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Research Article

Determinants of marketing outlet choices of irrigated onion (*Allium cepa* L.) producers in Northwest Ethiopia: A multivariate probit regression analysis approach

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Abstract: *Vegetable farming plays a vital role in generating income for a significant portion of rural households in Ethiopia. However, facilitating access to markets and ensuring active market participation remains a key challenge for onion producers. Given the perishable nature of onions, selecting appropriate marketing outlets is essential. This study aimed to examine the factors influencing onion producers' choices of marketing outlets. A multistage random sampling technique was employed to select kebeles and farm households, resulting in a sample of 155 respondents. Both primary and secondary data were collected to fulfil the study's objectives. The data were analyzed using descriptive statistics and a multivariate probit regression model. The analysis showed that 77.42% of households were sold to wholesalers, 25.51% to rural collectors, 67.74% to retailers, and 74.19% to consumers. Statistical results indicated that choices between wholesaler and rural collector, consumer and rural collector, and retailer and wholesaler outlets were negatively and significantly correlated, suggesting competitive relationships. In contrast, the choice between retailer and rural collector outlets exhibited a positive and significant correlation, indicating a complementary relationship. The results from the multivariate probit model revealed that decisions regarding market outlet selection were significantly influenced by several factors, including the quantity of onions produced, household head's education level, family size, cooperative membership, past onion prices, market distance, frequency of extension service contact, and access to credit. Based on these findings, the study recommends that policymakers and stakeholders prioritize the development of rural-urban infrastructure, improve access to agricultural credit, and enhance both formal and informal education to better support onion producers' market participation.*

Keywords: Dera district, market actors, multi stage sampling, rural households, Vegetable farming
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1. Introduction

Ethiopia has various climate and altitude conditions that are favorable to various agricultural activities. Vegetable production plays an important role in creating new employment opportunities for poor farmers and improving the feeding habits of the people (Endris et al., 2020). Among the common irrigated vegetables, onion (*Allium cepa L.*) is one of the oldest vegetable crops under cultivation and ranks first both in area coverage and consumption. It is

indicated that it can be cultivated twice per year, both in irrigation agriculture and rainfed conditions, in different parts of the country (Belay et al., 2015). India and China are the leading onion-producing countries, with 31,687,000 tons and 24,542,011.2 tons produced annually, respectively (Nigatu, 2016). In 2022, the eight other leading onion-producing countries, ranked by production volume from highest to lowest, were Egypt (3,663,943.34 tons), the United States (2,918,958 tons), Bangladesh (2,517,070 tons), Türkiye (2,350,000 tons), Pakistan (2,062,336 tons), Indonesia (1,982,360.22 tons), Iran (1,900,000 tons), and Algeria (1,763,117.95 tons) annually (Mulatu and Gemechu, 2023). The average production of 10.76 tons per ha-1 (Mossie et al., 2020b), which is much less than the productivity of the USA (54.6 tons ha-1), Netherlands (49.7 tons ha-1), Egypt (33.7 tons ha-1), and Iran (31.8 tons ha-1) (Nigatu, 2016). Egypt and Algeria are the top onion producers in Africa (Tafesse et al., 2023), and Egypt is the world's third-largest onion producer (Verma and Bose, 2023). Ethiopia is the largest onion producer in Sub-Saharan Africa, with vast potential for onion production (Abrahim et al., 2021; Miruts et al., 2021). However, the average onion production intensity in Ethiopia is 9.74 tons ha-1, lower than global averages of 19.1 tons ha-1, 35.5 tons ha-1 in Egypt, and 18 tons ha-1 in Sudan (Zegeye et al., 2024).

Onion production is an important economic activity in Ethiopia, ranging from smallholder farmers to large-scale commercial farms (Tamirat and Zeleke, 2021). Onion is a significant cash crop in Ethiopia, particularly in the Amhara Region (CSA, 2022/23). It is a crucial source of income, contributes to foreign exchange earnings, and improves the livelihoods of smallholder farmers (Zegeye et al., 2024). Onion is also essential for enhancing flavours in Ethiopian cuisine, particularly in daily stews known as "Wot" and vegetable-based meals (Zegeye et al., 2024). Onion production is heavily dependent on weather conditions, bulky in nature, and perishable (Zenbaba, 2021). The area under onions is increasing from time to time, mainly due to its high profitability, as well as the increase in small-scale irrigation areas (Xaba and Masuku, 2013; Tufa et al., 2014). Additionally, onion provides health benefits by neutralizing acidic substances during digestion (Aragie et al., 2023). It is essential in the Ethiopian diet, which is widely consumed as a spice and/or vegetable in stews (Nigatu et al., 2018), and it is the main foundation of flavonoids in human food and it is used to reduce the danger of cancers, temperament diseases, as well as diabetes (Alemu et al., 2022).

According to Wondim (2021), in Ethiopia, the production of vegetable products is seasonal, and the price is inversely related to the quantity supplied. During the peak supply period, the prices decline, and the situation is worsened by the perishable nature of the products and poor storage facilities (Asale et al., 2016). According to the same study, along the vegetable channel, 25% of the product is spoiled (Yeshiwas et al., 2024). Onion production and marketing are poorly addressed in Ethiopia (Alemu et al., 2022; Tafesse et al., 2023). However, these days, efforts have been stepped up to improve and support the sector. Within this line, the current Growth and Transformation Plan (GTP2) prioritizes intensive production and commercialization of horticulture as a sector for attention (Ashinie and Tefera, 2019). Thus, the development policy initiates the need to accelerate the transformation of the sub-sector from subsistence to business-oriented agriculture. But the existing constraints of production, post-harvest handling, and marketing, such as input utilization, productivity, packing, warehousing, cold storage, and distribution, have played their deterring role in the production, trade, and consumption of vegetables in all parts of Ethiopia (Hailu, 2016; Faris et al., 2018).

The onion is produced under rainfed conditions in the "Meher" season (main rainy season) and irrigation in the off-season. In many areas of the country, the off-season crop (under irrigation) constitutes much of the area under onion production. According to CSA (2022/23), in the Meher season, the average national onion production reached about 11.68 tons ha-1, whereas, in the Amhara region in the Amhara region. Figure 1 indicates that, despite the area increase, the low productivity of onions could be attributed to the limited availability of quality seeds and associated production technologies used, low market integration, lack of infrastructure, and postharvest losses; it accounts for about 10.7% and 30% for onions and other vegetables, respectively (Haile et al., 2016; Abebe, 2018; Yeshiwas et al., 2023).

