Determinants of Market Participation Decision and Intensity among Date Producers in Afar Region, Ethiopia: A Double Hurdle Approach

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ABSTRACT
Date palm production and marketing contribute substantially to food security, reduction of malnutrition, mitigation of poverty, and income diversification for poor agro-pastoralists in Ethiopia. However, marketing systems are not sophisticated and well functioning, and producers do not as such benefit from date market participation due to different factors. This study examined factors that determine date market participation decisions and intensity. A total of 384 date producers were selected through a multi-stage sampling technique. A Descriptive and Double hurdle model was employed to analyze the data. The Double hurdle econometric model revealed that producers with access to extension services, improved date palm varieties, credit, road infrastructure, market information, land access, better market prices, better educational status, and direct to consumer marketing channels were more likely to participate in and supply the date market. Whereas producers who had livestock, dwellings distant from the nearest market, or a greater number of date palm trees, were adversely affected in date market participation intensity. The results of this study support the recommendations for establishing extension services, rural education, rural road infrastructure, marketplaces, and institutional support; and providing credit access, improved date palm varieties, additional hectares of land for date production, and updated market information to date palm producers.

KEYWORDS
Date; market participation; intensity of market participation; Double hurdle model; Ethiopia

Introduction
The date palm (Phoenix dactylifera L) from the Arecaceae family represents a living symbol of the desert due to its high tolerance to high temperatures as compared to other food crops. Date palm is currently cultivated in nearly 30 countries on the Asian, African, American, and Australasian continents (Mustapha El Bouhssini 2018). For 200 years, date palm trees have been planted in Ethiopia’s Afar, Somali, Gambella, Dira Dawa, and Benishangul-Gumuz regions, as adopted from the middle east countries of Yemen and Sudan (Demeli, 2013). Date production in the Afar region has a long history, especially in the Afambo, Asayita, Gewane, and Amibara districts, which are suitable for date palm plantations (Salah, 2015).

Dates have health benefits, such as being high in fiber, potassium, iron, B vitamins, dietary fibers, fatty acids, proteins, and many other nutrients. Dry dates can be processed, or they can be made into final or intermediate products, such as concentrates, date pieces, pastes, pitted dates, syrup, baked goods (bars, cookies, etc.), and more. In addition to human consumption, date pits, and dates falling from palms before maturity are used as animal feed (Chao and Krueger, 2007). Date plantations are tolerant to high temperature, drought and saline soils, and are used for the control of desertification, as a means of land reclamation, and for shade in towns in arid climates (El Bouhssini et al., 2018, Aregawi; Lemlem et al., 2018).
In line with this, more than 75% of the peoples of the Afar regional state are pastoralist and agropastoralists (Central Statistical Agency [CSA], 2012). Afar is in the tropical ecological zone, therefore date plantations are vital for income diversification, as source of food for both humans and their animals, and for environmental conservation. However, producers in this area produce date palm fruit mainly for their own consumption rather than to supply the local market (Aregawi Lemlem et al., 2019). The quantity available in the market is therefore often much lower than the demand for the product (Hussen, 2010). To address this demand, the government of Ethiopia imports about 1715 tons of date palm annually (Aregawi Lemlem et al., 2019).

The rate of date market participation by domestic producers is fragile due to malfunctioning and unsophisticated marketing systems in general, and particularly due to higher transaction costs, lower market prices, transportation problems, market information asymmetry, large distances between producers and markets, the role of market intermediaries, and other factors (Aregawi Abadega, 2021; Belayneh et al., 2019; Hagos et al., 2020; Lemlem et al., 2019; Muzemil, 2020; Oyka and Abebe, 2020; Regasa et al., 2019). These factors make producers less enthusiastic to produce and supply dates to the market. The results of this low participation include harm to employability, income, food security, and environmental protection, all of which have negative consequences for the economy of the region and the nation.

