetables produced, onion is commonly produced in the study area.

When the dependent variable is just a continuous variable, Greene (2003) specifies the multiple regression analysis as Y= f(price, onion seed supplied(used), access to extension service, education level, access to market information, experience in vegetable production, sex of household head, access to credit, age, and so on...). The supply function econometric model specification in matrix notation is estimated by:

$Yi= \beta 0 + \beta iXi + Ui$ …… (3)

Where:

Yi = amount of Vegetable supplied (used) by Household
β0 = the constant/intercept
βi = a vector of the estimated coefficient of the explanatory variables
Xi = a vector of explanatory variables
Ui = Error term

Following Green (2003), the multiple linear regression models are specified as;

Yi=F(X1, X2, X3, X4, X5, X6, X7, X8, X9, X10, X11, X12, X13, X14)

Where

Yi= quantity of vegetable seed Supplied (used) by household
X1= Lagged Market Price
X2= Frequency of Agricultural Extension Contact
X3= Farm Land allocated
X4= Number of Oxen owned
X5= Age of household head
X6= Education of household head
X7= Access to Credit
X8= Adoption of seed
X9= Gender
X10= Income from Off Farm job
X11= Access to market information
X12 = Family size
X13 = Membership of Primary Cooperatives
X14 = Distance from the nearest market

Results and discussions

Descriptive Result

Important household background variables are sex, age and education of the household head and family size. Detailed information on these variables is presented in this sub-section. Gender was analyzed by checking the numbers of male and female-headed households (Table 2). The sample population of farmer respondents considered during the survey was 150. As shown in Table 4, out of the total households headed by interviewers, 133 (88.7%) were male-headed households, while 17 (11.3%) were female-headed households.

Table 2. Sex of Household head characteristics

Variables	Indicators	Frequency	Percent (%)
Sex of HH	Female	17	11.3
	Male	133	88.7
Total		150	100

Source: Survey result

The level of education of the household head, a primary decision maker, is an important variable for vegetable production. The result indicated that only 0.67% of the sampled vegetable producers were illiterate, and from grade one up to eight (1–8) 49.33%, from high school (9–12 grades) 44.67%, and above 12 grade/diploma holder was 5.33% (Table 5). On average vegetable producers in the study area are grade eight complete. This finding shows the proportion of literate household heads for the current study is higher than previous reports by Demis (2014) in Bora district of the same zone, who found only 55%, and the same district (Adea) reported by Teshome (2009), who found 65% of the household heads were educated. The proportion of uneducated household heads in the current study is also lower than the proportion of uneducated seed-producing households in the SNNP region reported by Walelign (2008), who found 20%, 10%, 23%, and 30% levels of illiteracy in Angacha, Dale, Chencha, and Hula districts, respectively. This suggests that access to formal education is improving over time, which is an opportunity to better understand vegetable production practices and hence increase productivity (Table 3).

Table 3. Education level of household head

Variable	Frequency	Percent
Education level of household headed		
Uneducated	1	0.67
Grade 1-8	74	49.33
Grade 9-12	67	44.67
Above 12	8	5.33
Total	150	100

Source: Survey result, 2021

The number of family members in rural households is an important input for agricultural labor. The study result indicated that the average family size of the sample household was 4 persons (Table 4). The table also shows that the mean number of extension

contacts of the respondents in the study area is 12.06. Extension service providers included experts working for agriculture departments, DAs, and forward-thinking farmers. The services provided were about vegetable production, input supply and use systems, seedling raising, harvesting, and post-harvest handling. Experience in vegetable farming is important to learn from experience about vegetable production practices. As shown in Table 4, the mean farm experience of the respondents in the study area is 4.77.

Oxen are an important asset for rural households for several purposes. They are sources of draught power for plowing. They are also used for threshing, a means of storing assets and an indication of wealth in a rural setting. The study result indicated that the majority of the sample households owned a pair of oxen, which is important for ploughing land. The mean number of oxen ownership of the respondents in the study area is 2.27 (Table 4).

Land is one of the key inputs for agricultural production in general and vegetable production in particular. The result indicated that the mean land holding of the sample vegetable producers was 2.12 hectares, with a standard deviation of 0.41 hectares. The minimum and maximum land holdings were 0.25 hectares and 5 hectares, respectively (Table 4).