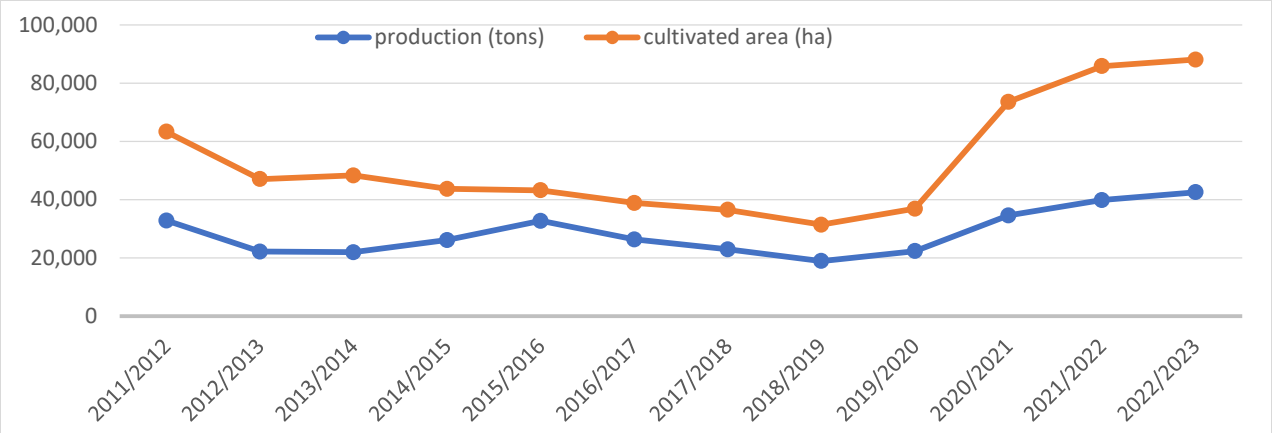

Figure 1: Trends of onion production for the last nine years from 2011/2012-2022/2023 in Amhara region

Identifying market channel determinants helps solve production and sales challenges, improves consumer satisfaction, and influences other channels (Alemu et al., 2022; Tafesse et al., 2023). Choosing direct, profitable channels boosts producers' earnings by reducing intermediary costs (Zegeye et al., 2024). The largest onion-producing regions in Ethiopia are Amhara, Oromia, and the South Nation Nationality People region (Zegeye et al., 2024). The Amhara Region accounts for about 50% of national irrigated onion production, with a yield of 12.3 tons per hectare. Key onion production zones in Amhara region include. Marketed onion production in the region reached 16,485 tons in 2019/20, 25,6906 tons in 2020/21, and 18,254.2 tons in 2021/22, with respective prices of 31.40 birr/kg, 16.30 birr/kg, 31.96 birr/kg, respectively (CSA, 2022/23). Central Gondar, East Gojjam, North Wollo, South Wollo, and South Gondar (Koye et al., 2022; Mulatu and Gemechu, 2023). Dera and Fogera districts have strong potential for cultivating various crops, supported by major rivers like Gumara and Rib. In Dera district, onion is mainly produced for market demand using dry-season irrigation.

Several empirical studies have been conducted on the factors influencing marketing channel choice decisions for various products. For example, studies were conducted on onions (Mossie et al., 2020), vegetables (Gosa et al., 2023), peppers (Wosene et al., 2019), potatoes (Asfaw et al., 2022), coffees (Degaga and Alamerie, 2020), mango (Hagos et al., 2020), honey (Yeserah et al., 2019), chickpeas (Sah et al., 2022), Garlic (Kindu Wubet, 2022), banana (Tarekegn et al., 2020), haricot bean (Andaregie et al., 2021), tomatoes (Mohammed et al., 2019), bamboo culms (Mengstu et al., 2023), and teff (Abate et al., 2019a; Degefa et al., 2022) marketing outlet choices in Ethiopia. The studies on onion production in Ethiopia mainly focused on the marketing of onions (Tura Debela, 2021). Although Tafesse et al. (2023) studied production efficiencies in northern Ethiopia, no empirical research has examined the determinants of onion market channel choices in the study area. This study aims to fill that gap by identifying key factors influencing market channel selection among onion producers in Northwest Ethiopia.

2. Research Methodology

2.1. Description of the study area

The study was undertaken in the in the Dera district, located in northwestern Ethiopia, were purposively selected depending on their irrigated onion production potential. Geographically, the district lies between 11°41′26″ and 11°43′07″ N latitude and 37°35′30″ and 37°38′30″ E longitude (Figure 2). Onion production is a key income source for smallholder farmers, but productivity remains low due to traditional practices and reliance on local seed varieties, which limits yield potential and hinders production efficiency. The study area, farmers face a lack of access to suitable markets that offer fair prices for their products. This issue is especially critical for onions, which are highly perishable. Farmers have limited market channels and are often unable to sell their onions to processors. The rainy season in the district extends from May to October, with peak rainfall occurring in July and August (Atinkut and Mebrat, 2016). In the dry season, irrigable land is

primarily used for the production of horticultural crops (Abdulkadir, 2015).

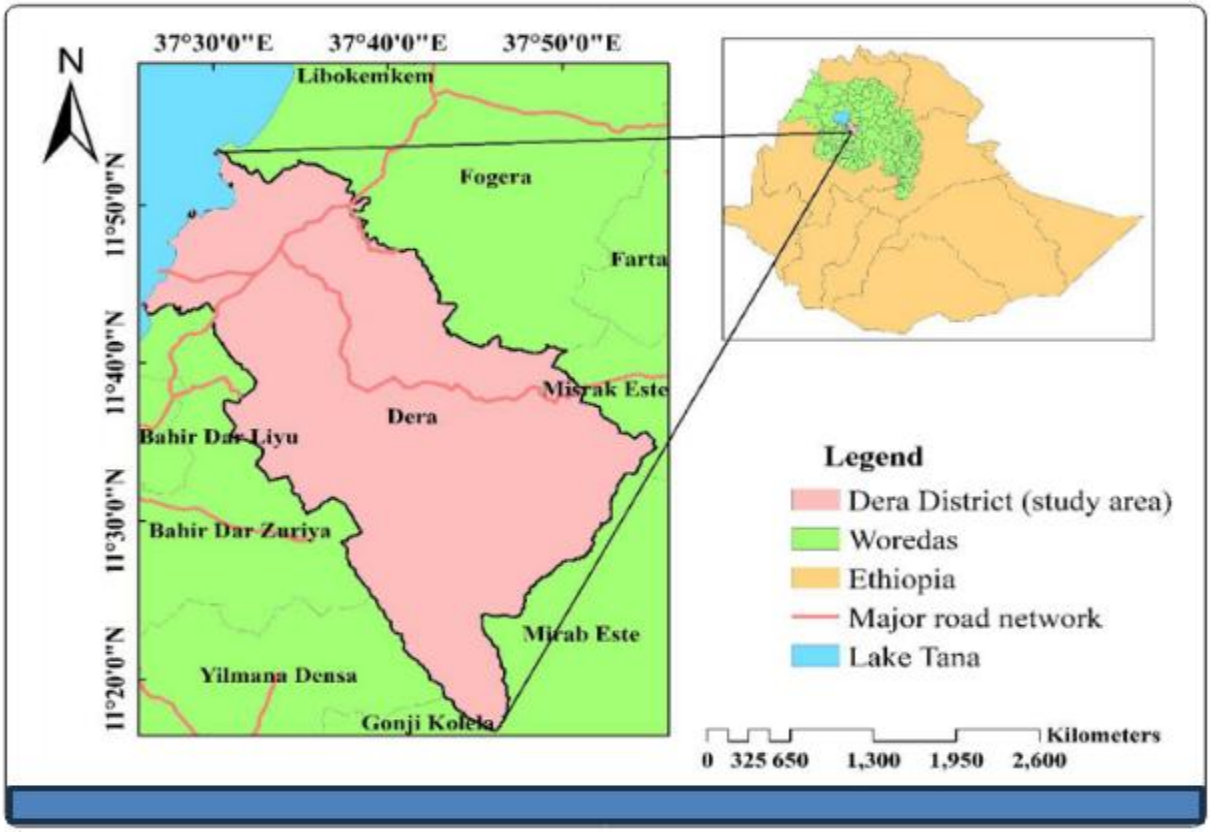

Figure 2: Map of the study area

2.2. Types and sources of date and their collection methods

Quantitative and qualitative data were collected from both primary and secondary sources. Primary data was collected through personal face-to-face interviews with randomly selected farm households, using a structured questionnaire containing both open- and closed-ended questions.

