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Original Research

Determinants of production and marketing of Kororima (*Aframomum kororima*); the case of South Ari district, South Omo zone, SNNPR, Ethiopia

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Abstract

The spice sector is a vital component of Ethiopia's agriculture, generating substantial foreign exchange. Aframomum corrorima, often known as Ethiopian cardamom or kororima, is one of the spices used extensively for a variety of applications throughout the nation. However, there are a number of limitations on its marketing and production. This study is aimed to determine and evaluate the factors influencing the production and marketing of Aframomum corrorima in the South Ari district, specifically the market outlet choice decisions. For this study, 150 sample farmers were chosen from five kebeles by using a multi-stage sampling technique. Data were collected through a survey of the sample respondents. Econometric models the multiple linear regression and Multivariate probit model were used to analyze the data. The result of multiple linear regression models indicated that out 12 variables included into the model 7 variables significantly (P < 0.05) affected the production of Aframomum corrorima. The result of multivariate probit model showed significant difference in producer market outlet choice. The study found that household, gender, access to price information, and distance to the nearest market significantly influenced the selection of collector outlets. While household gender, education level, landholding size, and access to pricing information significantly influenced the choice of retailer outlets at different probability levels, wholesaler outlet choice was also highly influenced by distance to the closest market and price information availability. These findings suggest that the livelihoods of smallholder farmers in the study area could be effectively improved by interventions that address these issues.

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INTRODUCTION

Globally, spice production has shown steady growth, reaching an estimated 12.8 million tons in 2018 (Titus and Wojtek, 2020). In Ethiopia, spices together with pulses and oilseeds constitute key agricultural export commodities after coffee, contributing significantly to foreign exchange earnings (EMI, 2015). The country produces more than 50 different spice crops and has a long-standing history of spice cultivation and trade (Titus and Wojtek, 2020). Spices are cultivated on an estimated 222,700 hectares nationwide, with a potential annual production of approximately 244,000 tons, including more than 200,000 hectares located in lowland areas (GIT, 2016). Empirical evidence indicates that Ethiopia's spice production increased from 234,000 tons in 2013 to 356,000 tons in 2018, accompanied by an expansion in cultivated area from 150,000 to 207,000 hectares (Titus and Wojtek, 2020).

Ethiopia's diverse agro-ecological zones and favorable climatic conditions provide a strong comparative advantage for spice production. Major spice-producing regions include the Southern Nations, Nationalities and Peoples' Region (SNNPR), Oromia, and Amhara (Titus and Wojtek, 2020). Among these, SNNPR is recognized as the leading region, producing a wide range of spices such as kororima (*Aframomum corrorima*), turmeric (*Curcuma longa*), cardamom (*Elettaria cardamomum*), black pepper (*Piper nigrum*), cinnamon (*Cinnamomum verum*), and ginger (*Zingiber officinale*) (Endrias and Asfaw, 2011; Asale and Ashango, 2017). Despite this favorable production environment, Ethiopia's contribution to global spice exports remains relatively low, and productivity levels fall short of international standards (Shimelis, 2021).

Among Ethiopia's indigenous spice crops, *Aframomum corrorima,* commonly known as kororima, or Ethiopian cardamom holds a unique position. The crop is native to Ethiopia and widely cultivated in regions such as Kaffa, Jimma, Illubabor, Sidamo, Bale, East and West Wollega, Gamo Gofa, South and North Omo, and parts of Gojam (Zakir, 2018). Kororima is deeply integrated into Ethiopian culture and cuisine and serves multiple functions, including food seasoning, traditional medicine, income generation, and soil conservation. It is also an important export commodity with substantial potential to enhance smallholder livelihoods and national foreign exchange earnings (Eyob *et al*., 2007).

Aframomum corrorima can be propagated both sexually and vegetatively and typically reaches maturity within three to five years after planting, with an economic lifespan exceeding seven years (FAO, 2011). The crop thrives under forest canopies in coffee-growing areas, particularly in southwestern and southern Ethiopia, at altitudes ranging from 1,700 to 2,300 meters above sea level (Hibistu, 2020). Despite its ecological adaptability and socio-economic importance, kororima production has shown a declining trend over time. This decline is largely attributed to deforestation, agricultural expansion, land-use changes, climate variability, and the degradation of its natural forest habitat (Zakir, 2018).

In addition to environmental challenges, the production and marketing of *Aframomum corrorima* are affected by a range of institutional, technical, and market-related factors. These include low productivity of existing varieties, limited access to improved planting materials, inadequate extension services, traditional harvesting and post-harvest handling practices, pest and disease pressures, and damage caused by wild animals (Mulatu and Gadisa, 2010; Gebreyesus, 2016). Marketing challenges are equally severe and include poorly organized market structures, limited access to formal market outlets, illegal trading, low farm-gate prices, weak bargaining power of farmers, and a lack of transparent price-setting mechanisms (Adicha *et al*., 2022; Tiru *et al*., 2017). Consequently, farmers often market small quantities at low prices, discouraging investment in improved production technologies and practices.

In South Ari District and the wider South Omo Zone, *Aframomum corrorima* is predominantly produced by smallholder farmers and represents an important source of household income (Zakir, 2018; Adicha *et al*., 2022). Nevertheless, despite the district's considerable production potential, farmers continue to face persistent challenges related to low productivity, limited access to improved technologies, weak extension support, poor market linkages, and price instability. These challenges constrain both production efficiency and market participation.

