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Determinants of Niger Seed Commercialization in the Jabitehenan District, West Gojjam Zone, Amhara National Regional State, Ethiopia

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ABSTRACT

Ethiopia's oil seed industry is expanding swiftly to meet rising domestic and foreign demand, assisting the country in generating foreign exchange earnings and income. This study aimed to quantify the level of household commercialization of Niger seed output and analyze the determinants affecting it. This research utilized a three-stage random sampling technique to gather quantitative and qualitative data from primary and secondary sources. The primary data came from sampled households through a semi-structured interview. Moreover, 150 samples were selected randomly. Descriptive statistics and the Tobit censored regression model were utilized to analyze the data. SPSS version 20 and STATA 13 software were also employed. The average level of Niger seed commercialization in the area was 0.71%. Several determinants, including the amount of Niger seed output, market information, frequency of extension service, training access, age, and total livestock unit, influenced the level Niger seed. The regional government and district leaders should strengthen the provision of different training to raise the production, productivity, and level of Niger seed commercialization by enhancing the marketable surplus of Niger seeds.

Keywords: Commercialization; Niger seed; Factor; Tobit model

INTRODUCTION

Most developing countries benefit from agriculture due to its impact on economic growth, income generation, and fulfilling household food security (Dube, 2016). Unfortunately, it is impossible to achieve sustainable food security and the welfare of society through a subsistence agriculture system. Hence, many countries and development organizations focus on household commercialization to realize it.

Smallholder farmers (Cervantes-Godoy, 2015) made up most of those working in agriculture in developing countries, especially subsistence farming (International Labour Organization [ILO], 2011). Ethiopia's agriculture sector has significantly contributed to the country's gross domestic product (GDP). This sector contributed 42.7% to GDP, 80% of

employment opportunities, 70% of foreign exchange earnings, and more than 70% of inputs for local factories (Zehirun, Breitenbach, & Kemegue, 2015).

Agribusiness aims to move crop producers from subsistence to commercialized agriculture. Hence, the government should encourage smallholder farmers to participate in market-oriented farming. Agricultural commercialization is crucial to agricultural transformation (Pingali, 1997).

After cereals and pulses, oil seed is Ethiopia's third major crop in the land area, and it ranks second in foreign exchange earner products next to coffee. Ethiopia's oil seed sector is growing rapidly to fulfill domestic and foreign demand, essential in generating foreign exchange earnings and income for the country (Foreign Agricultural Service U.S. Department of Agriculture, 2016). Expanding infrastructure investment could sustain benefits from commercial activities, enhancing smallholder farmers' livelihoods (Tafesse, Megerssa, & Gebeyehu, 2020).

Niger seeds (*Guizotia abyssinica Cass*), locally known as *Noug*, have become Ethiopia's second highly produced oilseed crop. It accounts for over a quarter of total oilseed production and 28% of the cultivated area for oilseeds. The Amhara and Oromia highlands account for more than 95% of Niger's seed production. There are two major surplus-producing zones in the Oromia Horogudru region: East Wellega and West Wellega, while in the Amhara region, East Gojjam, West Gojjam, North Gondar, and South Gondar zones are the four-major producer areas (Foreign Agricultural Service U.S. Department of Agriculture, 2016).

According to the Central Statistical Agency [CSA] of Ethiopia (2020), in the primary production season in the Amhara region, about 248,602 smallholder farmers produced 783,659.2 quintals of Niger seeds on 74,969 ha of land. Of this, 138,756.81 quintals were produced in West Gojjam on 13,383.18 ha, and 255,327.64 quintals were yielded in East Gojjam on 8,839.2 ha.

Commercialization helps advance the production system for smallholder farmers. Subsequently, higher production is achieved through economies of scale, regular communication, disclosure of new ideas, learning by doing, and better incentives in the form of income (Jaleta, Gebremedhin, & Hoekstra, 2009). Agricultural commercialization requires a commitment to practice farming and adopt new technologies, willingness to invest, improved soil fertility, better access to financial markets, business management skills, product and process quality control and assurance, continuous improvement, and efficiency enhancement starting from the production to consumption system (Poole, Chitundu, & Msoni, 2013).

Moreover, Aman, Adam, & Lemma (2014) reported that the producers' market participation was crucial for the sustainability of economic growth, income, rural employment, food security, and poverty alleviation. Designing policy to improve market access, farmers' awareness of the market, and land productivity (using the best agronomic practice and improved technology) enhanced smallholder farmers' commercialization level (Abate, Mitiku, & Negash, 2022). Furthermore, establishing appropriate agricultural policy aims to enhance farmers' access to agricultural inputs, strengthen extension services,

disseminate reliable market information, reduce unfair profit distribution, and increase the bargaining power of producers to accelerate economic growth and poverty reduction by enhancing output commercialization level (Aliyi, Faris, Ayele, Oljirra, & Bayessa, 2021).

