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Application of multivariate probit on determinants of sesame farmers market outlet choices in Gimbi District, Ethiopia

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Sesame (*Sesamum indicum* L.) is an important crop produced in Ethiopia for oilseed production and it was ranked first in total production from oil crops in 2013. The study is based on a survey of 166 farmers covering six kebeles in Gimbi district, Ethiopia with the objectives of identifying factors affecting choice of market outlet of sesame producers in the study area. Data were collected from both primary and secondary sources in 2015/2016. Multivariate probit model was for analysis. The results indicated that the probability of wholesalers to choose an outlet was positively and significantly affected by household education, distance from the nearest market, quantity produced and market price of sesame but negatively affected by collector market outlets. On the other hand, the probability of choosing cooperative marketing outlet is positively affected by membership of cooperative and distance from the market whereas it is negatively affected by market price of sesame. Therefore, the study confirmed the continued viability of sesame marketing cooperatives as suppliers of sesame-to-sesame buyers in the study area. The results obtained have important implications for farm management and future of farmers, as well as for the assessment of their development impacts.

Key words: Sesame, multivariate probit model, market outlet choices.

INTRODUCTION

Among the important oil crops grown in Ethiopia, sesame seed commands a unique position chiefly because of the fact that it is highly adapted to arid and semi-arid low land environment and yields fairly well. The country's main sesame production areas are located in the semi-arid lowlands of North-West Ethiopia that include mainly Humera, Tsegede and Wolkayit in Tigray and Metema, Quara and Tach Armachiho in Amhara Regional State. These production zones account for more than 70% of the national production (Goitom, 2009).

Ethiopia is among the top-five producers of oilseeds in the world. One of the oilseeds for which Ethiopia is

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known for in the international market is sesame. In the last few years, sesame production and marketing has shown very significant growth. Between 1998 and 2005-2006, the total area of production and the quantity of sesame produced has grown threefold. As a major producer of sesame, Ethiopia stands fourth in the global sesame market following China, India, and Burma, respectively and national sesame production has more than doubled in the past 5 years. Ethiopia exports almost all of its produce and is poised to become one of the top two leading sesame-exporting countries in the world, with a rapidly growing export performance in recent years, destined for markets in China, Japan, Korea, Israel and Turkey. Sesame is the major oil seed in terms of exports in Ethiopia, accounting for over 90% of the values of oil seeds exports (ATA, 2014).

Sesame is currently among the major Ethiopian export crops and is one among the agricultural crops for which Ethiopia is known in international markets (Sorsa, 2009). Evidences indicate that Ethiopia ranks fourth in sesame production in 2011/2012 (FAOSTAT, 2012) in the world, and the third in sesame seed export next to India and Sudan (Alemu and Meijerink, 2010). Evidences reveal that there is still potential arable land in different parts of the country to grow the crop and increase its supply response to the considerable demand for Ethiopian sesame seed in international markets (Sorsa, 2009). This indicates that, growth and improvement of the sesame sector can substantially contribute to the economic development of the country by benefiting agents at national, regional, and local levels. Yet, it is important to unravel how the agents can benefit from the sector through production and selling through different market outlet in the study areas.

Ethiopia's oilseeds production is essentially full of challenges yet replete with opportunities. Despite immense potential for improving the production and productivity of the sector, it is believed that primary producers lack the necessary marketing outlet to improve their production and productivity; trade arrangements are not well organized; the necessary government policies and institutions, and the enforcement of regulations are either non-existent or functioning too ineffectively to ensure a smooth operating chain. Therefore, the objective of the study is to investigate the factors affecting choices of sesame farmer's market outlet in the study areas.

METHODOLOGY

The study was carried out in Gimbi Woreda, located about 441 km West of Addis-Ababa and 2 km West of Gimbi town, the capital of Western Wollega Zone of Oromia region (Figure 1). It has an estimated area of 1,183.44 km^2; bordered in the South by Haru, on the Southwest by Yubdo, in the West by Lalo Asabi, and in the North by the Benishangul-Gumuz Region, on the East by the East Wollega Zone, and on the Southeast by an exclave of the Benishangul-Gumuz Region. The Woreda has a total of 32 Kebles, of which 30 are rural based peasant administration areas. The Woreda total population and households are estimated to be 74,623 and 18,301, respectively. Of the total households, 97% are rural residents making their livelihood from agriculture (CSA, 2007).