Table 4. Descriptive statistics of continuous variables

Variables	Mean	Std. Dev.	Min	Max
Age of HH	38.58	9.76	22	61
Education HH	8.24	2.89	0	13
Extension Contact	12.06	5.69	0	44
Land size of HH	2.12	0.41	0.25	5
Oxen Ownership of HH	2.27	0.67	2	4
Family size of HH	4	1.37	2	7
Farm experience of HH	4.77	2.28	1	12
Seed price	49512.5	33510.92	8750	160,250

Source: Own survey Result 2021

Access to institutional service of farm households

Starting from land preparation up to the marketing of the product, finance is among the crucial elements assisting the activities. As indicated in Table 5, only 21.33% of sampled producers had access to credit while 78.67% of them had no access during the survey period. The main purpose farmers needed credit was to purchase fertilizer, seeds for vegetables, chemicals, and other agricultural inputs. The reason behind the limited access to credit for farmers was that the majority of farmers cover the cost of production of vegetables by selling grain produced by rainfall and lack of collateral. Although credit was accessible and available for poor farmers to build assets and secure food by purchasing the different packages designed by the regional government for grain producers, there was a lack of attention to access and avail credit for vegetable producers.

Households in the study area practiced handcraft, renting assets, petty trade, selling of local drinks, and salary. In the sampled

households, about 35.33% were engaged in off-farm income activities (Table 5).

A look at access to market information shows that there is no system in place for systematically collecting, analyzing, and disseminating information relevant to the needs of different actors. However, almost all (89.33%) of the sampled farmers had access to market information from different sources, and only 10.67% had no such access (Table 5). Analysis revealed that the major sources of market information were traders/agro-dealers, brokers, radio/television, friends/relatives, district and kebele experts, and combinations of them.

Table 5. Descriptive statistics of dummy variables

Variables	Category	Frequency	Percent
Off-farm Income of HH	No =0	97	64.67
	Yes = 1	53	35.33
Access to credit	No = 0	118	78.67
	Yes =1	32	21.33
Access to market information	No = 0	16	10.67
	Yes =1	134	89.33
Total		150	100

Source: Own survey result, 2021.

Vegetables seed supply chain system

Table 6 shows the sources of vegetable seed for the sampled household. The majority (86.66%) of the sampled household purchased vegetable seed from informal sources, whereas 10.67% purchased from formal sources, and about 2.67% did so from semi-formal sources. Given that the majority of the sampled households obtained seed from informal sources, the quality of the seed is questionable, which, in turn, would affect vegetable production and productivity (Table 6).

Table 6. Vegetables seed supply chain system for the sample household

Seed source type	Frequency	Percent
Informal	130	86.66
Semi-formal	4	2.67
Formal	16	10.67
Total	150	100

Source: Own survey result, 2021

Table 7 presents the production and productivity of onion in the sample households. Households in the study area allocated about one hectare of land for onion and nearly one hectare for tomato production for the season. The average seed rate for onion was 5 kg/ha whereas that of tomatoes was 0.75kg/ha. Another important finding shown in the Table is the yield of the two crops. The average yield for onion was 303.25 quintal per hectare whereas the yield of the tomatoes was 463.74 quintal per hectare. The yield of both onion and

tomatoes are by far higher than the national average yield of 75.3 quintal and 58.13 quintals per hectare, respectively as reported by CSA (2020). On average the sample household produced a total of 33814kg of onion from 1.06 hectares of land.

Table 1. Vegetable production and productivity of the sample households per household

Crop	Particulars	Obs.	Mean	Std. Dev.	Min	Max
Onion	Area (ha)	150	1.058	0.552	0.25	3.25
	Seed used (kg)	150	4.965	2.231	1.25	12.5
	Seed rate (kg/ha)	150	5.001	1.022	2.462	7.5
	Production (kg)	150	33813.5	24026.7	4125	141375
	Yield (kg/ha)	150	30325.3	9695.1	16000	50000
Tomatoes	Area (ha)	150	0.944	0.514	0.25	2.5
	Seed used (kg)	150	0.739	0.467	0.125	2
	Seed rate (kg/ha)	150	0.754	0.121	0.333	1
	Production (kg)	150	45181.7	30130.1	6875	140000
	Yield (kg/ha)	150	46374.3	12183.4	13333	76000

Source: Survey result, 2021

Factors affecting Onion Seed supply

The regression analysis showed that, out of the thirteen explanatory variables included in the model, eight of them had a significant impact on onion seed use by the sampled household (Table 8). The significant explanatory variables are sex, age, education level, farm experience, access to credit, land size of the household, price of onion seed and income from onion of the sampled household. Both the F statistic [$F(13,136) = 26.46$, $P<0.000$)] and the R-square value = 0.716 indicated that the overall fitness of the model is good. The R-square value offers the total variation in the dependent variable (quantity of onion seed used) that is explained by the independent variables. The result suggested that 71.6% of the total variation in the quantity of onion seed used by the sample household was explained by the explanatory variables included in the model.