Smallholder commercialization is a critical factor for rural development and poverty alleviation. It illustrates how commercialization can help alleviate poverty and boost economic development by improving the income of smallholders. Similarly, smallholders are also willing to have commercialization and benefit from increased productivity through high income (Kirsten, Mapila, Okello, & De, 2012). In agribusiness, stepping up to intensive and profit-oriented commercial farming improved farmers' welfare (Mariyono, 2019). Commercializing smallholder farmers through increased participation in agricultural output has become one strategy to improve agricultural productivity, eradicating poverty and food insecurity among rural farmers in developing regions (Goletti, 2005; Jaleta et al., 2009). A better input and output quality must exist before agriculture can be transformed from a subsistence to a commercial production system (Salami, Kamara, & Brixiova, 2010).

The edible oil supply from oil processing factories was less than 20% of the country's total consumption, and 80% was the recipient of food aid and import from Asia for local consumption. Increasing question on the consumer use of palm oil has created favorable conditions for Niger seed oil (Tadesse, 2013). Even though having a high production of Niger and line seeds, Ethiopia still imports large amounts of edible oils, especially palm oil, from Malaysia, Singapore, and the United Arab.

Niger seeds are the major oil seed crop produced and marketed as a cash crop and have been an advanced oil seed processor. However, the production and supply of Niger seeds and their processed product are in short supply compared to the increasing demand from oil processors and the growing population. There is a research gap on specific commodities in Ethiopia, where the society receives palm oil imported by the government and exports raw crops to other countries (Injigu, Ashagre, & Temesgen, 2018).

Commercialization studies in Africa mainly focused on the horticultural industry, demonstrating that smallholder horticultural commercialization increased household incomes and reduced poverty at the household level. Even though most smallholder farmers in Africa grow food crops, only some empirical studies focused on their commercialization (Muriithi & Matz, 2015).

Several studies were conducted on Niger seeds in Ethiopia. Injigu et al. (2018) researched Niger seed value chain analysis in the Toke Kutaye District. Other research evaluated Niger seed (*Guizotia abyssinica Cass*) production, seed storage, and virgin oil expression (Tadesse, 2013). However, these previous studies did not emphasize the commercialization of Niger seed output. Therefore, this study helps to fill this knowledge gap.

Several oil processing factories have opened up in different parts of Ethiopia. These new oil processing factories were established in the Amhara region, notably the West Gojjam and East Gojjam zones. The WA Industrial Edible Oil Complex in Debre Markos town was constructed by well-known Ethiopian investor Worku Aytenew and was inaugurated in 2021. This factory can process over 1.5 million liters daily. Oil is extracted from Niger, peanut, soy,

and sesame seeds. West Gojjam, specifically in Burie Town, has an integrated agro-industry. Other factories exist, such as the Richland Oil processing factory and Fibela industrial complex. Fibela industrial complex is expected to cover 60% of the country's oil demand.

These oil processing factories used to rely on farmers to supply input to produce an output at a minimum cost, but now they rely on imported input. The resulting increase in ultimate final product cost strikes the consumers. Therefore, the investors must acquire input from a commercial farm in the country. Transforming from a subsistence to a commercial production system is crucial to achieving this goal. However, there is negligible information about Niger seed commercialization and its determinants. Generally, generating such information is critical as it helps producers increase Niger seed productivity and supply surplus products to processing factories. Specifically, it addresses the following objectives: (1) quantify the level of commercialization for producers of Niger seeds through a crop-specific index, and (2) analyze the factors affecting it.

Conceptual Framework

The success of smallholder commercialization highly depends on the ability of farmers to participate in input and output markets. Factors determining the producers' ability to participate in the market should be considered to acquire the anticipated benefit and improve the welfare of society (Govereh, Jayne, & Nyoro, 1999). The conceptual framework in Figure 1 demonstrates the interrelationship between the Niger seed commercialization index, the key variables involved, and the welfare of the households.