Lowland and midland agro-ecological zones characterize the Woreda's climate. Minimum annual temperature in the study area is 14°C and the maximum temperature reaches as high as 26°C while mean annual rain fall ranges from 800 to 2000 mm. The main rainy season in the Woreda is from March to the end of May and from June to the end or middle of September. The economy of the Woreda is dominated by traditional cash and other crops such as maize farming mixed with livestock husbandry. The major crops produced in the Woreda include sesame, maize and sorghum (GWOoARD, 2013).

Gimbi Woreda is known for its high potential for sesame, coffee and maize production. Besides, it is rich in small ruminant animals, incense and gum resources. Except for the very small areas under vegetables and fruits, crops in all farms (commercial and smallholders) are grown under rain fed condition. In the area, sesame, coffee, and maize are the most important marketable commodities, and account for 90% of the Woreda's cultivated area. Both primary and secondary data were used to collect data. Primary data were obtained using structured questionnaires administered to smallholder farmers and wholesalers from three purposively selected kebeles, collectors, commissioners, retailers, processors and exporters. The structured questionnaire was pre-tested with similar households operating within the study area, but not included in the final survey. Data were collected on household characteristics, socioeconomic and demographic characteristics, farm information, input utilization, and access to services such as extension, credit and market information. Experienced enumerators were recruited and well trained for actual field data collection. The data were collected in January 2015/2016.

A two-stage sampling procedure was used to select representative households from the study area. In the first stage, with the consultation of district agricultural experts and development agents, 3 out of 12 sesame producing kebeles were purposively selected based on their sesame production potential. In the second stage, sample size was determined using a simplified formula provided by Yamane (1967). Out of the total 1025 households, 127 households were selected using simple random sampling methods.

Descriptive statistics and econometric models were used to analyze the data collected from households. Descriptive data analysis includes the use of ratios, percentages, means and standard deviations for describing households based on their socioeconomic, demographic and institutional characteristics. To identify factors affecting market outlet choices decision of sesame producers at the individual household level, multivariate probit model was used. The multivariate probit is an extension of the probit model and is used to estimate several correlated binary outcomes jointly. Generally, the multivariate probit model can be written as:

$$y_{im} = \beta_{im} \times_{m} + \varepsilon_{im}$$

Where y_{im} (m= 1... k) represent the dependent variable of sesame market outlet selected by the i^{th} farmer. (i = 1… n). The dependent variables are polychotomous variable indicating whether sales are made through the relevant marketing outlet. The outlet was aggregated into three groups: wholesalers, cooperatives, and collectors. Each farm can use one or more marketing outlet. X_{im} is a 1 × k independent variable that affects the choice of marketing outlet decisions and βm is a k × 1 vector of unknown parameters to be estimated ε_{im}, m = 1, …, m are the error terms distributed as multivariate normal, each with a mean of zero, and variance-covariance matrix V, where V has values of 1 on the leading diagonal and correlations.