Although several studies have examined spice production and marketing in Ethiopia, research specifically focusing on the production determinants and market outlet choices of *Aframomum corrorima* producers at the local level remains limited and fragmented. Moreover, many existing studies may not adequately reflect current conditions due to evolving socio-economic dynamics, changing market structures, and location-specific factors. Therefore, there is a critical need for context-specific empirical evidence to better understand the factors influencing kororima production and market outlet choices. This study aims to fill this gap by identifying and analyzing the key factors influencing the production and market outlet decisions of *Aframomum corrorima* producers in South Ari District, with the ultimate goal of informing policy interventions and development strategies to enhance productivity, market participation, and smallholder livelihoods.

METHODOLOGY

Description of the study Area

The study was conducted in South Ari District, one of the nine districts of the Ari Zone, located in southwestern Ethiopia within the South Omo Zone of the Southern Ethiopia Regional State. Geographically, the district lies at approximately 5.91° N latitude and 36.58° E longitude (Figure 1). The study area surrounded by North Ari District to the north, Malle District to the east, Bena Tsemay District to the south and southeast, and Salamago District to the west, with parts of its southern boundary adjoining Mago National Park. The district is situated close to Jinka, the zonal capital, while its administrative center, Gazer Town, is located approximately 17 km from Jinka. South Ari District covers a total area of about 513.13 km² (51,313.19 hectares) and comprises 46 rural kebeles and five administrative towns. According to the Woreda Office of Agriculture and Development, land use in the district is predominantly agricultural, with approximately 35,209.09 hectares under cultivation. Grazing land accounts for about 8,017 hectares, forest land covers 2,846 hectares, and the remaining 5,241.1 hectares are allocated to settlements and other land uses.

Agro-ecologically, the district encompasses semi-arid and diverse climatic zones, including *kola*, *weynadega*, and *dega*, characterized by varied topography consisting of lowland, midland, and highland areas. These conditions support agro-pastoral livelihoods, with communities at different stages of transition from nomadic to sedentary farming systems. The district has an estimated total population of 168,225, representing approximately 35% of the population of the South Omo Zone. Infrastructure development is limited, as only 24 kebeles (48%) are accessible by vehicle via dry-weather roads. The distance between individual kebeles and Jinka Town ranges from 4 to 83 km, with an average distance of 37 km. The population of South Ari District is ethnically homogeneous, predominantly composed of the Aari people, who possess a distinct language and cultural identity.

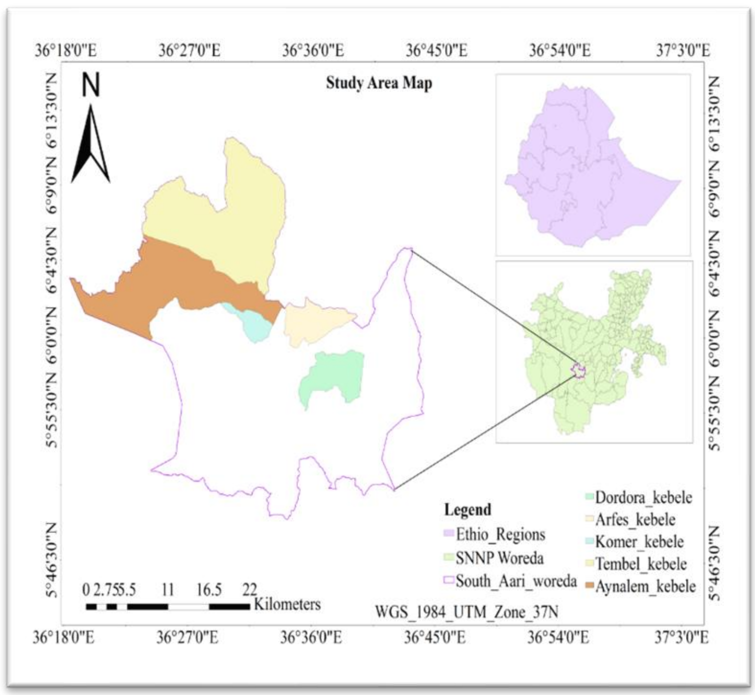

Figure 1: Map of the study Area

Data types, data sources, and data gathering methods

Primary and secondary sources were used to gather both qualitative and quantitative data. To evaluate the production and marketing of Aframomum corrorima, qualitative data were gathered through key informant interviews using checklists, semi-structured and open-ended questionnaires, focus groups, and direct observation. Primary and secondary data sources were used to examine the socioeconomic and demographic traits of Aframomum corrorima producers as well as the conditions surrounding the plant's production and commercialization. The primary data came from the respondents in the selected representative sample. Secondary data was also collected from the district and zonal planning offices, the trade and investment office, and both published and unpublished studies.

Sampling techniques and sample size determination

A multi-stage sampling procedure was used to choose the sample respondents in the South Ari District. Because of its strong potential for producing *Aframomum corrorima* and its relative accessibility for research, the district was specifically selected from the South Omo Zone. Activities, in contrast to those in other areas. Eleven of South Ari District's out of 28 kebeles are known to produce *Aframomum corrorima*.