Before the main survey, the questionnaire was pre-tested on fifteen non-sample respondents to assess its clarity and relevance. Feedback from the pre-test and pilot study led to revisions and finalization. At the beginning of each interview, the purpose of the study was explained, and respondents were assured of the confidentiality of their responses. Informed consent was obtained verbally, which was appropriate given the high illiteracy rate in the area.

Enumerators, including undergraduate students and Kebele development agents, were trained on the study's objectives, data collection methods, and ethics. Data were collected using the Kobo Toolbox app under the principal researcher's supervision. The questionnaire was translated into Amharic for better understanding, and ethical standards, including proper citation, were strictly followed.

Data collected in April–May 2023 included respondents' socioeconomic traits and factors affecting onion market outlet choices, along with trader surveys on finances, marketing, sales, pricing, and demographics. To enrich the primary data, informal interviews were conducted using checklists, alongside five focus group discussions and ten key informant interviews. Additionally, secondary data were obtained from sources including the Kebele Office of Agriculture, Dera District Agriculture and Rural development, Trade, and Industry, agricultural cooperatives Offices, relevant government institutions, websites, and both published and unpublished materials. These sources provided further insights into price trends, production volumes,

the roles of various market actors, and the number of active traders in the area.

2.3. Sampling technique and sample size determination methods

The study used a probability sampling method to ensure representativeness, targeting commercial onion producers and key market actors like wholesalers, retailers, and collectors. A multi-stage random sampling approach was applied. First, 20 rural Kebeles were classified into irrigated and non-irrigated onion producers. Next, three Kebeles-Jegna, Zara, and Tebabary were randomly chosen from the 12 irrigated Kebeles with help from development agents (Table 1). Finally, 155 onion-producing household heads were randomly selected from household lists, with sample sizes proportionate to each sample Kebele's population. The sample size was determined using the scientific statistical method provided by Yamane (1973). To account for variations in population sizes among Kebeles, Probability Proportional to Size (PPS) sampling was applied to allocate the number of commercial farmers selected from each Kebele.

$$n = \frac{N}{1+N(e)^2} = \frac{5350}{1+5350(0.08)^2} = \frac{5350}{35.5} = 1551 \quad [1]$$

Where; N = population size (5350), n = sample size (155), and e = the margin of error (8%). The authors computed the sample sizes separately to have representative samples from each study area, used to make statistical comparisons reliable.

Table 1: Sample size of respondents from each sample Kebeles

Sample Kebeles	Onion producing household heads	Sampled household heads
Jegna Kebele	1,511	51
Zara Kebele	2,254	67
Tebabary Kebele	1,585	37
Total	5,350	155

2.4. Data analysis

2.4.1. Descriptive statistics

Descriptive statistics including mean, percentage, standard deviation, minimum, and maximum values were employed to summarize the characteristics of onion-producing households. A multivariate probit model was applied to analyze the factors influencing market channel choices, given that most producers sold their onions through multiple outlets.

2.4.2. Estimation strategies

The Random Utility Model was employed to analyses producers' decisions regarding market outlet selection. The core assumption of the model is that producers make outlet choices based on the utility they expect to derive. According to Tarekegn et al., (2017), the indirect utility function represents the average utility of a producer, given specific characteristics, assigns to each alternative outlet within a given choice set. This approach is grounded in rational choice theory, which assumes that farmers act as rational agents who priorities alternatives based on utility maximization (Keith, 2018).

To illustrate this framework, four marketing outlets were identified for onion producers: consumers, rural collectors, wholesalers, and retailers. Each farmer (i) faces a choice among these j = 1, 2, 3, and 4 alternatives, with each alternative providing a utility level Uij. The model assumes that farmers select the market outlet that offers the highest expected utility. This decision is made by comparing the marginal benefits and costs associated with each available channel. Since utility cannot be directly observed, the producer's choice indicates the outlet that yields the greatest perceived utility. Following Arinloye et al. (2015), the utility function is decomposed into two components [2]: a deterministic part (Vij) that reflects observable factors, and a stochastic or random part (εij), capturing unobserved influences:

$$Uij = Vij + \varepsilon ij \quad [2]$$

Since the random term **ε** cannot be directly observed, we cannot predict with certainty which marketing outlet a farmer will choose. Therefore, we model the decision in probabilistic terms, that is, the probability that farmer *i* chooses outlet *j* depends on the

likelihood that the utility from outlet *j* is greater than that from all other alternatives.

Onion producers in the study area use multiple marketing outlets to maximize profits, influenced by socioeconomic, institutional, production, and market factors. Common analytical models such as multivariate probit, multinomial logit, and nested logit. For instance, Gosa et al. (2023) applied the multivariate probit model for outlet preferences, while (Asfaw et al,, 2022) used the multinomial logit model for exclusive outlet choices.

As onion producers more likely choose two or more than two types of outlets simultaneously in the study area, assuming the selection of different marketing outlets, as well as their simultaneous use, depends on producers' willingness to maximize their profit and is conditional to socioeconomic, institutional, production, and market-related factors. The multivariate probit (MVP) model is preferred as it jointly estimates multiple binary choices, accounts for correlations among unobserved factors, and avoids the restrictive IIA assumption, thus better capturing the complexity of outlet selection (Bhatti and Al-Shanfari, 2017).

2.4.3. Multivariate probit model specifications

Following the literature, the researchers concluded that a producers' decision to sell in an advantageous market derives from the maximization of profit he or she expects to gain from these markets.

Let V_0 being the utility if no outlet is chosen, and Vk the utility from chosen K^{th} outlet (wholesalers Y1, retailers Y2, collectors Y3, consumers Y4). The farmer chooses the K^{th} outlet if the net benefit $Yik = Vik - V0 > 0$, where this latent benefit depends on observed factors (Xi) and an error term representing unobserved utility.

The MVP approach for this study was characterized by a set of n binary dependent variables Yij such that:

$$Y^{*}ij = \beta jXi + \varepsilon i,\ j = 1,2,3,\dots,n \qquad [3]$$

Where j = 1,2,3,4 denotes the onion market outlet choice; Xi is a vector of explanatory variables, βj denotes the vector of parameters to be estimated, and εi represents random error terms distributed as a multivariate normal distribution with zero mean and unitary variance. Yi* is an unobservable latent variable that denotes the probability of choosing a j type of market outlet. The multivariate probit model is presented by Equation [4], and the selection of an appropriate market outlet (j) by a farmer *(i)* is Y_{ij}^{A} defined as the choice of farmer i to transact with market outlet j ($Y_{ji}^{A} = 1$) or not ($Y_{ji}^{A} = 0$) *is* expressed as follows:

$$Y_{ji}^{A} = \begin{cases} 1\ if\ \beta jiXji + \varepsilon i^{A} \geq 0 \\ 0\ if\ \beta jiXji + \varepsilon i^{A} < 0 \end{cases} \qquad [4]$$

Where β_{ji} is a vector of estimators, εi^{A} is a vector of error terms under the assumption of a normal distribution, Y_{ji}^{A} a dependent variable for market outlet choices, and X_{ji} is the combined effect of the explanatory variables.

Because the choice of one market outlet influences the selection of others, using separate univariate probit models would produce biased results. To address this simultaneity issue, a multivariate probit model was applied to jointly estimate the interrelated market outlet decisions of onion producers and identify the key factors influencing their choices.

$Yi1 = \beta 1Xi1 + \varepsilon 1$

Where; Y_{i1} = 1 if a farmer chooses wholesaler and 0 otherwise,

$Y\ i2 = \beta 2Xi2 + \varepsilon 2$

Where; Y_{i2} = 1 if a farmer chooses collectors and 0 otherwise,

$Y\ i3 = \beta 3Xi3 + \varepsilon 3$

Where; Y_{i3} = 1 if a farmer chooses consumers and 0 otherwise,

$Y\ i4 = \beta 4Xi4 + \varepsilon 4$

Where; Y_{i4} = 1 if a farmer chooses retailers and 0 otherwise.