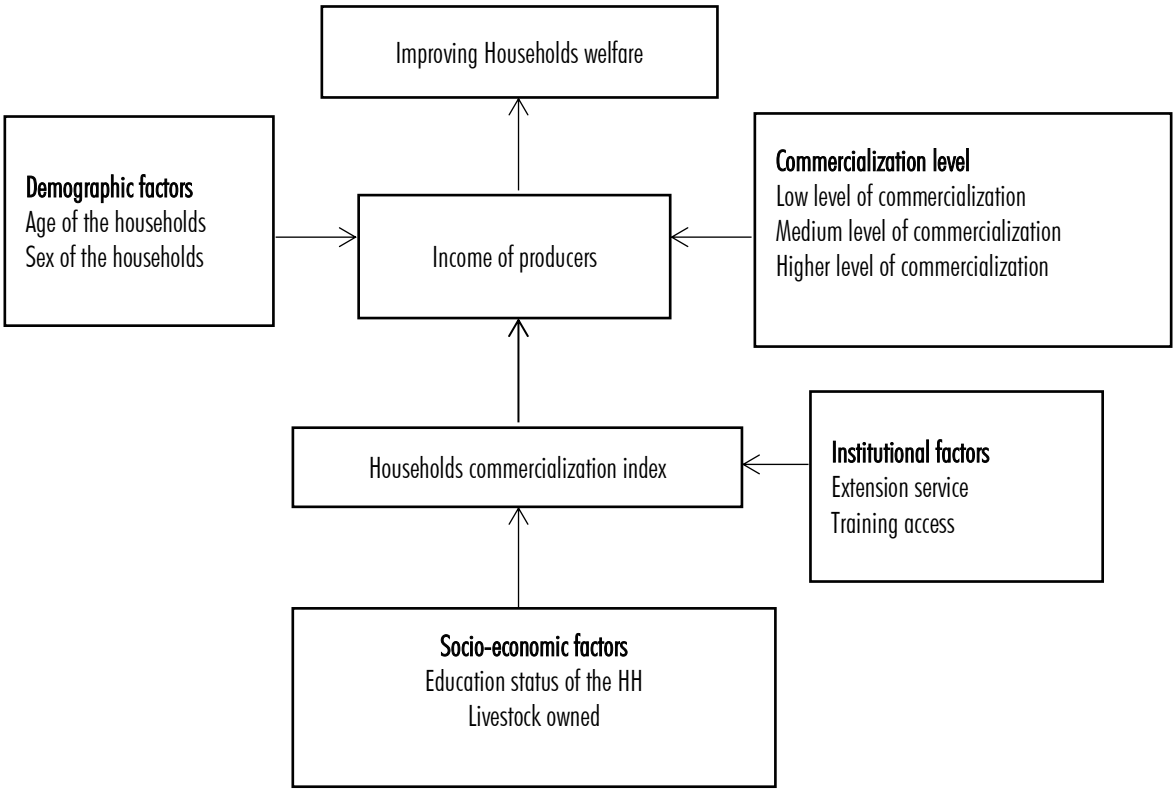

FIGURE 1. CONCEPTUAL FRAMEWORK OF THE STUDY

RESEARCH METHOD

Description of the Area

Jabi Tehnan District covers an area of 112,772.1 and is bounded by Quarit and Dega Damot in the East, Burie in the West, Sekela in the North, and Dembecha and Abay River in the South (Figure 2). The average annual temperature for most parts of the district is 14-32°C, and the elevation varies from 1,500-2,300 mm above sea level (m.a.s.1), with an average annual rainfall of 1,250 mm. The district has 37 rural *kebeles* and two urban *kebeles*. Moreover, 94% of the population lives in rural areas, and the rest is urban. The livestock population, such as cattle, sheep, goats, horses, mules, donkeys, and poultry, can be discovered roaming the area. However, among these animals, cattle are the dominant species in the area. Maize, finger millet, pepper, teff, wheat, fava bean, potato, barely, shallot, garlic, coffee, and bananas are grown-well crops in this area (CSA of Ethiopia, 2007)