Various agricultural policies launched to enhance agricultural productivity and marketing have not achieved expected outcomes, specifically with regard to marketing issues. For instance, the agricultural development policies of Ethiopia since 1957 found that grain and cash marketing in Ethiopia is still constrained by a host of setbacks, and much remains to be done to develop markets as channels through which the benefits of macro-economic policy reforms reach the people that they are meant to serve (Alemu et al., 2002). The main objectives of Ethiopia’s agricultural-sector policy and investment framework applicable from 2010 to 2020 were to increase smallholder household cash incomes by increasing the proportion of agricultural production marketed (Food and Agricultural Organization [FAO], FAO, 2002), to increase commercialization of Ethiopian agriculture through extension services from input supplier, to knowledge broker, and facilitator (Gebremedhin et al., 2006). In addition rural development policy and strategies also designed for the purpose of work toward market-led agricultural development of different agro-ecological zones through (Ministry of Finance and Economic Development [MoFED], 2003). However, these policy frameworks failed to enable the development of sophisticated and well-functioning date marketing systems, especially in the Afar regional state.

Studies on the determinants of market participation decisions for different agricultural products have previously been conducted. For example, (Abadega, 2021) and (Ahmed et al., 2016b) conducted a study on the determinants of potato market participation in southern Ethiopia and the Oromiya region, and revealed that land, non-farm income, education, market information, and livestock ownership were the main determinants for market participation. The determinants of market participation and intensity for various fruits were evaluated by (Regasa et al., 2019), for mango by (Hagos et al., 2020), for banana by (Kassa et al., 2017; Komarek, 2010), and for bulla by (Lefebre et al., 2016). These fruit market participation studies found that access to transportation and extension services, family size, seed types, and distance to the market were the main factors responsible for market participation decisions.

The common approaches of modeling market participation and intensity are the Tobit, Heckman, and Double hurdle models (Dlamini and Huang, 2019; Kefyalew, 2012). The Tobit model is a statistical model suggested by James Tobin in 1958 to analyze the relationship between a non-negative dependent variable and an independent variables (Sigei et al., 2014). Some studies have used the Tobit model to address farmers’ market participatory decisions and marketable surplus (Bellemare and Barrett, 2006; Martey et al. 2012; Gani and Adeoti, 2011; Muzemil, 2020), but the major drawback of this model is that participation and sales volume decisions are made simultaneously and hence factors that affect the participation decision and the sales volume decision are the same (Abadega, 2021; Belayneh et al., 2019; Hagos et al., 2020; Kefyalew, 2012). This might yield biased parameter estimates (Wanyoike et al., 2015) and also the variable that determines date market participation
decision might not have the same effect on the marketable supply of date. Therefore, to relax such a restrictive method recent study proposed an alternative approach that is, the Heckman model (Kefyalew, 2012).

The Heckman model used two step procedure, in the first step applies the probit model to analyze the probability of market participation decision (selection model) and in the second step, the ordinary least-squares regression model (outcome model) for analyzing the determinants of marketable surplus, conditional on market participation (Bellemare and Barrett, 2006; Dlamini and Huang, 2019; Kassa et al., 2017; Lefebro et al., 2016; Mulatu, 2021). Under Heckman model, the zeros (not participating) in the selection model are treated as cases of unobserved or missing data rather than corner solution (genuine zero) (Dlamini and Huang, 2019; Heckman, 1979). There may be a systematic difference between participating and nonparticipating farmers in the market, which may cause a sample selection problem.

The Heckman model rectifies this sample-selection problem by computing Mills ratio in the selection model (Lefebro et al., 2016). The model is popular in market participation of agricultural commodities studies, for example, in banana (Tarekegn and Yosef, 2017), bulla (Lefebro et al., 2016), wheat (Dubale Abate et al., 2021), Ethiopian banana (Mulatu, 2021), and pineapple (Sigei et al., 2014). However, the model is best suitable for nonrandom samples and it is poor when the normality assumption is not achieved (Dlamini and Huang, 2019; Komarek, 2010).

The Double hurdle model assumes producers are faced with two hurdles in any agricultural decision-making process (Cragg, 1971; Kefyalew, 2012). This model is a generalization of the Tobit, where the participation and quantity decisions are determined with two separate stochastic processes. In the first stage, the probit model is applied to analyze the participation decision of producers, and the second stage uses a truncated regression model to analyze the extent of market participation for market participants (Sigei et al., 2014; Abadega, 2021; Tura et al., 2016; Oyka and Abebe, 2020, Abate et al. 2021).