The kebeles were divided into high-, medium-, and low-producing groups based mostly on production data from the South Ari District Office of Agriculture and Natural Resources. Consequently, seven kebeles were found to be high-producing, two as medium, and two as low-producing. Five kebeles, three from the high-producing group, one from the medium-producing group, and one from the low-producing group were chosen at random from these strata based on market accessibility and production potential. Using a probability proportional to size sampling technique, respondents were then chosen at random from the population of Aframomum corrorima producers within the chosen kebeles. Yamane's (1967) formula was used to calculate the total sample size in order to guarantee statistical representativeness.

Sample size determination

The numbers of sample participant were determined based on the Yamane (1967) formula.

$$n_0 = \frac{N}{1+N(e)^2} \qquad n_0 = \frac{3522}{1+3522(0.08)^2} = 149.612 \cong 150$$

Where, n_0 - is the sample size,

N - Is the population size and

e - Is the level of precision (equal to 8%).

Then, sample respondents from each kebeles were calculated as:

$$n_i = \frac{\text{Total sample size } \times \text{total number of farmer from given kebeles}}{\text{Total number farmer in each selected kebeles}}$$

Table 1: Selection of sample farmers from the population

No	Selected kebeles	Number of farmers in given kebeles	Sample selected
1	Komer	732	31
2	Dordora	695	30
3	Aynalem	836	36
4	Arfes	617	26
5	Tembel	642	27
	Total	3522	**150**

Source: Own computation, 2023

Methods of Data Analysis

Both descriptive statistical approaches and econometric analysis techniques were used in this investigation. Descriptive statistical tools, such as means, percentages, standard deviations, frequency distributions, ratios, and tabulations, were used to assess quantitative data. Additionally, t-tests for mean comparisons and Chi-square testing for categorical variables were used to investigate variations among sample respondents in *Aframomum corrorima* production and market outlet preference.

Econometric Model

Multiple linear regression models are used to identify the factors influencing *Aframomum corrorima* output, an econometric approach, specifically a multiple linear regression model, was employed.

Model Specification: The continuous dependent variable of the model, indicated in kilograms (Kg), is the total amount of Aframomum corrorima produced by the head of the sampled household. The most often used statistical method for data analysis is multiple linear regression modelling, which is the proper econometric approach to handle continuous dependent variables. It is a general statistical method for analysing the connection between a group of continuous, dummy, or categorical independent variables and a continuous dependent variable.

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_K X_K + U_i$$

Where, Y_i= amount of Aframomum corrorima produced by sampled household in kilogram; X_1, X_2,….X_k are explanatory variables which is factor affecting the production of Aframomum corrorima. β_0, β_1, β_2,……..β_k is parameter, which indicate the mean change of explanatory variables for a unit change in dependent variables. U_i random error term.

Multivariate probit model

The best models for examining the factors influencing the sample household's decision to choose a market outlet are the multivariate probit and multinomial logit models. Collectively exhaustive multinomial models are suitable when the outlet option is mutually exclusive (Gumataw *et al*., 2016). However, given the potential for simultaneous outlet selections and the possible linkages between these market outlet selections, the producers' market outlet choices in this study are not mutually exclusive. Due to its advantages over the multinomial logit model, the multivariate probit model was employed. Based on some empirical studies farmer have different market outlet choices and choose the particular marketing outlet that maximizes expected utility. Wholesalers, collectors, retailers, and consumers are the four categories into which the potential market outlets have been divided. There is some overlap, and many farmers sell on many market outlets since each farmer can use one or more marketing outlets, or multiple combinations of various outlets that optimize the predicted benefit (Honja, *et al*., 2017). In addition to accounting for the possible association between unobserved disturbances and the relationship between market outlets of various activities, the MVP technique concurrently models the impact of the set of explanatory factors on each of the many market outlet choices.

The multivariate probit model considers the probable correlation in the selection of different outlets as well as the potential dependency in market outlet choices. The likelihood that a specific market outlet will be preferred is calculated based on the selection of any other relevant outlet. Each subject is assumed to have unique binary responses in the multivariate probit model, along with a matrix of covariates that may consist of any combination of continuous and discrete variables. In general, the multivariate probit model makes the assumption that, given a collection of explanatory variables, the multivariate response indicates the likelihood that an unobserved latent variable would fall within a specific range. There are several ways for Aframomum corrorima producers in the research area to market their produce, including wholesalers, local collectors, and retailers (Adicha, *et al*., 2022).

Aframomum corrorima is thus a cash crop that allows producers to select multiple, non-exclusive market outlets to maximize their returns. Considering the possibility of simultaneous outlet choices and potential correlations among these decisions, the multivariate probit model was deemed an appropriate approach for capturing household-level variation in market outlet selection and for jointly estimating multiple correlated binary outcomes. The selection of appropriate market out let *i* by farmer *j* is Y_{ij}^A defined as the choice of farmer *j* to transact market out let $i(Y_{ij}^A = 1)$ or not $(Y_{ij}^A = 0)$ is expressed as follows:

$$Y_{ij}^A = \begin{Bmatrix} 1 \; if \; Y_{ij}^A = X_{ij}^A\beta_{ij} + \varepsilon^A \geq 0 \leftrightarrow X_{ij}^A \geq -\varepsilon^A \\ 0 \; if \; Y_{ij}^A = X_{ij}^A\beta_{ij} + \varepsilon^A < 0 \leftrightarrow X_{ij}^A < -\varepsilon^A \end{Bmatrix} \dots\dots\dots\dots(1)$$