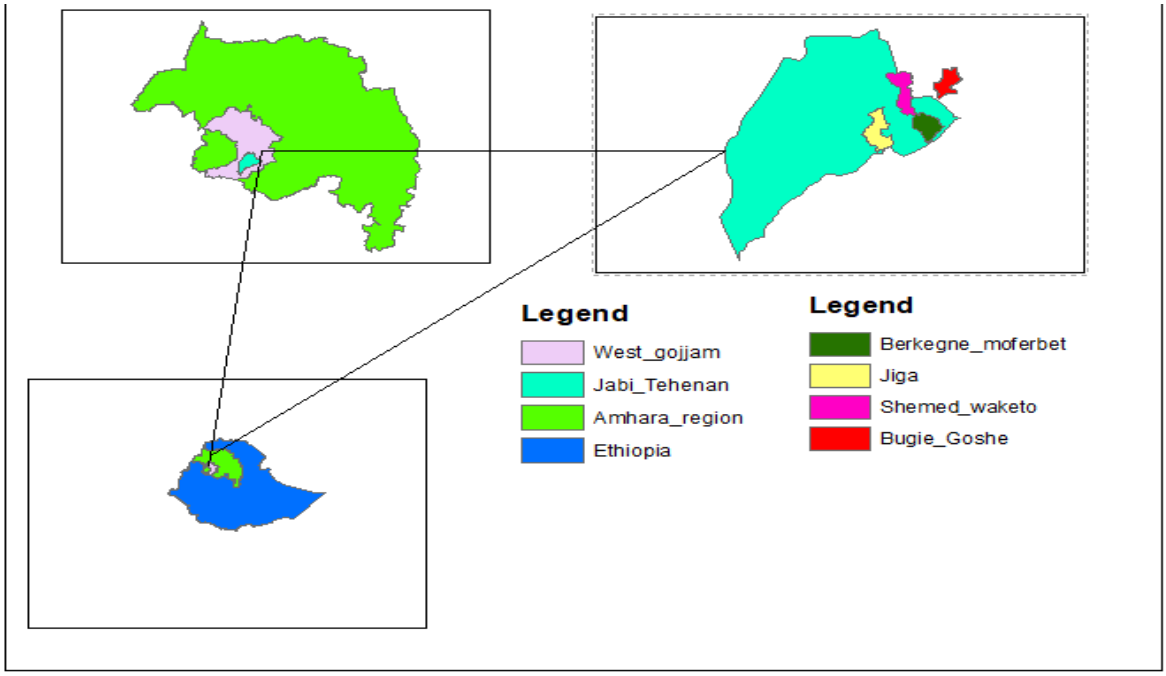

FIGURE 2. DESCRIPTION OF THE AREA

Sampling Procedure

A representative sample was drawn from each *kebele* using a three-stage sampling procedure. The Jabitehenan District in the West Gojjam zone was selected in the first stage due to its high potential for producing Niger seeds. Subsequently, after consulting with local agricultural and development agents, four Niger seed production areas, covering Berkegne, Shemed Waketo, Bugie, and Jiga, were selected randomly from the sampled *kebeles*. The last stage involved 150 households randomly selected based on the probability proportional to the population size (Table 1). Two situations should be considered in determining sample size for proportion. (1) If the approximation value of p is known (from a previous study), that value can be employed to calculate the sample size. (2) If the approximation value of p is unknown,

p=0 should be employed, providing a sufficiently large sample size to ensure accuracy (Ott & Longnecker, 2010). This study utilized *p=0.11*, taken from the previous study (Taye, Abebe, & Tadie, 2018). The total sample size was determined by Cochran's (1977) formula.

$$n = \frac{Z^2 P q}{e^2} = \frac{1.96^2 0.11 * 0.89}{0.05^2} = 150\ HHS \quad (1)$$

n represented the sample size, *Z* defined the confidence level (α =0.05), *e* referred to the desired level of precision (0.05), *p* was the estimated proportion, and *q=1-p*. The value of *z* was disclosed in the statistical table, containing the area under the normal 95% confidence level curve.

TABLE 1. PROPORTIONAL SAMPLE SIZE DETERMINATION OF SAMPLED HOUSEHOLDS

List of *kebele*	Number of producers	Proportion	Sample size
Berkegne	873	0.24	36
Shemed Waketo	986	0.28	42
Bugie	954	0.26	39
Jiga	771	0.22	33
Total	**3,584**	**1.00**	**150**

Data Sources and Data Collection Method

This study deployed both primary and secondary data sources. Primary data were collected through a semi-structured interview, while secondary data were gathered from different office reports, encompassing the CSA, zonal and regional office, and district agriculture office reports.

Data Analysis Method

Descriptive statistics and Tobit censored regression model were employed to analyze data. SPSS version 20 and STATA version 13 software tools were applied.

Descriptive Statistics

Descriptive statistics such as mean, frequency, percentage, and standard deviation were employed to analyze sampled households' demographic and socio-economic characteristics. In addition, the commercialization index was utilized to determine the output commercialization level of Niger seeds to avoid the crude distinction between commercialized and non-commercialized households. The level of commercialization was categorized into three: subsistence (≤50% output sold), semi-commercial (50-75% output sold), and commercial (>75% output sold) (Takesure, 2017).

$$HHCI = \left(\frac{Quantity\ of\ Niger\ seed\ sold\ HH\ i\ year\ j}{Quantity\ of\ Niger\ seed\ output\ produced\ \ HHi\ year\ j}\right) X\ 100 \quad (2)$$

HHCI refers to the household commercialization index of Niger seeds, the numerator implies the quantity of Niger seeds sold by the i^{th} farmer in the year *j* (2020/2021), and the denominator signifies the total amount of Niger seeds produced by the i^{th} farmer in the year *j*.