The regression output result revealed that the age and sex of the household head negatively affected the quantity of onion seed used at a 1% significance level. The result suggested that as the age of the household head increases by one year, the amount of onion seed used decreases by 0.032 kilograms, ceteris paribus. This finding suggested that the younger are better at using vegetable seeds as compared to the older household heads.

The model output result further indicated that, as expected, the level of education of the household head had a positive impact on the quantity of onion seed used at a 1% level of significance. As the education of a household head increases by one year of schooling, the quantity of onion seed used increases by 0.139 kilograms of seed, keeping other factors constant.

Another variable that had a significant but negative impact on the quantity of onion seed used is access to credit. Access to credit enhanced the financial capacity of the farmer to use the improved varieties of seed and other inputs; thereby increasing onion productivity was reflected in the utilization of seed supplied/used by farmers households. If there is access to credit to farmers in the production of vegetables, there is an increase in the productivity of onion production which in turn increases the household's income. It is also hypothesized here that access to credit has a positive influence on the level of vegetable production.

The price of onion seeds plays a role in how much farmers plant. As expected, the study found a negative relationship between seed price and seed use. This means that when the price of onion seeds goes up, farmers tend to plant less. However, the impact is quite small. Even if the price of seeds increases by one Ethiopian Birr (ETB), the amount of seeds used only decreases by a tiny amount, 0.0002 units.

Table 8. Factors affecting the quantity of Onion seed used by the sampled households (dependent variable: Onion seed use)

	Coef.	Robust St. Err.	t-value	p-value
Sex of HHH	-0.6822	0.334	-2.04	0.043**
Age of HHH	-0.0357	0.016	-2.23	0.027**
Education of HHH	0.1395	0.0526	2.65	0.009***
Family size	0.0718	0.10718	0.67	0.504
Farm experience	0.348	0.0702	4.95	0.000***
Off/non-farm income	-0.1681	0.2334	-0.72	0.473
Oxen owned	0.2226	0.2046	1.09	0.279
Credit access	0.5551	0.3142	-1.77	0.080**
Extension contact	0.0140	0.021	0.66	0.513
Market information	-0.2933	0.3487	-0.84	0.402
Onion Seed price	-0.0002	0.00003	-7.25	0.000***
Income	3.71e-06	7.68e-07	4.83	0.000***
Constant	0.7516	0.9047	0.83	0.408
Mean dependent var.	4.965	SD dependent var.		2.231
R-squared	0.716	Number of obs.		150
F-test	26.46	Prob. > F		0.000
Akaike crit. (AIC)	455.62	Bayesian crit. (BIC)		497.77

***, **, * significant at 1%, 5% and 10% significance level head
Source: Analysis result, 2021.

Conclusion

According to the study's findings, various factors were discovered to have an impact on the quantity of onion seed supplied (used) by the sample households. The age of the household head was discovered to have a negative impact on the amount of onion seed used, meaning that the younger people were better at expanding onion farms in the study area. On the other hand, educated household heads were positively associated with the quantity of onion seed use, implying that enhancing education among farm households can increase onion production. According to the regression results, the price of onion seed

was adversely connected to the quantity of onion seed used. Ethiopia's seed system requires significant improvement to function efficiently. A key element is ensuring strong collaboration and dedicated roles for each stage of the three-pronged seed system (foundation, registered, certified). Additionally, several areas deserve focus: An effective seed system in Ethiopia relies on several key pillars. Understanding farmers' needs through proper seed demand assessment is essential to producing the right seeds in the right quantities. Involving farmers in the planning process ensures that developed varieties address their specific challenges and preferences. An inclusive seed production system that integrates all qualified producers maximizes production capacity. To encourage farmer participation, the seed system must offer high-quality seeds, ensure timely availability through convenient locations, and maintain fair pricing. Furthermore, increasing seed production cycles throughout the year can help bridge the gap between demand and supply. Stronger linkages between research institutions and seed producers are crucial for translating research advancements into improved seeds that benefit farmers. Finally, developing and implementing a clear, comprehensive national seed strategy provides a roadmap for the overall direction and improvement of Ethiopia's seed system.

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