In the MVP, it is possible to simultaneously use several market outlets. The error terms jointly follow a multivariate normal distribution with a zero conditional mean and variance normalized to unity. The correlation between endogenous variables (Mohammed et al., 2019) is represented by ρ_{ji};

$$\begin{pmatrix} \varepsilon^W \\ \varepsilon^L \\ \varepsilon^C \\ \varepsilon^P \end{pmatrix} \ldots\ldots N\left[\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}\begin{pmatrix} 1 & \rho_{12} & \rho_{13} & \rho_{14} \\ \rho_{21} & 1 & \rho_{23} & \rho_{24} \\ \rho_{31} & \rho_{32} & 1 & \rho_{34} \\ \rho_{41} & \rho_{42} & \rho_{43} & 1 \end{pmatrix}\right] \quad [5]$$

$E(\varepsilon/X) = 0; var(\varepsilon/X) = 1; cov(\varepsilon/X) = \rho$

The loglikelihood function associated with a sample outcome is then given by:

$$\ln L = \sum_{i=0}^{n} \omega i \; ln\Phi(\mu i, \; \Omega) \quad [6]$$

Where ω is an optional weight for observation i and Φ_i is the multivariate standard normal distribution with arguments μ_i and Ω, where μ_i can be denoted.

2.4.4. Definition of Variables and Working Hypothesis

Onion marketing outlet choices is a categorical variable representing the probability of a producer's choice among alternative market channels. As various factors affect producers' choices of market outlets, selecting an appropriate market outlet for the delivery of farm products is not an easy task (Yeserah et al., 2019). Choosing a specific marketing channel was influenced by different socioeconomic, demographic, household, and farm characteristics variables. Important variables were selected based on theoretical and empirical studies to identify the determinants of onion producers' market outlet choices (Table 2). These variables include family size (Tefera, 2014), age (Wosene et al., 2019; Asfaw et al., 2022), sex of the household head (Ozkan et al., 2022), and the educational status of the household head is measured in years of schooling (Sah et al., 2022). Other variables, such as quantity sold (Tarekegn et al., 2017); distance from the nearest market (Abebe and Debebe, 2020), off-farm income opportunities (Fikiru et al., 2017), credit utilization (Alemayehu and Alemu, 2022), farming experience (Dessie et al., 2018)**,** average farm gate price of onion (Sah et al., 2022); access to market information (Tefera, 2014), and frequency of extension services (Tarekegn et al., 2018) were also hypothesized to influence market choices in some way.

Table 2: Hypothesis and description of variables used in the multivariate probit model

Dependent variable					
Onion marketing channel choices: It is a categorical dependent variable and measured by the probability of household heads selling onion products to different market channels.	1. If a producer chooses wholesalers 2. If a producer chooses rural collectors 3. If a producer chooses consumers 4. If a producer chooses retailers				
Independent variables					
Independent variable	Measurement	Expected outcome on market outlet choices			
		Wholesaler	Rural collector	Consumer	Retailers
Age of household head	Continuous (year)	+ve	-ve	-ve	-ve
Sex of the household head	Dummy (1 if Male, 0 if Female)	+ve	+ve	+ve	+ve
Household family size	Continuous (man equivalent)	+ve	+ve	+ve	+ve
Education status of households (Secondary education)	Categorical (0 if Illiterate, 1 basic, 2	+ve	+ve	+ve	+ve
Membership in agricultural cooperatives	Dummy (1= if yes, 0= otherwise)	-ve	+ve	-ve	-ve
Credit utilization for production	Dummy (1 yes, 0 no)	+ve	+ve	+ve	+ve
Quantity of onions produced through irrigation	Continuous (tons)	+ve	+ve	+ve	+ve
Frequency of extension services	Continuous (No. of visits/year)	+ve	+ve	+ve	+ve
Livestock ownership (TLU	Continuous (TLU)	+ve	+ve	+ve	+ve
Distance to nearest market center	(walking minutes)	-ve	-ve	-ve	-ve
Land size allocated for onion production in 2023	Continuous (Ha)	+ve	+ve	+ve	+ve
Irrigated onion production farming experience	Continuous (years)	+ve	+ve	+ve	+ve
Lagged Price of onion	The price of onion (ETB/kg)	+ve	+ve	+ve	+ve

3. Results and Discussion

3.1. Descriptive statistics for dummy variables

The descriptive statistics of the categorical variables provide important insights into the socioeconomic characteristics of the surveyed households. The majority of household heads (80.49%) are male, indicating a male-dominated household leadership structure in the study area. In terms of education, a significant proportion (57.99%) of the respondents was illiterate, while 36.31% had only basic education. Only a small fraction received education through religion (5.15%) and secondary education (0.54%) as indicated in Table 3. This low level of formal education could limit households' ability to

access and interpret agricultural information and market opportunities (Sah et al., 2022).

Regarding market information access, 57.99% of the households did not have access, which could hinder their ability to make informed decisions about production and marketing. Lack of timely and accurate market information may result in inefficiencies and reduced income. Additionally, credit utilization among households is relatively low; only 32.25% reported using credit, while the majority (67.75%) did not access credit services (Table 3). This limited use of credit could constrain investment in productive agricultural inputs and technologies, ultimately affecting productivity and income levels (Chekol and Mazengia (2022).

3.2. Descriptive statistics for continuous variables

The mean and percentage of household characteristics by onion market outlets are provided in Table 3 below. The average age of the total household heads was 44.9 years, with a standard deviation of 13.7, indicating that most sampled households or farmers were experienced farmers in crop production. The youngest household head was 19 years old, while the oldest was 77 years old. The mean age of household heads who sold to wholesalers, collectors, retailers, and consumer market outlets was 43.68, 45.05, 43.74, and 47.53 years, respectively (Table 3).

Among the respondents, household sizes ranged from 1 to 10 members, with an average of 4.91 members and a standard deviation of 1.60. The households that sold their products to wholesalers, collectors, retailers, and consumer market outlets were with an average family size of 4.52, 4.60, 4.32, and 4.51 persons in adult equivalent, respectively. According to Emana et al. (2015), horticultural production systems are often labor-intensive and require more workforce compared to cereal production.

The average farming experience among the sampled households was 19.4 years, with a standard deviation of 13.88 years. The least experienced farmer had 1 year of experience, while the most experienced had 57 years. Specifically, the average years of onion farming experience among those who sold to different market outlets were as follows: wholesalers, 16.35 years; collectors, 16.13 years; retailers, 16.35 years; and direct consumers, 16.84 years (Table 3).

Extension services significantly influenced onion marketing. Frequent contact with extension agents especially during the land preparation, seedling production, and harvesting stages along with market information sharing, helped boosting onion productivity and returns. On average, farmers met extension agents 5.1 times per year (SD = 7.69), ranging from 0 to 6.75. Those farmers who sold their products to wholesalers, collectors, retailers, and consumers had 6.13, 6.34, 6.84, and 6.35 extension contacts per year, respectively (Table 3).

The average travel time to the nearest market center by onion producers, who sell their irrigated onion product to a wholesaler, collectors, retailer, and consumer market outlets, was on average 45.26, 22.18, 32.18, and 25.15 walking minutes, respectively (Table 3).