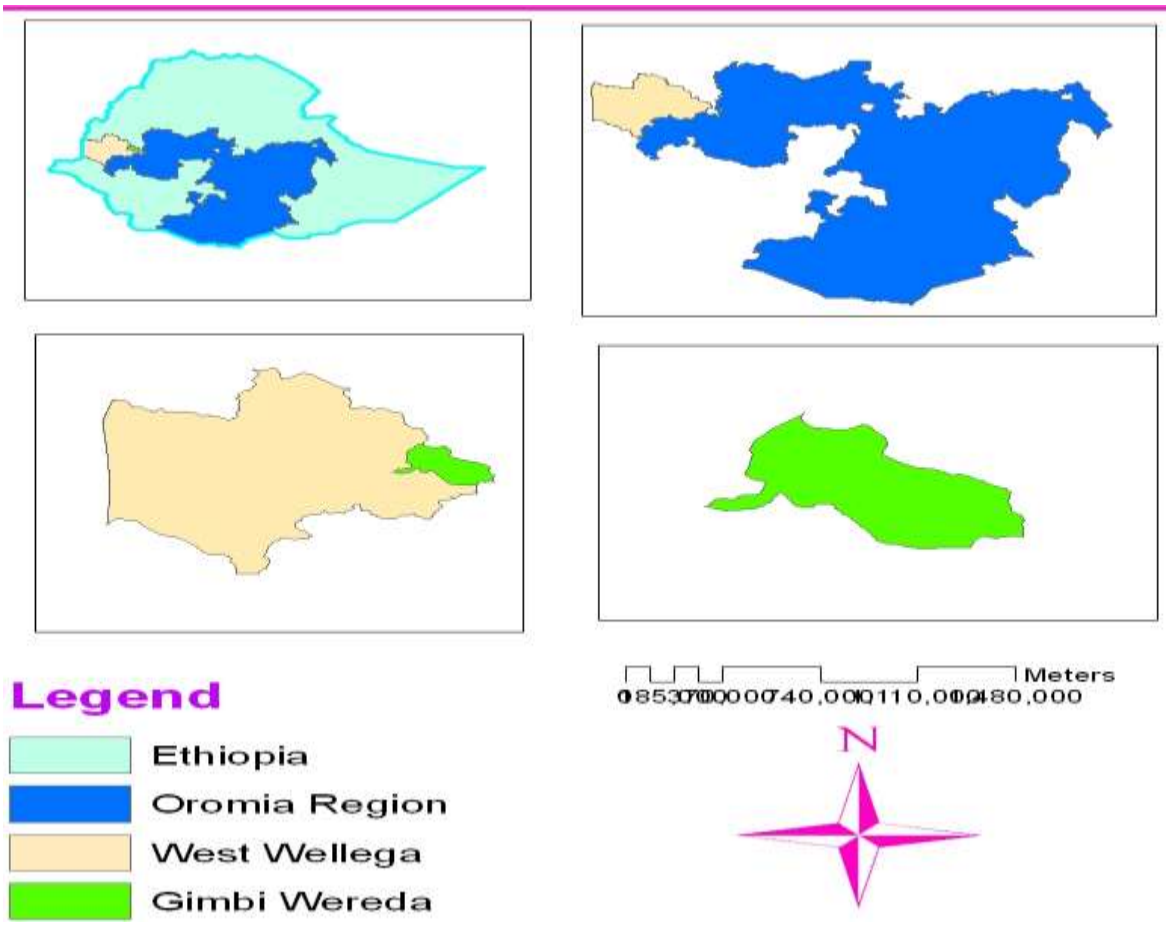

Figure 1. Map of the study area. Sources: Captured by GIS Expert for Research Purposes in 2016.

The aforementioned equation is a system of m equations shown in the following equations:

$$y_{1i}^{*} = \beta_1^{'} X_{1i} + \varepsilon_{1i}$$
$$y_{2i}^{*} = \beta_2^{'} X_{2i} + \varepsilon_{2i}$$
$$y_{3i}^{*} = \beta_3^{'} X_{3i} + \varepsilon_{3i}$$

The latent dependent variables are observed through the decision to adopt or not (yki) such that:

$$y_{im} = \begin{cases} 1 & if \quad y_k^{*} > 0 \qquad k = 1,2,3. \\ 0 & otherwise \end{cases}$$

There are six joint probabilities corresponding to the six possible combinations of choosing and not choosing each of the three outlets. The probability that all three components of the sesame market outlet have been selected by household 'i' is given as:

$$\Pr(y_{1i} = 1, y_{2i} = 1, y_{3i} = 1) = pr\left(\varepsilon_{1i} \le \beta_1^{'} \times_{1i}, \varepsilon_{2i} \le \beta_2^{'} \times_{2i}, \varepsilon_{3i} \le \beta_{3i}^{'} \times_{3i}\right)$$
$$\Pr(y_{1i} = 1, y_{2i} = 1, y_{3i} = 1) = pr\left(\varepsilon_{3i} \le \beta_3^{'} \times_{3i}, \varepsilon_{2i} \le \beta_2^{'} \times_{2i}, \varepsilon_{1i} \le \beta_{1i}^{'} \times_{1i}\right)$$
$$\Pr(y_{1i} = 1, y_{2i} = 1, y_{3i} = 1) = Xpr\left(\varepsilon_{2i} \le \beta_2^{'} \times_{2i}, \varepsilon_{1i} \le \beta_1^{'} \times_{1i}, \varepsilon_{1i} \le \beta_{1i}^{'} \times_{1i}\right)$$

This system of equations is jointly estimated using maximum likelihood method. The estimation is done using the user-written STATA mvprobit procedure (Cappellari and Jenkins, 2003) that employs the Gewek-Hajivassiliour-Keane smooth recursive conditioning simulator to evaluate the multivariate normal distribution (Train, 2003). The GHK simulator was indicated (Cappellari and Jenkins, 2003) to have desirable properties in the context of multivariate normal limited dependent variables that the simulated probabilities are unbiased, they are bounded within the (0, 1) interval, and the simulator is a continuous and differentiable function of the model's parameters.