Econometric Analysis

Different alternative econometric models could be employed to analyze the factors affecting the commercialization of Niger seed output, such as Heckman's two-stage, the double hurdle, and the Tobit models. The Tobit censored regression model has commonly been applied to analyze the dependent variable, upper or lower (Greene, 2003). *HCI* is lower censored at zero and upper censored at one. Niger seed producers who could not sell their crops had a value of HCI equal to zero, while those who sold the total produced product had a value of HCI equal to one. This study measured the commercialization level as the volume of Niger seed output each producer sold. Tobit censored regression model is suitable for estimating the upper and lower limit dependent variables against the independent variables (Walker, Norton, Harris, Williams, & Styles, 2019).

TABLE 2. VARIABLES MEASUREMENT AND WORKING HYPOTHESIS

Variable	Type	Measurement/code	Expected sign	Reference
Household commercialization index	Continuous	Percentage		
Age	Continuous	Year	+ve	Megerssa, Negash, Bekele, & Nemera (2020)
Sex	Dummy	1 male, 0 otherwise	+ve	Tarekegn, Asado, Gafaro, & Shitaye (2020)
Education	Categorical	0= could not read and write 1= could read and write 2= attending primary school 3= attending secondary school	+ve	Tafesse et al. (2020)
Family size	Continuous	Adult equivalent	+ve/-ve	Martey, Al-Hassan, & Kuwornu (2012)
Quantity of Niger seed produced	Continuous	Kg	+ve	Worku, Adugna, & Mussa (2021)
Landholding size	Continuous	Ha	+ve	Roberts, English, & Larson, (2002) & Olwande, Smale, Mathenge, Place, & Mithöfer (2015)
Total livestock number	Continuous	TLU	-ve	Gebre, Tilahun, Tadesse, Haile, & Legesse (2022) & Abafita, Atkinson, & Kim, (2016)
Frequency of extension contact	Continuous	Number of contacts	+ve	Martey et al. (2012)
Distance to the nearest market	Continuous	Walking Hour	-ve	Kassaw, Teshome, Chanie, & Addis (2021)
Access to market information	Dummy	1 had access to information, 0 otherwise	+ve	Chagomoka, Afari-Sefa, & Pitoro (2014)
Farming experience	Continuous	Years	+ve	Abate et al. (2022)
Access to training	Dummy	1 had access to training, 0 otherwise	+ve	Ojulu (2021)

Tobit censored regression model considered that the observed dependent variable for observation $j=1...n$ satisfied the following.

$$Yj = max(Y^*,0 \quad (3)$$

Y^*s represents the latent variables generated by the linear regression model.

$$Y^* = \beta_o + \sum \beta_i X_i + \varepsilon_i, \quad Yj = \begin{cases} Y^* \text{ if } Y^* > 0 \\ 0 \text{ if } Y^* \leq 0 \end{cases} \tag{4}$$

Y^* denotes crop commercialization index (*CI*) and $Y=Y^*$ when $Y^*>0$ and $Y=0$ when $Y^* \leq 0$.

The equation model could be entirely written as follows.

$$\begin{aligned} \text{Crop commercialization index: } & \beta o + \text{Age } xi + \text{Sex } xi + \text{Education } xi + \text{Family size } xi + \text{Output produced} \\ & xi + \text{Total land size } xi + \text{Total livestock unit } xi + \text{Frequency of extension} \\ & \text{contact } xi + \text{Distance to the market } xi + \text{Access to market information} \\ & xi + \text{Access to training } xi + \varepsilon i \end{aligned} \tag{5}$$

Parameters in the Tobit model did not directly correspond to changes in the dependent variable brought by the changes in explanatory variables. According to Greene (2003), the marginal effect on the intensity of commercialization due to the change in the explanatory variable is given in Equation 6.

$$\frac{\partial E(Y/X)}{\partial X_k} = \beta_k \Phi \left(\frac{X\beta}{\sigma} \right) \tag{6}$$

The dependent variable ranged from 0 to 100%. Hence, the Tobit model was utilized to analyze the factor affecting the commercialization level. *Y* was equal to zero when a farmer did not engage in commercialization; *Xi* = determinants of commercialization; εi = stochastic error term. The variable measurement and hypothesis are presented in Table 2.