Where β_{ij} a vector of estimators, ε^Aa vector of error is terms under the assumption of normal distribution, Y_{ij}^A the dependent variable for market outlet choices simultaneously and X_{ij}^A combined effect of the explanatory variables. The farmer's decision to select a certain set of market outlets is expected to be affected by the same explanatory variables.

$$\begin{cases} Wholesaler\ j = X_1'\beta_1 + \varepsilon^A \\ Collector\ j = X_2'\beta_2 + \varepsilon^B \\ Retailer\ j = X_3'\beta_3 + \varepsilon^C \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where X1 to X3 are vectors of variables, β1 to β3 are vectors of parameters to be estimated, and ε is the disturbance term; Wholesaler j, Collector j, and Retailer j are binary variables that take values of 1 when farmer j picks wholesalers, collectors, and retailers, respectively, and 0 otherwise.

The multivariate model permits the simultaneous consideration of multiple market outlets, with the error terms jointly assumed to follow a multivariate normal (MVN) distribution, characterized by a zero conditional mean and unit-adjusted variance. The correlations among the endogenous variables are denoted by ρ_{ij}.

$$\begin{pmatrix} \varepsilon^A \\ \varepsilon^B \\ \varepsilon^C \end{pmatrix} \ldots N \left[\begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} \begin{pmatrix} 1 & \rho_{12} & \rho_{13} \\ \rho_{21} & 1 & \rho_{23} \\ \rho_{31} & \rho_{32} & 1 \end{pmatrix} \right] \ldots\ldots\ldots\ldots\ldots (3)$$

$E(\boldsymbol{\varepsilon}/X) = 0$

$Var\ (\varepsilon/X) = 1$ ……………………………………………………… (4)

$Cov\ (\varepsilon/X) = \rho$

Dependent and independent variables

The amount of *Aframomum corrorima* in Kg produced during the year 2022/23.

Market outlet choice decision (MKTOTCD): It is a categorical variable which takes the value 1 = Wholesaler 2 = Collector 3 = Retailer of Aframomum corrorima during the year 2022/23.

Table 2: A Summary of the dependent and independent variables used for multiple linear regression models

No	Variable Name	Variable Code	Variable type	Hypothesis
I	**Dependent variables**			
1.	Quantity of Aframomum corrorima produced	QAKPROUED	Continuous	
II	**Independent variables**			
1.	Gender of household head	GEND	Dummy	+/-
2.	Age of household head	AGE	Continuous	+/-
3.	Family labor	FLAB	Continuous	+/-
4.	Education level of household head	EDULEVEL	Categorical	+
5.	Size of land holding in (Ha)	SLAND	Continuous	+
6.	Disease	DEASES	Dummy	-
7.	Farming experience	FEXP	Continuous	+
8.	Extension service	EXTSRV	Dummy	+
9.	Access to price information	MKTINFO	Dummy	+
10.	Lagged price of Aframomum corrorima	LPAFC	Continuous	+

Source: Own construction, 2023

Table 3: A Summary of dependent and independent variables for Multivirate probit model

No	Variable Name	Variable Code	Variable type	Expected Effect		
I	**Dependent variables**			**Collector**	**Retailer**	**Wholesaler**
1.	Market outlet choice of Aframomum corrorima producer	MKTPK	Categorical			
II	**Independent variables**					
	Gender of household head	GEND	Dummy	+	-	+
2	Age of household head	AGEHH	Continuous	+	-	-
3	Quantity of Aframomum corrorima production	QUANTITYKP	Continuous	-	+	+
4	Family Labor	FLAB	Continuous	-	+	+
5	Education level of household head	EDULEVEL	Categorical	+	+	+
6	Size of land holding	SLAND	Continuous	-	-	+
7	Disease	DEASES	Dummy	-	-	+
8	Extension service	EXTSRV	Dummy	-	-	+
9	Farming experience	FEXP	Continuous	-	-	+
10	Lagged price of Aframomum corrorima	PAFC	Continuous	-	+	+
11	Distance from the nearest market	DNMARK	Continuous	-	-	-
12	Credit Access	CREDIT	Dummy	+/-		
13	Price information	PINFO	Dummy	-	+	+

Source: Own construction, 2023

RESULT AND DISCUSSION

Household socioeconomic and demographic characteristics

Table 4 below illustrates how the sample respondents' socioeconomic and demographic traits were divided into discrete and continuous variables. One discrete variable that is thought to have an impact on Aframomum corrorima productivity is household gender. Of the 150 respondents, 26 (17.3%) are female, and 124 (82.7%) are male. The sample respondents were divided into five groups according to their educational attainment. 46 (30.7%) of the sample respondents are illiterate, 47 (31.3%) have an education level of 1-4, 36 (24%) have an education level of 5-8, 14 (9.3%) have an education level of 9–12, and 7 (4.7%) have an education level of more than 12.