The data covered information necessary to make household level indices of social, economic, demographic, and institutional indicators comparable across different categories of sesame market outlets choice at the individual household level. In order to identify factors affecting market outlet choice decision of sesame producers at the household level, continuous and discrete variables were identified based on economic theories and empirical studies as follows.

Marketing outlet (MktO)

Three classes of dependent variables were identified in market

Table 1. Proportion of producers by demographic characteristics across marketing outlets (%).

Variable	Item	Wholesaler	Cooperative	Collector
Sex	Male	94.5	90.1	8.6
Education status	Literate	78.1	74.4	24.4
Membership to cooperatives	Yes	27.8	72.2	47.4
Access to extension service	Yes	82.5	70.5	6.6
Credit	Yes	55.5	81.5	7.8

Source: Authors' computation from survey result, 2015.

Table 2. Proportion of producers by demographic characteristics across marketing outlets (%).

Variable	Wholesaler	Cooperative	Collector
Age	43.01	43.05	44.23
Land	3.61	3.51	3.62
DMkt	22.66	24.17	23.71
Price	24.46	22.26	18.78

Source: Own computation from survey result, 2015.

outlets: whether the farmer chooses to sell sesame to wholesalers, cooperatives and collectors. Each farmer can use one or more marketing outlet. In the analysis, it is measured by the probability of selling sesame to either of the markets. A farming household would choose one or more of the sesame market outlet if and only if the utility expected is higher than otherwise (Fafchamps and Hill, 2005).

RESULTS AND DISCUSSION

In this study, three major sesame market outlets were identified for the farmers to sell majority of their sesame products. More than 90% of male households chose wholesaler and cooperative market outlet, respectively. However, about 91.9 and 83% of female households sell their products to the cooperative and collectors respectively. Although the role of agricultural cooperatives in smallholder farmers marketing is recognized as vital, many of them reported that cooperatives as alternative market outlet in their sesame marketing. Accordingly, from those who are members of cooperatives, more than 70% of them sold their sesame to the cooperatives whereas 27.8 and 47.4% of them sold to the wholesalers and collector respectively (Table 1).

Compared with the collector's outlet, households with more education may have greater access to choose wholesalers and cooperative market outlet. Accordingly, of the literate households, about 78% sold their sesame to the wholesaler's market outlet. Educated farmers may have a greater ability to decide to choose any of better outlets from market channel. On the other hand, more than 80% of illiterate households choose collector market outlet to sell their sesame. Less educated households may be less likely to choose market outlet and practices, since they may be able to earn higher capital if they are used in other outlet. Thus, the probability and level of adoption increase with the education level of the farmers.

Econometric

Table 2 presents the results of the multivariate probit model. The results showed that the correlation coefficients among the equations are highly significant, which means that the multivariate probit model is superior to the individual probit models. In addition, a likelihood ratio test rejects the restrictions implied by separate probit models for the three outlets. According to Fafchamps and Hill (2005), the correlation is positive between the wholesalers and the cooperatives but is negative between the wholesalers and the collectors' outlets as well as cooperatives and collectors. This suggests that farmers who start using an alternative chain to the collector one are more prone to using another one.

According to Nyaupane and Gillespie (2011), the signs of the parameters confirm that the collector outlet is an alternative to both wholesalers and collector outlet, while wholesalers and cooperative are largely influenced in the same way by the variables. Larger farms are more likely to choose the wholesaler outlet, as indicated by the significant and positive relevant parameter. The corresponding parameters are significant and negative for the cooperative and collector outlet (Table 3).

Membership to any cooperatives was another highly significant variable that positively and significantly affect cooperative market outlet choice. This result indicates that if a household is member of any cooperative the probability of choosing wholesalers and collector outlet decreases. This is mostly related to the fact that those

Table 3. The multivariate probit.