RESULTS AND DISCUSSION

Demographic and Socio-Economic Characteristics of Households

Table 3 exhibits that the mean age of the households was 50.83 years, depicting that they were within the productive age. Agriculture has become a labor-intensive industry. Therefore, this sector is crucial in reducing the country's unemployment rate. Hence, if no idle resources exist, agricultural production and productivity will rise, and agro-processing factories can obtain enough input.

TABLE 3. STATISTICAL SUMMARY OF CONTINUOUS VARIABLES

Variable	Measurement	Minimum	Maximum	Mean	SD
Age	Year	25	75	50.82667	11.83655
Family size	Adult equivalent	2	9	5.156333	1.554451
Total land size	Hectar	0.125	2.5	1.31	0.50
Total livestock unit	TLU	3.21	14.78	7.69396	2.288219
Frequency of extension contact	Number of contacts	1	6	2.32	1.183329
Distance to the market	Walking hours	10	180	86.76667	41.46696
Farming experience	Year	3	47	17.99333	9.032749

Each household comprised five people on average, producing surplus products beyond home consumption. Each sample respondent met 2.32 times with development agents and other service providers. The extension contact played a critical role in agricultural production and productivity enhancement, disseminating information about adopting modern

agricultural technologies and current market information. The lack of interaction between producers and experts had little impact on increasing Niger seed output. The average livestock holding of the households was 7.68 TLU. It was a valuable input for farmers since they could utilize their oxen and other animals to plow the land timely and as transportation after harvesting.

Conversely, producers could allocate land for animal grazing; in this case, land allocated for Niger seed production could decline, thus, decreasing production. As displayed in Table 3, the mean land size of the households in the area was 1.31 ha. It was the critical factor of production, although less than the average national land size of 1.71 ha per household (CSA of Ethiopia, 2007).

Table 4 shows that 88% of the respondents were male household heads, while the other 12% were female, indicating that women were marginal in producing Niger seeds in the study area. The study discovered that 50.67% of respondents were illiterate, 38.67% were able to read and write, and 7.33% attended primary school. Briefly, the results unveiled that most of the respondents lacked basic literacy skills. In this case, they could not adopt new technologies to advance the productivity of Niger seeds. Access to market information helped earn a higher return for the output sold. Around 44% of the sampled respondents had access to market information, illustrating that most producers supplied the output at peak season without considering the market situation. Training access over the last three years was limited in the study area. The training was essential since only 38.67% of the respondents had access to it. However, training could raise awareness about the production, utilization, and commercialization of Niger seed products, as listed in Table 4.

TABLE 4. STATISTICAL SUMMARY OF CATEGORICAL VARIABLES

Variable	Description	Frequency (Number of persons)	Percentage (%)
Sex	Male	88	12
	Female	12	88
	Could not read and write	76	50.67
	Could read and write	58	38.67
Education level	Primary school	11	7.33
	Secondary school	5	3.33
Access to market information	Yes	66	44
	No	84	56
Access to training	Yes	58	38.67
	No	92	61.33

The average Niger seed yield per farm was 2.25 quintals, under its national average production of 3.15 quintals (CSA of Ethiopia, 2020). A total of 239.60 quintals of Niger seeds were sold out of a total production of 337.5 quintals (Table 5). This difference was due to consumption, especially on holidays like the New Ethiopian Year, Christmas, and other holidays, donations for other relatives, low production amount, and producers using some Niger seeds for the following production season. Most producers in the region did not even come close to meeting the national average of Niger seed production, and even fewer of those

crops made it to the market. It was due to most producers utilizing Niger seeds for household consumption, especially around the holidays. The output was also employed for seed purposes and gifted to other poor people in the area. The average commercialization rate of Niger seeds in the region was 0.71, higher than its national average sale of 61.89% (CSA of Ethiopia (2020).

TABLE 5. STATISTICAL SUMMARY OF GROSS AMOUNT OF PRODUCTION, AMOUNT OF OUTPUT SOLD, AND COMMERCIALIZATION INDEX

Variable	Observation	Total production in Quintal
The gross amount of production	150	337.5
Amount of output sold	150	239.62
Household output commercialization index	150	0.71

As depicted in Table 6, most producers (59.33%) were categorized as commercial. The semi-commercial category included around 16.67% of Niger seed producers. Meanwhile, the remaining 24% belonged to subsistence. Generally, these results implied that Niger seed commercialization fell in the commercial system. Even though the output commercialization was categorized under the commercial system, an effort should be made to transform the households categorized under the subsistence system into semi-commercial and commercial systems.