The basic difference between Heckman and the Double hurdle model is: the assumption of the Heckman that non-participants will not participate under any circumstance (those zeros from non-participants are measured as unobserved or missed observation). In contrast, the Double hurdle assumes that the decision not to participate in the market is a deliberate choice (thus the zeros from non-participants are taken as genuine zero in the utility-maximizing model) (Tura et al., 2016). The Double hurdle model permits a subset of the data to a pile-up at some value without causing bias in estimating the determinants of the continuous dependent variable in the second stage (Dlamini and Huang, 2019; Heckman, 1979). The model is also flexible, which means there are no restrictions that limit the components of explanatory variables in two estimation stages (Kefyalew, 2012). Therefore, the double hurdle model is less restrictive than the Heckman, and best suited for samples drawn through random probabilistic sampling procedures (Komarek, 2010).

Although more than half of date production in Ethiopia takes place in the Afar regional state (Aregawi Lemlem et al., 2018), to date no studies have been conducted on the determinants of date market participation decision and intensity in this area. This study area has distinct characteristics compared to other studied areas, including different technologies (i.e. fully irrigated), different agro-ecological zones (i.e. tropical), and different know-hows of production and societal ways of life (i.e. agro-pastoralist) (Asfaw, 2021). In line with this, most previous studies used the Heckman sample selection model to analyze the data on market participation decisions, which was affected by too many zeros. Therefore, this study used the Double hurdle model to analyze the determinants of date market participation decision and intensity in the Afar region of Northeast Ethiopia.

**Methodology of the Study**

**Description of the Study Area**

The study was performed in the Afar regional state of Ethiopia, in the Afambo and Asaiyta districts. The Asaiyta district has a latitude and longitude of 11°34’N 41°26’E and an elevation of 300 m. Pastoral
and agro-pastoral systems of livestock production are the main economic activities (G. Bekele et al., 2017). The mean temperature is between 30°C and 45°C per annum, and the climate is tropical (CSA, 2007). Awash dam is the main source of water for irrigated crop production. The Tendaho and Middle Awash Agriculture Development farms, owned by the government of Ethiopia, are the largest in the area (G. Bekele et al., 2017).

The Afambo district, or woreda, is bordered on the south by the Somali Region, on the west by Dubti, on the north by Asayita, and on the east by Djibouti (CSA, 2007). The average elevation in this woreda is 404 m, and the latitude and longitude are 11°34’N 41°26’E. The mean temperature is between 28°C and 44°C per annum, and the climate is tropical (CSA, 2007). The only perennial river is the Awash, which passes through Lake Afambo, and a chain of lakes south and east of it: Laitali, Gummare, Bario, and Lake Abbe (CSA, 2007). The Afambo district has a total population of 24,153. While 3.40% of the total population are urban dwellers, a further 27.03% of them are pastoralists. A total of 4,251 households were counted in this district, which results in an average of 5.7 persons to a household (CSA, 2007).

**Sampling Technique and Sample Size**

The sampling technique in this study was the multistage sampling technique. In the first stage, the Afambo and Asaita districts were purposively selected due to the yield capacity of dates per production season and the long-year date production. In the second stage, Alasabolo and Humadoyta kebelles from Afambo district, and Mamulie and Kerebora kebelles from Asaita district, were selected purposively based on the date production experiences and capacities in these kebelles. Kebelles are the lowest political administrative unit in the Ethiopia. In the third stage, a total of 384 date producers, including 188 from Alasabolo, 98 from Humadoyta, 48 from Mamulie, and 40 from Kerebora kebelles were selected based their population proportion (Asaita district agricultural bureau, 2021). The specific date producers from each sampled kebelle were selected using simple random sampling techniques.

The intended sample sizes were determined by using Kothari (Kothari, 2004) sample size determination formula as follows (equation 1).

\[
n = \frac{Z^2pq}{e^2} = \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2} = 384.16 \approx 384
\]

Where: \(n\) is the sample size; \(z\) is 1.96 to achieve the 95% level of confidence; \(p\) is the proximate proportion of producers to non-producers of date palm in the study areas (50% as a rule of thumb); \(e\) is the tolerant marginal error defined as 0.05, that is, 5% maximum discrepancy between the sample and the general population.

**Sources and Methods of Data Collection**

Primary data was collected from 384 date producers from Asaita and Afambo district by a structured questionnaire that incorporated demographic, socioeconomic, institutional, and marketing characteristics of the sampled date producers, through a team of four trained enumerators for each sampled kebelles (Supporting Data File S1).