Variable	Wholesalers			Cooperatives			Collectors		
	Coef	Std. error	Z	Coef	Std.error	Z	Coef	Std. error	Z
Sex	0.074	0.498	0.15	0.779	0.564	1.38	-723	0.486	-1.49
Age	-0.021	0.013	-1.63	-0.026	0.015	-1.69	0.167	0.012	0.01
HEduc	0.371**	0.013	1.18	-0.148	0.342	-0.04	-0.358*	0.307	-1.17
MCoop	-0.429	0.411	1.05	0.381***	0.011	1.00	-0.599	0.383	-1.56
Credit	0.349	0.401	-0.85	0.231	0.368	0.62	-0.693	0.377	-1.84
DMarket	0.211**	0.012	1.76	0.321**	0.015	2.02	-0.045*	0.012	-0.17
QProdn	0.114*	0.028	0.51	-0.055	0.031	-1.83	-0.889*	0.028	-0.01
Price	0.076*	0.031	0.19	-0.023*	0.034	-0.15	-0.341**	0.027	-1.23
OTran	0.391	0.362	1.08	-0.667	0.503	-1.33	-0.296	0.353	-0.84
MInfmn	-0.326	0.435	0.75	0.301	0.613	0.49	-0.491	0.414	1.19
AExtnto	0.184	0.263	0.70	-0.046	0.281	-0.16	0.144	0.248	0.58
-cons	1.903	1.101	1.73	1.652	1.208	1.37	-1.319	1.062	-1.24
Correlations				**(Coef , t-ratio)**					
R (Wholesalers, Cooperatives)				(0.641***, 4.15)					
R (Wholesalers, Collectors)				(-0.548***, -4.48)					
R (Cooperatives, Collectors)				(-0.431***, -2.79)					

LR test of rho21 = rho31 = rho32 = 0: chi^2 (3) = 29.058; $prob>chi^2$ = 0.0000 Log likelihood = -181.076; Number of observation = 127; ***, **,*: significant at 1, 5 and 10%, respectively. Source: Own computation from survey result, 2015

multipurpose cooperatives provide production and market information they directly or indirectly accessed to their members. Although the role of agricultural cooperatives in smallholder farmers marketing is recognized as vital, many of them reported cooperatives as alternative market outlet in their sesame marketing.

Market price of sesame has positive and significant effect on wholesalers' market outlet choice whereas negative and significant effect on cooperative and collector outlet choice. According to the result, the majority of the household head received more prices from the wholesaler's market outlet compared to cooperative and collector market outlets. These two outlets might have lower capitals than wholesaler might which constrain them from paying higher prices.

Distance from the nearest market has positive and significant on both wholesaler, and cooperatives market outlet choice whereas has negative effect on collector market outlet choice. This indicates that households who are closer to market were assumed to have more probability to choose wholesalers and cooperatives outlet whereas household who are far from the market were expected to be associated with sales to the collector market outlet Fafchamps and Hill (2005). This is may be due to the reason that as the distance to the market center increases transportation and other marketing costs increased.

CONCLUSION AND RECOMMENDATIONS

The objective of the study is to identify the factors affecting outlet choice decisions of farm households. Market outlets were classified into three categories according to farmer market outlet choice decision: wholesalers, cooperatives, and collectors. The model results indicated that the probability to choose the wholesalers outlet was positively and significantly affected by household education, distance from the nearest market, quantity production and market price of sesame but these variables negatively affect the probability of choosing collector market outlets. The probability of choosing cooperative marketing outlet was positively affected by membership to any cooperative and distance from the market whereas negatively affected by market price of sesame. Hence, most of the effects of the variables are in line with the study hypothesis and different literatures as discussed previously. Therefore, governmental and non-governmental organization is needed to improve sesame production in the study area. In the study area farmers are small scale and unorganized; this state of affairs clearly needs strong governmental and non-governmental organizations intervention. In addition, improving credit, training, and market information access is needed to improve the existing sesame production in the study area. Sampled farmers complained about lack of finance, low price of sesame, lack of packaging materials, and lack of shortage and transport facility in the area. In this regard, farmers require immediate intervention and support. Therefore, improving credit and transportation access to the farmers is essential to make sesame market efficient in addition to developing road infrastructures. In addition to this, smallholder farmers have complained about the

crop failures at different stages due to sesame diseases, rainfall related problems, soil acidity and cracks, and pest infestation problems. This requires research and development works in the area to sustainably solve these problems.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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