Regarding onion production, the quantity produced ranged from a minimum of 0.2 tons to a maximum of 6.5 tons per household and an average of 2.968 tons. On average, households that selected collectors, wholesalers, retailers, and consumers' market channels produced 2.908 tons, 2.725 tons, 2.926 tons, and 2.926 tons, respectively (Table 3).

The average livestock holding of the sample households was 5.51 tropical livestock units, with a standard deviation of 5.92. Sample households sold an average livestock size of 6.48, 5.51, 5.68, and 5.47 in tropical livestock units to wholesalers, collectors, retailers, and consumer market outlets, respectively (Table 3). This indicates that households with larger livestock holdings are more likely to generate higher returns, which can help offset high bargaining and transaction costs (Wosene et al., 2019).

In terms of land allocation, the average area dedicated to onion cultivation was 1.30 hectares/household, with a standard deviation of 0.77 hectares. The smallest and largest areas allocated were 0.20 and 1.5 hectares, respectively. The average land size allocated by onion producers who sold to wholesalers, collectors, retailers, and consumer market outlets was 0.33, 0.34, 0.33, and 0.35 hectares, respectively (Table 3).

In the 2023/2024 production year, the average market price of onion was 39.25 birr/kilogram (approximately $0.234), with a standard deviation of 13.7 birr. Prices lower than 19 birr ($0.06) and higher than 77 birr ($0.739), highlighting the significant seasonal fluctuations. The average lagged prices received by irrigated onion producers varied by market outlet: 40.17 birr/kg from wholesalers, 36.04 birr/kg from collectors, 35.75 birr/kg from retailers, and 35.67 birr/kg from direct consumer sales (Table 3).

Table 3: Mean household characteristics by onion market outlets

Variables	Mean (standard deviation) of market outlets				Mean	SD	Min	Max
	Rural collectors	Whole-sealers	Retailers	Consumers				
Age of household head	45.05 (13.16)	43.68 (11.68)	43.74 (13.41)	47.53 (14.4)	44.9	13.7	19	77
Farm land size allocated for onion (ha)	0.34 (0.14)	0.33 (0.62)	0.33 (0.45)	0.35 (0.55)	1.3	0.55	0.2	1.5
Household size (man equivalent)	4.51 (1.65)	4.52 (1.61)	4.32 (1.78)	4.60 (1.76)	4.91	1.6	1	10
Irrigated onion production farming experience (years)	16.84 (13.81)	16.34 (12.57)	16.35 (13.95)	16.13 (12.9)	19.4	13.9	1	57
Distance to the nearest market center (walking minutes)	22.18 (0.09)	45.26 (0.11)	32.18 (0.09)	25.15 (0.08)	40.3	14.2	10	100
Oxen owned by the household (TLU)	5.51 (3.24)	6.48 (3.44)	5.68 (3.19)	5.47 (3.46)	5.51	5.92	1	11
Lagged price of onion per kg (ETB)	36.04 (4.34)	40.17 (5.08)	35.75 (4.18)	35.67 (3.5)	39.3	22.2	17	92.3
Quantity of onion produced (tons)	2908 (1749)	3524 (3674)	2725 (1348)	2926 (1607)	297	144	200	6500
Access to agricultural extension services (frequency per year)	6.35 (3.95)	6.13 (2.9)	6.84 (3.81)	6.34 (2.57)	5.10	7.69	0	6.75

Categorical variables	Measurement	Frequency	Percent
Sex of the household head (SXHH)	Male	125	80.49
	Female	30	19.51
Education level of households (EHH)	Illiterate	90	57.99
	Basic education	56	36.31
	Religious	8	5.15
	secondary	1	0.54
Access to market information (Acc_Mkt information)	Yes	65	42.01
	No	90	57.99
Households Credit utilization (CRE-UTL)	Yes	50	32.25
	No	105	67.75

Note: SD = standard deviation

3.3. Proportion of producers choosing market outlets and the total volume of sales

Out of the total sampled households, about 77.42%, 25.51%, 67.74%, and 74.19% of them chose wholesalers, collectors, retailers, and consumer market outlets, respectively. This result indicated that, the onion producer's choice of wholesalers' market channels over other market outlets for marketing the onion produced in the study areas (Table 4).

Table 4 shows the different onion market outlets used by the onion commercial producer when selling their product. Accordingly, one of the most commonly used market outlets by producers is the wholesaler's outlet, which was chosen by about 25.81% of

respondents with a mean supply of 5.87 tons (SD = 1.341), while about 67.74% of respondents sold to retailers with a mean supply of 0.38 tons (SD = 0.214) as collectors are also a common onion marketing outlet in the study area, around 77.42% of sample households sold to the collectors with a mean supply of 1.203 tons (SD = 0. 812). Consumers are a popular marketing channel in the district, so 74.14% of sample households sold to them, with a mean supply of 2.040 tons (SD =1.104). This implies that farmers have a limited number of market outlets through which they can sell their produce (Table 4).

Table 4: The proportion of market outlets chosen by households (multiple choices)

Decisions to market outlet choices	Market outlets							
	Retailers		Consumers		Collectors		Wholesalers	
	Freq.	percentage	Freq.	percentage	Freq.	percentage	Freq.	percentage
Yes	105	67.74	115	74.19	40	25.81	120	77.42
No	50	32.26	40	25.81	35	22.58	115	74.19
The quantity of onions supplied to each outlet (ton)	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	0.380	0.214	0.204	1.104	1.203	0.812	5.870	1.341

Note: SD = standard deviation

3.4. Market channel choices of producers

The survey identified five main marketing channels for onions in the study area, tracing the flow from producers to final consumers through various intermediaries, as shown in Figure 3.

The amount of onion transacted in these market channels was different. Out of the total 1,108.3 tons of onions marketed by sampled households during the survey year, 348.6 tons were marketed through channel 5 and 340.7 tones were marketed through channel 4, which were found to be dominant in terms of onion volume of transaction.

The main five marketing channels were identified for onions marketing and are presented below.

Channel 1: Producers → Consumers: This is the most direct marketing channel, where farmers sell onions directly to consumers without involving any intermediaries. According to the study, this was the shortest marketing channel, accounting for 15.79% of the total market volume with 234.7 tons traded.

Channel 2: Producers → Rural Collectors → Retailers → Consumer: In this channel, onion producers sell their produce to rural collectors, who then pass it on to retailers before reaching the final consumers. This channel represented 9.8% of the total supply (144.3 tons). It is considered one of the longest distribution chains in terms of intermediaries involved.

Channel 3: Producers → Wholesalers → Retailers → Consumers: Despite the absence of well-organized wholesalers with storage and resale facilities in the study area, the wholesaler channel still played a notable role. Approximately 4.89% of the total onion supply, equivalent to 40.0 tons, was marketed through this channel.

Channel 4: Producers → Rural Collectors → Wholesalers→ Retailers → Consumers: This was the longest and most complex market channel, accounting for 37.25% of the total marketed volume with 340.7 tons. In this chain, wholesalers purchase onions either directly from producers or through rural collectors, sometimes involving brokers, depending on the volume.

Channel 5: Producers → Wholesalers → Consumers: In this relatively short channel, producers sell directly to wholesalers, who then supply the onions to consumers. This channel also made up 37.25% of the total quantity marketed with 348.6 tons, making it the second shortest channel.