Table 4 : Demographic and socio-economic characteristics of households (discrete)

Demographic variables		Frequency	Percent
Gender of household head	Female	26	17.3
	Male	124	82.7
Education level of household head	Illiterate	46	30.7
	1-4	47	31.3
	5-8	36	24.0
	9-12	14	9.3
	>12	7	4.7

Source: Computed from field survey, 2023

Table 5 displays the sample respondents' socioeconomic and demographic information for continuous variables. One of the main demographic factors affecting respondents' choices for market outlets and production is their age. With a mean of 40.36 years and a standard deviation of 7.87 years, the sampled respondents' ages ranged from 25 to 65. The average family labor size among the sampled households was approximately five persons, with a minimum of 2.35, a maximum of 9, and a standard deviation of 1.45. An adequate family labor force enhances the capacity for *Aframomum corrorima* production and is likely to improve households' ability to select more appropriate market outlets. With a standard deviation of nine years, the respondents' average experience in *Aframomum corrorima* manufacturing and marketing was 21 years. They had at least five years and up to forty years of farming experience. With a mean farm size of 0.78 hectares and a standard deviation of 1.01 hectares, the studied farmers' total landholding size ranged from 0.125 to 6 hectares. Market distance, price information accessibility, and the seasonality of spice sales were the main factors influencing notable price swings in the research area.

For the sampled farmers, the selling price of *Aframomum corrorima* during 2022–2023 ranged from 60 to 350 birr per kilogram, with an average of approximately 160 birr and a standard deviation of 47 birr. Market distance was identified as a key factor influencing producers' decisions regarding production and choice of market outlet. On average, respondents were located 3.75 kilometers from the nearest market, with a standard deviation of 2.41 kilometers. The closest respondent was situated approximately 1 kilometer from the market, while the farthest was 11 kilometers away

Table 5: Demographic and socio-economic characteristics of households (continuous variables)

Demographic and socio-economic variables	Minimum	Maximum	Mean	Std. Deviation
Age of the household head	25	65	40.36	7.86572
Family labor	2.35	9	4.8247	1.44712
Farming experience	5	40	21.2067	8.68718
Size of land holding in (Ha)	0.125	6	2.188417	1.014454
Lag price in birr per Kg	60	350	159.2333	46.92467
Market distance from your home in Km	0.1	11	3.7487	2.41229

Source: computed from field survey, 2023

Institutional characteristics of the household

The production and market outlet decisions of farm households for various crops and spices are influenced by a range of institutional factors. Among those factors price information, credit service, and extension service are considered to influence the production and market outlet choice of corrorima. From the total respondent surveyed, 54 (36%) of respondents have no price information before selling their corrorima produce, which affect the choice of the best market outlet, whereas 96 (64%) of the respondent have price information before selling their corrorima produce. Allocating the land for corrorima production makes loss of an opportunity to allocate the same land over the period in which the spice is in the field.

Four (2.7%) of the total respondents to the study have credit services, while 146 (97.3%) do not. The majority of sample respondents cite restricted procedures, lack of interest, high interest rates, unfavorable repayment times, and incapacity to repay as reasons for not getting the credit. Another significant institutional component that influences *corrorima* production and commercialization is extension services. Extension services are primarily used in the research region to assist farmers with sophisticated planting methods, effective harvesting and post-harvest management, price information access, and choosing the best market outlets for *Aframomum corrorima* marketing. Out of all respondents, 74 (49.3%) have extension services, and 76 (50.7%) do not.

Table 6: Institutional characteristics of household (discrete variables)

		Frequency	Percent
Corrorima price information	No	54	36
	Yes	96	64
Credit service	No	146	97.3
	Yes	4	2.7
Extension service	No	76	50.7
	Yes	74	49.3

Source: computed from field survey, 2023

Factors influencing Aframomum corrorima production

Factors affecting the production of Corrorima wereanalyzed by using multiple linear regression models. Among the assumption of classical linear regression, multicollinearity and heteroscedasticity were checked for the hypothesized explanatory variables, and we confirm that there is no multicollinearity and heteroscedasticity problem.

With data of the study area's production potential and the fact that Aframomum corrorima is the primary cash crop there, we set out to identify the elements that influence productivity. The production of Aframomum corrorima is influenced by several institutional, agricultural, and socioeconomic factors. Seven variables are displayed as statistically significant at the 1% and 5% levels of significance out of the twelve variables that were incorporated in the model. Aframomum corrorima production is positively impacted by all important factors. Aframomum corrorima production is influenced by age and gender of the household head at the 5% level of significance, whereas the 1% level of significance is affected by farming experience, the amount of land used for kororima production, the use of enhanced spices, and price information.

Age of household head: It is one of the continuous explanatory variables that affect the production of Aframomum corrorima positively at 5% level of significance. As the age of house hold increase by 1 year on average, the production of Aframomum corrorima increase by 4.86Kg. An old age person is mainly known by producing those commodities that give a high price with less effort. This positive relationship is attributed to the fact that older farmers often possess greater farming experience, accumulated knowledge of production practices, and improved decision-making skills, which enable them to allocate resources efficiently to high-value crops (Ndambiri, *et al*, 2013).

Gender of household head: The results of multiple linear regression analysis indicate that gender difference among the respondent have significant influence positively at 5% level of significances on production Aframomum corrorima. If the household head is male, there is the advantage of cultivating, weeding, and harvesting for themselves as well as access to capital, and access to institutional credit, access to extension service, than female headed household. So, male household heads produce 86.64 Kg than female headed household at citrus paribus. This positive effect can be attributed to the greater access male household heads typically have to productive resources, including labor for cultivating, weeding, and harvesting, as well as better access to capital, institutional credit, and agricultural extension services compared to female-headed households (FAO, 2011). Male-headed households often have more control over land and inputs, enabling higher productivity of high-value crops like Aframomum corrorima.