TABLE 6. LEVEL OF COMMERCIALIZATION

HCI	Level of commercialization	Percentage (%)
0-0.5	Subsistence	24%
0.5-.75	Semi-commercial	16.67%
0.75-1	Commercial	59.33%

Determinants of Niger Seed Commercialization

Tobit censored regression model was employed to analyze the determinants affecting the level of Niger seed commercialization. The results uncovered that it was affected by the amount of Niger seed output, frequency of extension contact, market information access, training access, age of the household head, and total livestock unit, as demonstrated in Table 7.

The average age of household heads detrimentally impacted the country's Niger seed output commercialization by 10%. The marginal effect signified that as the households aged, the likelihood of selling Niger seed output decreased by 0.37% due to labor requirements to produce agricultural products and deliver the product to the market. Therefore, they preferred to lease the land to others. These findings confirmed Martey et al. (2012), discovering that aged producers were less likely to sell maize products. It contradicts the results of Tafesse et al. (2020), unveiling that senior households were likelier to sell their agricultural output. Having more experience in farming and being aware of changes in weather conditions, older farmers could better capitalize on the opportunities to apply pesticides to boost agricultural production. This result is in line with Wubet, Zemedu, & Tegegne (2022), revealing a positive effect of the farming experience on the potato market supply. However, it goes against the

findings of Tafesse et al. (2020) that older households tended to engage in agricultural product commercialization. They were risk-averse and lacked access to current market information.

TABLE 7. TOBIT REGRESSION ESTIMATES FOR OUTPUT COMMERCIALIZATION INDEX

Variable	Coefficient	std error	Marginal effect
Age (year)	-.0037306*	.0022497	-.0037633
Sex (male/female)	-.0942916	.062866	-.0828887
Education (level)			
Read and write	-.047975	.0444659	-.0176207
Primary school	.0381594	.0806387	-.0176207
Secondary school	-.1038049	.1189257	-.0176207
Family size (Adult equivalent)	-.0143214	.0143819	-.0160141
Output produced (quintal)	.000920**	.0004607	.0009529
Total land size (hectare)	.0028117	.0033804	.0026974
Total livestock holding (TLU)	-.0321027***	.0092323	-.0293885
Extension contact (number of contacts)	.033777*	.0186917	.0345944
Distance to the district market (hour)	-.0004093	.0005069	-.0003862
Access to market information (yes/no)	.1078935**	.0455302	.0982166
Niger seed farming experience (year)	.0040985	.0028707	.004253
Access to training (yes/no)	.0730727*	.043103	.0783595
Constant	1.040296***	.1438508	
LR chi2(12)		38.24	
Prob > chi2		0.0001	
Pseudo R2		0.5128	
Log Pseudo likelihood		-18.168827	

Note: ***, **, and * indicate the statistical significance of variables at 1%, 5%, and 10% significance levels, respectively.

The quantity of Niger seed output positively and significantly affected the level of Niger seed commercialization at a 5% significance level. Producing surplus goods allowed households to meet their consumption and seed purposes, donate to those in need, and deliver the remaining marketable surplus. This study suggested that households could generate greater Niger seed output. Moreover, the probability of selling their product could be raised by 0.95% due to the higher productivity and farmers' motivation to sell more products to earn more income. Gebre et al. (2022) disclosed that the amount of enset production positively and significantly affected marketed surplus.

Similarly, Haile, Gebre, & Workye (2022) confirmed the positive and significant effect of the quantity of maize on market participation. Therefore, increased Niger seed production led to more Niger seed output commercialization. It aligns with Worku et al. (2021), revealing that more producers entered the market as chickpea output rose. Hence, the amount of agricultural production was directly linked with the probability of agricultural output market participation. In addition, Abafita et al. (2016) concluded a positive and significant influence of crop produced on the probability of market participation and level of cereal output commercialization.

At the 1% significance level, the total livestock unit harmed the commercialization of Niger seed output. The marginal effect results demonstrated that the likelihood of selling the

goods dropped by 2.93% for farmers with more livestock. Larger farms could afford to set aside for grazing and rare animals, creating diversified producers' income sources. As Gebre et al. (2022) confirmed, livestock ownership negatively and significantly influenced the probability of enset market participation. Similarly, the negative and significant effect of livestock holding on market participation and degree of commercialization was reported by Ojulu (2021). This result is also supported by Asfaw, Shifaw, & Belete (2022). (2022), who discovered that livestock ownership significantly affected market participation for date producers. However, it contradicts Andaregie, Astatkie, & Teshome (2021), unveiling that total livestock holding was the significant determinant of haricot bean market participation. Additionally, Wubet et al. (2022) disclosed that farmers' potato market activity increased in response to an increase in the number of oxen owned. Income from cattle sales positively and substantially influenced involvement in the mango market, whereas Hagos, Dibaba, Bekele, & Alemu (2020) discovered the opposite.