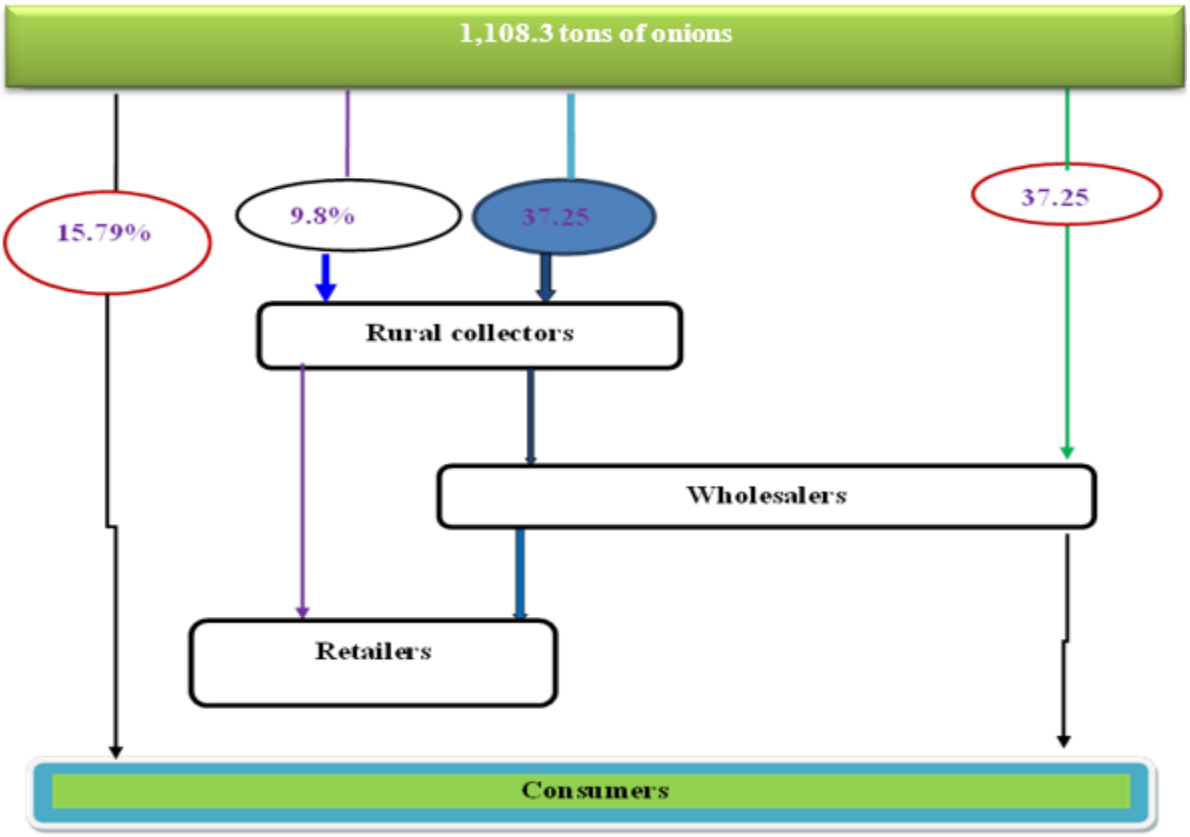

Figure 1: Marketing channel of onion in Dera District

3.5. Challenges of irrigated onion production in the study area

The key challenges of the irrigated onion production, are presented in Figure 4. All 155 respondents (100%) reported the high cost of agricultural inputs as the most critical barrier to productivity. This was followed by the shortages of fertilizers and improved seeds (74.19%), crop diseases and pests (46.45%), and synchronized planting periods (35.48%). Labor-related challenges primarily involved high labor costs, reported by 41.94% of respondents, and inefficient or improper use of agricultural inputs, noted by 21.29% of respondents. Structural challenges such as land shortages (29.03%) and soil infertility (12.9%) were also noted. Additionally, price fluctuations (23.23%), water scarcity (20.65%), unexpected rainfall during harvest (9.68%), and limited knowledge of proper storage techniques (9.68%) further impacted the onion production. These findings highlight the need for integrated interventions addressing input access, land use, climate resilience, extension services, and market stabilization.

The Focus Group Discussion (FGD) results highlight the key issues and opportunities in the onion value chain. Farmers struggle with shortage of quality seeds, herbicides, and tools, along with high input costs. Governmental support at different levels and strengthening the linkage between onion producers and input supplier is necessary (Table 5).

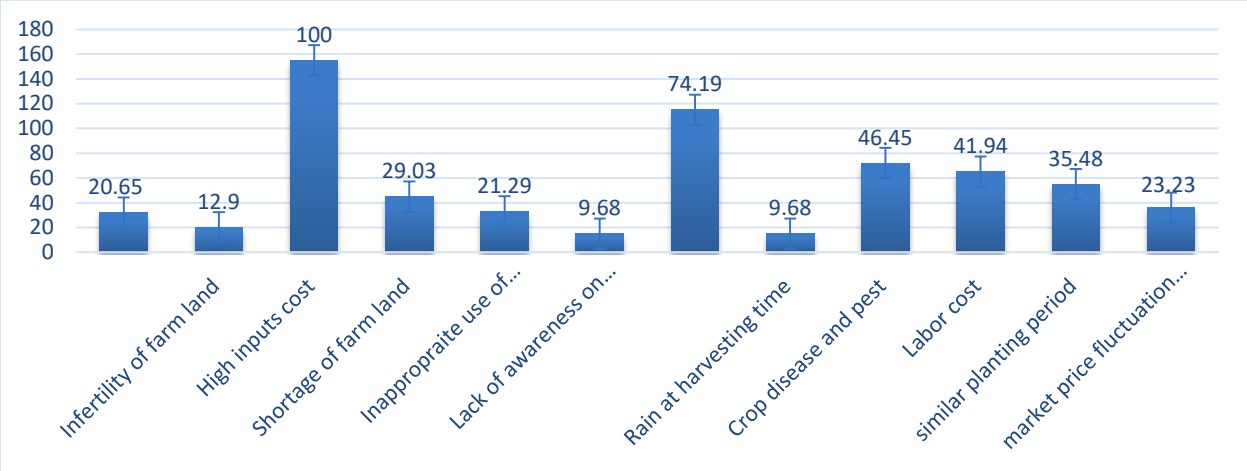

Figure 4: Major onion production constraints (frequency) in the Dera district

Table 5: Challenges and opportunities of actors along the onion value chain

Stage of value chain	Challenges for onion production	Opportunities for onion production	Interventions for onion production
Inputs supply	Shortage of good quality seed, herbicides, pesticides, and farm implements, High cost of inputs	High demand for the purchase of quality seed, chemicals, and farm implements, and Demand for compost application	Government support for easy access to inputs strengthens linkages between input suppliers and farmers.
Production	Reduction of irrigation water availability, Limited knowledge on recommended agronomic practices and post-harvest handling, low irrigation facility, Diseases and pest attacks, Lack of storage and high post-harvest loss, land degradation, and limited extension services	Availability of underground water, Availability of daily laborers, and human resource development, Favorable climatic conditions and fertile land for vegetable production - Enabling policy environments and support from public organizations and NGOs, and the Current national food security program, an excess of labor during winter	Concerned bodies should give attention to underground water. Conduct training for farmers for improved quality production and postharvest handling. Training and extension services for smallholders on disease and pest control methods Strengthen credits for service providers, institutions, and improve storage facilities
Marketing	Poor transport facilities, Price-setting problem, Product quality problem, presence of unlicensed traders, low price for the products, perishability of the products, and Limited function of cooperatives. Limited market research and credit service, Price fluctuation and market instability, and poor market price information	Government investment in infrastructure development Establishment of cooperatives, High market demand for vegetables, and Establishment of credit providers, the government encourages research and Development of road transportation facilities.	Strengthen the functions of farmer cooperatives and control unlicensed traders, increase credibility and market linkages of the vegetable value chain actors, Domestic market and export market promotion, improving farmers' bargaining power by supporting farmers' cooperatives.
Consumers	Income shortage and Lack of consumer cooperatives, lack of off-farm income alternatives	high consumption preference	Improve consumer awareness of consumption habits for vegetables.