Farming experience: It affects the production of Aframomum corrorima significantly at 1% level of significance. For spices like Aframomum corrorima, which are produced on a small scale, experience in production plays an important role in improving and increasing output. A household's production of Aframomum corrorima increases by 7.06 kg on average after a year of increased farming expertise. This result is consistent with findings reported by FAO (2011), which indicate that experienced farmers are generally better able to manage resources, adopt improved practices, and make informed decisions that enhance the productivity of high-value crops.

Size of land under corrorima production: It affects production of Aframomum corrorima significantly at 1% level of significance. If a large plot of land is allocated for corrorima production, people makes huge effort get a good product than if they allocate a small plot of land. Therefore, the average production of Aframomum corrorima increases by 248.5 kg for every hectare of land allotted for its production. This positive association between land size and agricultural output is consistent with empirical evidence that larger cultivated areas enable better use of capital, labor, and inputs, and are correlated with stronger overall agricultural performance across different contexts (Gollin, 2019).

Lagged price: It is the most critical factor affecting production decisions. If the farmer perceive that the lagged price is good, he/she can allocate more additional land and other resources than the previous year. It affects the production of Aframomum corrorima positively significantly at 1% level of significances. One birr increase in lagged price of Aframomum corrorima increases the production Aframomum corrorima by 0.66 kg per hectare. This finding is consistent with empirical evidence showing that farmers' supply responses are positively influenced by price incentives, as higher prices increase the area planted and yield produced by signaling greater returns to production (Gebreselassie, 2020).

Usage of improved corrorima: Mainly improved spice is obtained from an experienced farmer in the study area, not from an extension agent or any other institution. Usage of improved corrorima affects the production of Aframomum corrorima significantly at 1% level of significances. Those who use improved corrorima can produce 194 Kg per hectares than those who do not consider and use the suggested spice in the South Ari district. This finding support with empirical evidence indicating that the adoption of improved crop varieties significantly increases yield and productivity in smallholder farming systems, as improved seeds are often more resistant to pests and diseases, mature faster, and have higher market value (FAO, 2011; Gebreselassie, 2020).

Price information: It affects the production of Aframomum corrorima positively significantly at 1% level of significances. Those who have price information of either past or future are capable to produce more than those who have no information access about price of produce. Having information access can increase production of Aframomum corrorima by 77 Kg per hectares. This finding is consistent with empirical studies indicating that information on market prices enhances farmers' decision-making, improves input allocation, and encourages higher production in smallholder agriculture (FAO, 2011; Gebreselassie, 2020).

Table 7: Factors affecting the production of Aframomum corrorima

Quantity of Aframomum corrorima produced in Kg	Coef.	Robust Std. Err.	T-value	P>t
Age of household head	4.864282**	1.985404	-2.45	0.016
Gender of household head	86.64447**	33.9942	-2.55	0.012
Education level of household head	12.53884	8.76204	-1.43	0.155
Farming experience	7.061349***	1.682022	4.20	0.000
Size of land holding in (Ha)	8.362908	12.36871	-0.68	0.500
Size of land under corrorima production in (Ha)	248.5515***	54.2917	4.58	0.000
Lagged price of Aframomum corrorima	.6671133***	.2347192	2.84	0.005
Usage of improved corrorima	194.1645***	34.00931	5.71	0.000
Price information	77.16909***	21.24681	3.63	0.000
Spice disease	-.941145	20.18929	-0.05	0.963
Extension service	7.111058	7.616194	-0.93	0.352
Distance from the nearest market	1.398709	8.741504	-0.16	0.873
_cons	57.90003	102.2439	-0.57	0.572

*** and ** represents significance at 1% and 5% levels respectively

Source: computed from field survey, 2023

Corrorima Marketing Outlets

The sample respondent was first informed of the existing outlet options for selling Aframomum corrorima produce, and they were also asked whether there were any more options. Collectors, wholesalers, and retailers were the outlets chosen based on the indicated option. In the study area, those are the outlets that people most frequently choose to sell their produce together. The various market outlets used by *Aframomum corrorima* producers are presented in Table 8. With an average supply of 96.1 kg, the collector outlet was the most popular channel, selected by about 84% of respondents. By contrast, with a mean supply of 48.5 kg, over 70% of respondents sold their produce to wholesalers. With 46.7% of studied families giving an average of 49.9 kg, retailers were also a prominent marketing outlet, demonstrating their popularity in the research area.

Table 8: *Corrorima* market outlet descriptions

Description	Corrorima market outlets					
	Collectors		Wholesalers		Retailers	
	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency
Yes	84	126	70	105	46.7	70
No	16	24	30	45	53.3	80
Supply to each outlet	Mean (kg)	SD	Mean (kg)	SD	Mean (kg)	SD
	96.1	96.8	48.5	76.5	49.9	60.98

Source: computed from field survey, 2023

Factors influencing smallholder market outlet choices of Corrorima producers

When a farmer chooses the right market outlet, they can sell their produce for a fair price without having to pay intermediaries any needless expenses. Numerous institutional, societal, and demographic aspects affect producers' selection of *Aframomum corrorima* marketing channels. The Wald test (Wald chi²(42) = 92.64, p = 0.0000) is significant at the 1% level, as Table 11 illustrates, suggesting that the subset of coefficients in the model is jointly significant. This shows that the explanatory variables have enough predictive power, indicating that the multinomial probit (MVP) model fits the data well.