**Analytical Framework**

Data collected from 384 sample respondents were analyzed by two statistical methods. First, descriptive statistical methods, such as arithmetic means, standard deviations, percentages, and frequency

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1It is the lowest political administrative unit in the Ethiopia.
were used to describe and assess the socioeconomic characteristics, institutional and market characteristics of date producers in the study area. Inferential statistics including an independent t-test and a chi-squared test were then applied to detect statistically significant differences between market participants and non-participants, with regard to continuous variables and categorical variables, respectively.

The second analysis was done using the econometric analysis approach to examine the determinants of market participation and the intensity of market participation. The Tobit (Edward et al., 2012; Gani and Adeoti, 2011) and Double hurdle model (Kefyalew, 2012) were evaluated the intensity of market participation. An appropriateness test between the Tobit and the Double hurdle models was performed using the likelihood ratio (LR) best fit test (equation 2).

\[
\lambda = -2(LL_T - LL_P - LL_{TR})
\]  

(2)

Where: \(LL_T\), is log-likelihood values for the Tobit; \(LL_P\), is log-likelihood values for the Probit and \(LL_{TR}\) is log-likelihood values for the truncated. \(\lambda\) is an LR statistical value with Chi-square distribution with degrees of freedom equal to the number of independent variables. Under the null hypothesis, the Tobit model is more appropriate than the Double hurdle model. Consequently, the rejection of the null hypothesis means that the double hurdle model is a better alternative to fit the data. Therefore, the Double hurdle was adopted in this study to the analysis of our randomly selected sample data.

**Model Specification**

The Double hurdle model is designed to analyze first the decision to sell or not (participation), followed by the decision on how much (quantity of dates) to sell (outcome).

The market participation decision of date is modeled as probit regression as follow (equation 3):

\[
d_i^* = X_i^1\beta_1 + \mu_i, \mu_i \sim N(0, 1)
\]  

(3)

\[
d_i = \begin{cases} 
1 & \text{if } d_i^* > 0 \\
0 & \text{if } d_i^* \leq 0
\end{cases}
\]  

(4)

The intensity of supply of date is modeled as a truncated regression as follow (equation 5):

\[
Y_i^* = X_2i\beta_2 + v_i, v_i \sim N(0, \sigma^2)
\]  

(5)

\[
Y_i = \begin{cases} 
Y_i^* & \text{if } Y_i^* > 0 \text{and } d_i = 1 \\
0 & \text{if } Y_i^* \leq 0
\end{cases}
\]  

(6)

Where: \(X_i^1\) and \(X_2i\) are vectors of explanatory variables that affect these two-stage decisions, respectively. \(\mu_i\) and \(v_i\) are uncorrelated error terms for both decisions, respectively. \(\beta_1\) and \(\beta_2\) are the respective vectors of parameters. \(d_i^*\) is latent or unobserved market participation decision (if \(d_i^* = 1\), date producers participated in the market \(d_i^* = 0\), does not participate), \(d_i\) is observed market participation decision, \(Y\) is the observed amount of date supply to the market, and \(Y_i^*\) is the latent or unobserved amount of date supply to the market.

Assuming the error terms are independent, the stochastic specification in can be written as (equation 7):

\[
\begin{pmatrix} \mu_i \\ v_i \end{pmatrix} \sim N \left( \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & \sigma^2 \end{pmatrix} \right)
\]  

(7)

The Double hurdle model with independent error terms can be estimated by the following log-likelihood function as follows (equation 8):
\[ LL = \sum \ln \left[ 1 - \Phi \left( \frac{X_i \beta_j}{\sigma} \right) \right] + \sum \ln \left[ \frac{1}{\sigma} \Phi \left( \frac{Y_i - X_i \beta_j}{\sigma} \right) \right] \]  

(8)

Where: \( \Phi \) (Greek capital letter phi) denotes the standard normal probability, \( \phi \) (Greek small letter phi) is the density function; \( X_{ij} \) and \( X_{2i} \) represent independent variables for the probit model and the truncated model respectively; \( \beta_1 \), \( \sigma \), and \( \beta_2 \) are parameters to be estimated for each case.