3.6. Preliminary tests

A multivariate probit (MVP) model was employed to identify the factors influencing farmers' choice of market outlets. This approach accounts for the fact that onion producers may choose more than one outlet simultaneously to secure better prices. The model was estimated using the maximum likelihood method, which provided the marginal probabilities of selecting each market outlet. As shown in Table 6, the results indicate that the probability of an onion producer choosing a rural collector is the highest (52.18%), followed by wholesalers (44.32%), retailers (41.97%), and direct consumers (27.69%). Moreover, the model revealed the joint probabilities of success or failure in choosing the four outlets. The results suggest that farmers are more likely to fail than succeed in selecting all four outlets simultaneously. Specifically, the probability of successfully choosing all four outlets was only 1.32%, while the probability of failing to do so was significantly higher at 7.45% (Table 6).

The Wald chi-square ($\chi^2(100) = 552.78$, $p = 0.0000$) confirms the model's overall significance, while the LR test ($\chi^2(6) = 43.65$, $p = 0.0000$) shows strong correlation among error terms. These results validate the MVP model's fit and its ability to capture interdependence in outlet choices. The LR test for the null hypothesis that all correlation coefficients (ρij) are jointly zero ($\rho 21 = \rho 31 = \rho 32 = \rho 41 = \rho 42 = \rho 43 = 0$) is rejected at the 1% significance level, supporting the model's goodness-of-fit. This suggests heterogeneity in market outlet choices among producers. Examining individual correlations: $\rho 21$ (correlation between the choice for wholesaler–rural collector) is negative and significant at 1%; $\rho 31$ (correlation between the choice for retailer–rural collector) is positive and significant at 1% probability level; $\rho 32$ (correlation between the choice for retailer–wholesaler) is negative and significant at 5% probability level; and $\rho 41$ (correlation between the choice for consumer–rural collector) is negative and significant at 10% probability level. These findings highlight interdependencies among outlet choices in the study area. There was a competitive relationship between the district retail and consumer market outlets. However, producers selling to wholesalers were more likely to also sell to consumers, indicating a complementary link. Conversely, producers selling to local collectors were less likely to sell to wholesalers, and those selling to district retailers were less likely to sell to consumers, highlighting competition between these outlet pairs (Table 6).

Table 6: Overall model fitness, probabilities, and correlation matrix of market outlet choices

Variable	Rural Collector	Wholesalers	Retailors	Consumer
Predicted probability	.5218769	.4432157	.4197235	.2769781
Joint probability of success	0.0132682			
Joint probability of failure	.0745394			
Number of draws (SML, # draws)	5			
Number of observations	155			
Log Likelihood	-276.51601			
Wald chi2(100)	552.78			
Prob > chi2	0.0000			
Estimated correlation matrix	ρ_1	ρ_2	ρ_3	ρ_4
ρ_1	1.00			
P_2	0.070	1.00		
P_3	0.216**	-0.227**	1.00	
P_4	0.204**	0.257**	0.153*	1.00
Likelihood ratio test of: $P21 = P31 = P41 = P32 = P42 = P43 = 0$:				
$\chi2\ (6) = 12.023$				
Prob > $\chi2$ = 0.0615(*)				

Y_1, Y_2, Y_3, and Y_4 represent wholesalers, rural collectors, consumers, and retailers, respectively

*** p < 0.01. **p < 0.05. *p < 0.1; Note: Coef. = Coefficient and RSE = robust standard errors

3.7. Determinant factors of onion market outlet choices

Out of 12 explanatory variables included in the MVP model, five variables significantly affected wholesaler market outlet, four variables significantly affected district retailer outlet, five variables significantly affected collectors' outlet, and five variables affected consumer outlet choices at 1%, 5%, and 10% probability levels. MVP was used to analyze the onion producers' market outlet choices among four different outlets included in the model. In this section, the significance of the determinants influencing producers' decisions in market outlet choice is discussed based on the results of the MVP model in Table 7.

3.7.1. Frequency of extension contact

The likelihood of farmers choosing local collectors and retailers as market outlets was positively and significantly influenced by the frequency of extension contacts, at the 5% and 1% significance levels, respectively (Table 7). This relationship can be attributed to the fact that farmers who engage more frequently with Development Agents (DAs) tend to have better access to market information, including awareness of outlets offering more favorable prices. Moreover, extension services enhance farmers' capacity to adopt improved production techniques, leading to increased output. Higher production levels, in turn, improve producers' ability to select the most advantageous market channels. Consequently, households that received more frequent visits from extension agents were more inclined to sell their onions through local collectors and retail markets. This result is in line with the result obtained by Erkie et al. (2021), although they contradict the conclusions of Wosene et al. (2018) and Kasım et al. (2021) found that farm experience negatively affected the selection of retail outlets.

3.7.2. Lagged price of onion

The findings of this study, the lag price of onion has a negative and significant relationship with the likelihood of household heads choosing wholesalers, consumers, and retailer's market outlets at the 10%, 1%, and 5% significance levels, respectively (Table 7). This meant that as the lag market price of onions increased by a birr per quintal, the likelihood of onion farmers using wholesalers, consumers, and retailers as market outlets decreased. As a result, producers are forced to supply onion products that are directly related to the price offer. The result is supported by the previous findings of Abate et al. (2019) and Ayyano et al. (2020) found that access to milk market prices negatively affects accessing cooperative milk market outlets as compared to individual consumer milk market outlets.

3.7.3. Market distance

The result showed that the variable was negatively and significantly related to consumer market outlet at a 5% significance level (Table 7). The negative and significant effect showed that households whose residences are far from the nearest market are less likely to sell to consumer market outlets and more likely to sell to other market outlets, like a wholesaler and local collector market outlet. Selling onions to the consumer requires labor and transportation facilities to get to the final consumer, which exposes the producer to additional marketing costs. As a result, the onion producers prefer the nearby market outlet to sell their produce at the farm gate to decrease the transaction cost. For instance, Arinloye et al. (2015); Mariyono (2019); Chekol and Mazengia (2022) suggests that farmers who are near distance from the nearest market center have more information about marketing-related issues than others. These findings are similar to those of (Endris et al., 2020), who discovered that regular contact distance from the nearest market center was significantly and positively associated with the use of wholesalers and retailer market outlets.

3.7.4. Education status

The education status of the households was positively and significantly related to wholesaler outlet choice at a 1% significance level and negative effect on the likelihood of choosing retailers (5%) (Table 7). Education is believed to give individuals the necessary knowledge that can be used to collect information, interpret the information received, and make productive and marketing decisions. The more educated the farmer is, the more likely to sell onion through wholesalers. This finding is consistent with Endris et al. (2020) discovered that education reduces the likelihood of choosing consumers, retailers, and

assemblers' outlets while increasing the likelihood of choosing wholesaler outlets for vegetable marketing. One possible reason for this is that formal education encourages farmers either to produce more and supply to wholesalers, or encourages farmers to get jobs other than farming vegetables Wosene et al. (2018). Another reason might be that as the education level increases, farmers' productivity increases, and the linkage with wholesalers strengthens (Sibhat et al., 2022).