The model's likelihood ratio test results (LR $\chi^2(3)$ = 10.6197, Prob > χ^2 = 0.0140) show that two of the estimated coefficients across the model's equations have substantial joint correlations. At the 5% significance level, the null hypothesis that the market outlet choice decisions ($\rho_{12} = \rho_{31} = \rho_{32} = 0$) are independent is rejected. This demonstrates the interdependence of household decisions on the three *Aframomum corrorima* marketing outlets and the bias of studying these outlet choices separately.

The likelihood ratio statistics for the estimated correlation matrix are presented, reflecting the variation in producers' market outlet choices. The ρ values (ρ_{ij}) indicate the degree of correlation between each pair of dependent variables. At the 1% significance level, the correlation between the wholesaler and collector outlet choices (ρ_{21}) is significant and negatively correlated.

Based on these results, it can be concluded that *Aframomum corrorima* producers are less likely to supply to a collector when they choose the wholesaler outlet (ρ_{21}), indicating a competitive relationship between wholesalers and collectors. The simulated maximum likelihood (SML) estimates indicate that the probabilities of selecting collector, wholesaler, and retailer market outlets are 83.68%, 69.93%, and 46.42%, respectively, demonstrating that producers are comparatively more likely to choose the collector outlet. Furthermore, the joint odds of success or failure suggest that households exhibit a tendency to consider the three market outlets collectively rather than independently. The probability that households will simultaneously select all three market outlets is 28.4%, whereas the likelihood that they will not choose any of the outlets is 2.41%.

Table 9: Overall fitness, probabilities, and correlation matrix of the market outlets from the MVP model output

Attributes		Collector	Wholesaler	Retailer
Predicted probability		0.8368591	0.6993037	0.464277
The joint probability of success		0.2840567		
The joint probability of failure		0.0247186		
Estimated correlation matrix				
		ρ_1	ρ_2	ρ_3
ρ_1		1		
ρ_2		-2.93***(-.4491212)	1	
ρ_3		0.93 (0.2530646)	0.76 (0.214831)	1
Likelihood ratio test of $\rho_{12} = \rho_{31} = \rho_{32} = 0$				
chi2(3) = 10.6197				
Prob > chi2 = 0.0140				
Number of draws (#)	5			
Number of observations	150			
Log pseudo-likelihood	-145.48149			
Wald chi2(42)	92.64			
Prob > chi2	0.0000***			

*** represents significance at 1% levels

Source: computed from field survey, 2023

The table below indicates that, among the 14 variables included in the model, several exert a significant influence on producers' market outlet choices. Specifically, three variables household gender, access to price information, and distance to the nearest market significantly affected the choice of collector outlets. Two variables, price information and distance to the nearest market significantly influenced the selection of wholesaler outlets. Additionally, four variables, household gender, education level, landholding size, and access to price information, significantly impacted the choice of retailer outlets, each at varying levels of statistical significance.

Gender of household head: - The likelihood of selecting a collector and retailer market outlet is positively and adversely correlated with the gender of the household head at the 5% and 10% significance levels, respectively. The outcome shows that households headed by men are more likely than those headed by women to select a collector market shop. Women are more likely to go to market and are primarily involved in the marketing of various products. It is anticipated that the cost of produce at the farm will be less than what is paid at the market. Therefore, if the leader of the home is a woman, she may choose to sell their goods in the market rather than at the farm. However, compared to households headed by women, households led by men are less likely to select retailer market outlets. Compared to households headed by men, households headed by women can obtain more information on the daily cost of products. Male-headed families are more likely to choose collector market outlets (87.72%) and retailer market outlets (68.48%), respectively, when compared to female-headed households. This is in line with empirical data showing that in smallholder agricultural systems, gender influences bargaining power, market involvement, and access to market information (Doss, 2001).

Education level of household head: It is positively and significantly related to the likelihood of choosing a retailer market outlet at 10% level of significances. If the house hold is more educated, the likelihood to produce more and choosing an appropriate market outlet by comparing the price at farm get and the price at the market is higher than for less educated household. More educated farmers can more likely compare the cost and benefit of their decision than less educated farmers to decide the right time and place to sell their produce to good price. As the education level of farmers increases, his/her ability to collect and interpret information increase which helps them to make informed decisions in choosing the appropriate market channel. This result is consistent with Alemayehu and Alemu (2022).

Size of land holding in (Ha): It affects the likelihood of choosing a retailer market outlet significantly negatively 10% level of significances. A farmer who allocates more land for the production of corrorima can produce more and choose the best alternative market outlet that buys large quantity with good price, like a wholesaler. So, as the size of land allocated to corrorima produce increase, the likelihood of choosing a retailer market outlet decreases because the farmer wants to sell a large quantity to the appropriate channel rather than selling it in smaller quantities at different times. This finding is consistent with empirical studies showing that farm size influences market outlet selection, with larger producers more likely to engage with buyers capable of handling large volumes and offering favorable prices (FAO, 2011).