Increased output and productivity of agricultural products directly resulted from increased frequency of extension interaction with producers. Farmers in Ethiopia benefited from the Ministry of Agriculture's extension services, provided through development agents. Households could boost agricultural output if they had several opportunities to interact with development agents and other service providers. Following the previous table, there was a 3.45% rise in the probability that households with more significant interaction with development agents within a given year would sell Niger seed products. Frequent contact of producers with extension agents helped producers obtain market information about agricultural products as they worked closely with farmers and became producers' main sources of information. This finding is similar to Hussen & Geleta (2021), uncovering that the full facet of services delivered by development agents encouraged farmers' participation in new production techniques through demonstrative exercises on-farm trial fields. Agricultural extension services increased the skills and knowledge of farmers, assisting them in adopting modern technology and facilitating liquidity and input supply constraints (Lerman, 2004). Furthermore, it is supported by the findings of Worku et al. (2021) that households with frequent contact with development agents were more likely to participate in the output market. In other words, the frequency of extension contact and agricultural commercialization had a direct relationship.

Similarly, Andaregie et al. (2021) discovered a positive relationship between the number of extension contact and haricot bean market participation. Due to extension service has become the medium through which new agricultural technologies from research centers could be disseminated to the farmers, this result disagrees with Martey et al. (2012), who disclosed that farmers who could access extension service were less likely to sell the product.

Producers require access to market information to gauge demand and supply accurately, enabling them to identify different market alternatives to earn higher product prices. At the 5% significance level, it had a beneficial effect on the level of Niger seed commercialization. The marginal effect results implied that producers with access to market information had a 9.8% greater chance of making a sale. The availability of market information positively

affected farmers' market participation decisions. Thus, accessing market information improved the adoption of new technologies (Wubet et al., 2022).

Furthermore, Chagomoka et al. (2014) unveiled similar findings that access to market information reduced asymmetric information among market actors and increased the possibility of enhancing farmers' productivity and market participation. However, these results contradict Martey et al. (2012), revealing that access to market information had a detrimental effect on the intensity of cassava commercialization due to the contractual agreement between producers and trading partners. Access to market information was evidenced to increase the likelihood of output commercialization. However, it positively and negatively affected different agricultural output market participation.

Gaining access to training aided producers in adopting different new agricultural technologies. Access to training at a 10% significance level rose the level of Niger seed commercialization. The model results revealed that households with access to training increased the probability of selling their products by 7.8%. It aligns with Taye et al. (2018), depicting the positive effect of access to training on onion market participation. As farmers could be awarded agricultural production skills, the domestic industry has demanded Niger seeds to produce processed oil products. Training on post-harvest loss minimization and application of new agricultural technologies and production systems enhanced farmers' production capacity. Training access helped farmers understand the market demand and quality of Niger seeds to be supplied to the market and processing factories. Gebre et al. (2022) reported that access to training influenced enset market participation positively

It is also supported by the findings of Gebrie & Teka (2019), who discovered that farmers with access to training were more likely to commercialize agricultural products. Moreover, Ojulu (2021) disclosed the positive and significant effect of training on the probability of maize market participation and degree of commercialization.

CONCLUSION

The study aims to analyze the determinants of Niger seed output commercialization in the Jabitehenan District. Specifically, it quantified the level of Niger seed output commercialization and analyzed factors affecting it. Niger seed output was 2.25 quintals, lower than the national average of 3.15 quintals. The average commercialization level of Niger seeds was 0.71. Following the Tobit model, the Niger seed commercialization was positively determined by the amount of Niger seeds produced, access to market information, frequency of extension contact, and access to training. Age and total livestock unit also had a detrimental impact.

The following policy implications were suggested. Understanding the current demand for different oil processing factories in the region helped increase the productivity and level of commercialization of Niger seeds to fulfill the demand of factories and earn higher profits for their output. Access to market information was critical to linking producers with the market. Concerned bodies should disseminate appropriate market information, such as the current demand for oil processing for Niger seeds, the market output price, and the economic

contribution of Niger seed output for foreign exchange earnings. The regional government and district leaders should strengthen the provision of different training to improve the production, productivity, and level of Niger seed commercialization by reducing losses during harvesting time and increasing the marketable surplus of Niger seeds. The local government should apply a cluster production system and utilize the sector's productive labor force.

Authors' Contributions: MM provided the idea, collected data, and analyzed and arranged the entire manuscript; CW validated and improved the manuscript; and SB enriched the result and discussion.

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