3.7.5. Access to credit

Credit access and utilization have a positive and highly significant effect on irrigated onion producers' choice of wholesalers ($p < 0.01$) and retailers' ($p < 0.01$) market outlets simultaneously. This implies that farmers who used credit were 58.6% more likely to sell their products to wholesalers and 50.9% more likely to sell to retailer market outlets compared to those who did not access credit (Table 7). The possible reason might be that farmers require finance to buy necessary inputs for mango production, to produce on a large scale, and hence sell to all channels from his/her large produce. This finding is consistent with previous studies by Hailu and Fana (2017) and Mohammed et al. (2019) found that obtaining credit has a positive and significant effect, which also found that access to credit to producers' choice of wholesalers' market outlets. The result is also in line with Goshu, et al. (2018) found that access to credit has a positive and significant effect on choosing a consumer market outlet for marketing onions.

3.7.6. Membership to agricultural cooperatives

Membership of agricultural cooperatives has a positive and significant effect on producers' choice of retailers' market outlets ($p < 0.01$). The result suggests that producers who were members of agricultural cooperatives were 59.2% more likely to sell their products to retailer market outlets, compared to those who were not members of agricultural cooperatives (Table 7). One possible explanation for this preference is that retailers offer higher prices, making them more attractive to onion producers. This finding aligns with a study conducted by Magogo et al. (2015) found that membership of agricultural cooperatives influences the choice of market outlet choices and at, where retailers are often located near farmers, they received farm gate price. However, this result contradicts the findings of Erkie et al. (2021) explained that membership of agricultural cooperatives has a negative influence on retail market outlets.

3.7.7. Age of the respondents

The age of the household head has a negative and significant influence on producers' choice of consumer market outlets at a 5% significance level. This means that as the age of the household head increases by one year, the probability of onion producers selling their products to consumer market outlets decreases by 2.8%, ceteris paribus (Table 7). This might be because older people in Ethiopia are relatively illiterate compared to younger people. This suggests that older onion producers prefer selling to market outlets other than consumer market outlets. One possible reason for this preference is that older producers may prefer selling to outlets that purchase at farm gate prices, as they may lack the energy to transport their onion products to the market and may not incur marketing and transaction costs, unlike younger producers. This result is in line with Erkie et al. (2021) confirmed that older farmers are not risk-takers to sell their products in different markets like younger farmers. The result of Mohammed et al. (2019) also confirmed that older farmers make their decision to choose a better market outlet that gives higher prices more easily than young farmers. By contrast, Endris et al. (2020) revealed that older farmers prefer rural markets to urban markets.

3.7.8. Farming experience

Experience in irrigated onion farming significantly influences the choice of consumer market outlets at the 10% level (Table 7). More experienced farmers are more likely to supply to consumer markets, as they better understand market dynamics, explore alternative outlets, and evaluate costs and returns, potentially reducing reliance on local consumer markets for more profitable options. This aligns with previous studies conducted by Abate et al. (2019) showed that the number of years a household spent in dairy farming positively and significantly affected milk market outlets.

3.7.9. Quantity produced

The probability of choosing a wholesaler market outlet was positively and significantly affected by quantity produced at a 1% significance level (Table 7). The positive sign indicates that those households producing a large quantity of onions prefer to use a wholesaler market outlet rather than other market outlets. On the other hand, households that produce a large output of onions are assessed by wholesaler market outlets compared to households that supply less because of wholesaler capacity, city to purchase a large quantity of onions at a fair price. The implication is that if the quantity of onions to be produced, farmers prefer a market outlet that buys large volumes at a fair price. But, if the quantity to be produced is low, farmers are not forced to search for price and market information. This result is in line with Abate et al. (2019) found that when the quantity of wheat produced increases, the probability of farm households choosing trader market outlets also increases.

Table 7: A multivariate probit estimation for determinants of onion producer`s market outlet choice

Variables	Rural collector Coef. (SE)	Wholesaler Coef. (SE)	Retailer Coef. (SE)	Consumer Coef. (SE)
Sex of the Household head	-.428 (.321)	.154 (.429)	-.189 (.290)	-.384 (.406)
Education status of the respondent	-.724 (.339) **	.853 (.386) ***	-.288 (.310)	.217 (.354)
Age of the household head (years)	-.015 (.019)	.010 (.022)	.003 (.019)	-.006(.021)**
Family Size of household head	.091(.125)	.056 (.140)	-.028 (.128)	.187 (.133)*
Onion farming experience	.116 (.055)	-.137 (.054)	.004 (.056)	-.055 (.048)*
Total land size allocated for onion	-.299 (1.478)	-.397 (1.43)	1.108 (1.415)	-.368 (1.565)
Membership in agricultural cooperatives	-.032 (.146)	.396 (.176) **	-.269 (.146)*	-.067 (.139)
Livestock owned (TLU)	.082 (.036) **	-.028 (.060)	-.002 (.039)	.020 (.039)
The lagged Price of onion	.038 (.034)	-.054 (.043)*	.016 (.033)**	.041(.036)***
Amount of onion produced (kg)	0.244(0.077)***	-0.057(0.057)	-0.025(0.050)	-0.038(0.054)
Distance from the nearest market center	-.006 (.069)	.0009 (.083)	-.007 (.072)	-.094(.066)**
Credit access and utilization	-.028 (.262)	.824 (.370) ***	.026(.269)***	-.156 (.344)
Frequency of extension services	-.191 (.041) ***	.311 (.056) ***	-.081(.041) **	-.036 (.040)
Quantity of onions sold (kg)	-.702 (.322) **	.427 (.379)	.235 (.298)	-.652 (.429)
Constant	3.005 (1.509) **	-5.66(1.955)***	2.1209(1.561)	-1.28 (1.663)

Note: Coef. = Coefficient and SE = standard errors

*** p < 0.01. **p < 0.05. *p < 0.1; ns = not significant

4. Conclusion

The study aimed to examine the factors influencing the marketing outlets choice among irrigated onion producers in Northwest Ethiopia. The study employed a Multivariate Probit regression model for analysis. During the survey period, the sampled households marketed a total of 1,108.3 tons of onion produced through irrigation. The amount of onion transacted in these market channels was different. The dominant marketing channels were Producers → Rural Collectors → Wholesalers → Retailers → Consumers, and Producers → Wholesalers → Consumers. Each of the channels accounted about 348.6 tons and 340.7 tons of onion, respectively, which were found to be dominant in terms of onion volume of transaction.

There were significant negative relationships between the choices of wholesaler and rural collector, consumer and rural collector, and retailer and wholesaler, indicating competitive dynamics between these outlets. Conversely, the relationship between retailer and rural collector was positively and significantly correlated, suggesting a complementary interaction. The choice of marketing outlet for onion is complex and interdependent in nature.

The choice of wholesaler market outlet was influenced by the respondent's education level, cooperative membership, lagged price of onion,

access to and use of credit, and frequency of extension services. Selection of rural collector outlets was also affected by education, total livestock owned, quantity of onion produced and sold, and extension service frequency. The retailer outlet choice was driven by cooperative membership, lagged onion prices, credit utilization, and extension services. For the choice of consumer outlet, age and family size of the household heads, onion farming experience, lagged price, and distance to the nearest market played a significant role. Based on these findings, the following policy recommendations are proposed.

- ☞ Investment in rural infrastructure like road and transportation network is inevitable to reduce the market chain, which complicated market access,
- ☞ Provision of awareness creation trainings and extension services on the market information sources, selection of profitable market channels and price negotiation by development agents and market experts is necessary.
- ☞ Improvement of the access of affordable credit services is crucial as it enables farmers to invest in production and allow them to identify the most beneficial marketing outlets.

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Data availability statement

Data will be made available on request

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Conflicts of interest

The authors declared that there is no any conflict of interest.

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