Price information: One of the factors that significantly affects every chosen source is price information. At the 5% and 1% levels of significance, respectively, access to price information has a negative impact on the likelihood of selecting collectors, a favorable impact on wholesalers, and a significant positive impact on retailers. Access to price information was found to have a negative impact on the likelihood of choosing collectors, a positive impact on the likelihood of choosing wholesalers, and a substantial positive impact on the likelihood of choosing retailers at the 5% and 1% levels of significance. By comparing local and nearby main market prices, producers who have access to current pricing information are better able to secure higher selling prices and are more likely to choose market outlets that give substantially greater returns.

According to Adicha et al. (2022) and Bezabih et al. (2015), there is a positive relationship between price information and wholesaler and retailers because if the farmer suspects the collector, they choose to take their produce to the main market for a high price and sell it to either a wholesaler or a retailer. The reason for the negative relationship between price information and collector outlet choice is that the farmer is primarily suspicious because the collector pays a lower price if they come to buy their *corrorima* produce at home.

Distance from the closest market:
Farmers' selection of market outlets is significantly influenced by the distance to the closest market. At the 1% significance level, the current study indicated that distance had a negative and statistically significant impact on the likelihood of choosing collector and wholesaler market outlets. Farmers who are farther from core markets are discouraged from selling through distant channels that necessitate frequent journeys or bulk deliveries because of the increased transportation costs and longer travel times. Rather, they might favor informal methods that lessen the logistical strain or closer farm-gate buyers.
This pattern aligns with recent empirical evidence showing that as the distance from the market increases, farmers are less likely to sell through formal outlets such as wholesalers and more likely to rely on local intermediaries closer to their farms, mainly to reduce transport costs and transaction time (Legesse *et al*., 2024)

Table 10: Multivariate probit estimations for determinants of market outlet choices of Corrorima producers

	Collector Coeff (Std.err)	**Wholesaler Coeff (Std.err)**	**Retailer Coeff (Std.err)**
Age of household head	-0.0186057 (0.0328762)	-0.0041691 (0.0691264)	0.01492 (0.024871)
Gender of household head	0.8772468** (0.3847449)	0.0143948 (0.6149971)	-0.6848408* (0.3549924)
Education level of household head	-0.1347876 (0.1531149)	-0.1648742 (0.2074552)	0.2139714* (.121169)
Family Labor	-0.0712816 (0.120756)	-0.1320403 (0.1696209)	0.1184778 (0.1021508)
Farming experience	0.0297988 (0.0294719)	0.0229196 (0.0486873)	-0.0225533 (0.0230842)
Size of land holding in Ha	0.0144556 (0.1611262)	0.1767113 (0.1996219)	-0.2223572* (0.1308438)
Total corrorima produced in Kg	-0.0018918 (0.0062161)	0.0173133 (0.0195384)	-0.004234 (0.0079947)
Total corrorima sold in Kg	0.0025623 (0.0062283)	-0.013769 (0.0189298)	0.0040837 (0.0079135)
Lagged price of Aframomum corrorima	0.0020593 (0.0037397)	0.0032049 (0.0056964)	-0.0012426 (0.0029501)
Price information	-0.8492668** (0.3848193)	1.106804** (0.5145892)	1.502484*** (0.3080726)
Spice disease	0.2544173 (0.3271023)	-0.9070326 (0.5784767)	0.2531218 (0.2591713)
Credit access	4.204682 (136.8422)	0.3433485 (1.369785)	-0.3473859 (0.8304794)
Extension service	0.1586212 (0.3101403)	0.4822853 (0.4733182)	0.2210711 (0.2490196)
Distance from the nearest market	-0.2227875*** (0.0701671)	-0.7813266*** (0.1717419)	0.095857 (0.0651987)
_cons	-2.696406 (136.8548)	1.397027 (3.379319)	-2.541502 (1.815768)

*, **, and *** stand for significant levels at 10%, 5%, and 1%, respectively. Coeff stands for coefficient, while Std.err stands for standard errors in parenthesis.
Source: computed from field survey, 2023

CONCLUSION

This study investigated the determinants of Kororima (*Aframomum kororima*) production and marketing in South Ari District, South Omo Zone, Southern Nations, Nationalities, and Peoples' Region (SNNPR), Ethiopia. The finding showed that Kororima production and marketing performance in South Ari District is significantly shaped by a combination of demographic, socio-economic, and institutional factors, particularly education level, land allocation, access to price information, gender roles in marketing, and market distance. Higher education enhances farmers' decision-making capacity and increases the likelihood of selecting more rewarding market outlets, while allocating larger land areas to Kororima improves productivity through better management practices. Access to timely and reliable market information shifts farmers away from low-paying collector outlets toward wholesalers and retailers, whereas long distances and poor transport infrastructure constrain optimal outlet choice. Based on these findings, it is recommended that government and development actors prioritize farmer education, strengthen formal market information systems, improve rural transport and market access, promote women's participation in marketing, and encourage expansion of Kororima cultivation through productivity-enhancing support. Such integrated interventions would improve market participation, increase farm income, and enhance the livelihoods of smallholder Kororima producers.

Ethical considerations

The study was carried out in compliance with accepted ethical standards for human subjects research. The Jinka University Research Ethics Review Committee granted ethical permission. All participants gave their informed consent prior to data collection, and their involvement was voluntary, private, and anonymous.

Data availability

All findings are presented within the article, and the raw data will be made available upon reasonable request to the corresponding author.

Competing interests

The authors declare that they have no conflict of interest.

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