Therefore, the first hurdle (probit) model for determinants of date market participation decision \((Mktpr_i)\) was specified as follows (equation 9):

\[
Mktpr_i = \beta_0 + \beta_1 Edu_i + \beta_2 Gen_i + \beta_3 Ext_i + \beta_4 of femp_i + \beta_5 Ols_i \\
+ \beta_6 Plmtyp_i + \beta_7 HHSiz_i + \beta_8 Crdit_i + \beta_9 Mrtst_i + \beta_{10} Dstfrm_i + \beta_{11} Age_i \\
+ \beta_{12} Plmtree_i + \beta_{13} Frm ln d_i + \beta_{14} Road_i + \beta_{15} Mrkdst_i + \eta_i
\]  

(9)

The parameter estimates \((\beta_i)\) are specified such that the signs of the partial effects of the independent variables on the estimated probability of the dependent variable \((Mktpr)\). However, marginal effects of parameter estimates \((\alpha_i)\) are used for evaluating the effect of each independent variable on the outcome variable for the \(i\)th sampled date producer household (Gujarati, 2003).

The second hurdle model (truncated regression) model for determinants of quantity of date product sold at the market \((Qtdt_i)\) was specified as follows (equation 10)

\[
Qtdt_i = \alpha_0 + \alpha_1 Edu_i + \alpha_2 Expr_i + \alpha_3 Ext_i + \alpha_4 Plmtyp_i + \alpha_5 Crdit_i \\
+ \alpha_6 Mrtst_i + \alpha_7 Dstfrm_i + \alpha_8 Plmtree_i + \alpha_9 Frm ln d_i + \alpha_{10} Mrkdst_i + \alpha_{11} Nfrminc_i \\
+ \alpha_{12} Mktinf_i + \alpha_{13} Road_i + \alpha_{14} Cmktpr_i + \alpha_{15} Lmktpr_i + \alpha_{16} Mktcha_i + \alpha_{17} Gen_i \\
+ \alpha_{18} Ols_i + \alpha_{19} HHSiz_i + \epsilon_i
\]  

(10)

The definitions and hypothesized signs of independent variables used in the Double hurdle to analyze the determinants of market participation and intensity of date producers are presented for the \(i\)th sampled date producer household in Table 1.

Before proceeding to econometrics analysis, all the hypothesized explanatory variables were checked for the existence of multicollinearity by using the Variance Inflation Factor (VIF) for continuous and categorical variables, and contingency coefficients (CC) for dummy variables (Gujarati, 2003); for heteroskedasticity using the Brushi–Pagan test (Wooldridge, 2015); and for Omitted variable test using the Ramsey test (Torres-Reyna, 2007).

**Definition of Variables and Hypothesis**

This study hypothesized that the date market participation decision and the intensity of date production by producers in the study area were influenced by farm-related, social, economic, and institutional factors, as listed below.

**Date market participation decision**: a binary dependent variable for estimating the probability of date market participation via the first hurdle (probit) regression model, which takes the value of one for producers that are participating in the date market, and zero for producers that are not participating in the date market.

**Quantity of date output sold at the market in quintal**: a continuous outcome variable for estimating the quantity of date sold in quintal (100 kg) at the market via the second hurdle (truncated) regression model, subject to the first probit date market participation decision.

**Household head year of schooling**: a variable representing the year of schooling of the household head. Education enhances skills and knowledge to transfer and disseminate information, innovations, and new technology necessary for increasing farm productivity, empowering marketing skills, and this, in turn, increases the likelihood of market participation (Ahmed et al., 2016a; Geoffrey et al., 2015;
Sori et al., 2017). Therefore, this study hypothesizes that there will be a positive association between this variable and market participation and supply.

**Gender**: a dummy variable which takes the value of one for male heads of household, and zero for female. Female farmers are generally more driven with household self-sufficiency rather than marketable surplus participation, and often have less resources available than their male counterparts (Dlamini and Huang, 2019; Sigei et al., 2014). Male-headed households were found to participate more in the market for pineapple (Geoffrey et al., 2015), (Sebatta et al., 2014), (Abadega, 2021). Therefore, a positive relationship between gender and market participation decisions is expected.

**Farming experience**: a continuous variable measuring the number of years the farmer has been involved in date farming. An experienced date producer captures market networks that accrue over time to enhance the search for trading partners and improve bargaining power (Oyka and Abebe, 2020; Tenka, 2016). This variable is expected to have a positive effect on market surplus.

**Frequency of extension contacts**: a continuous variable designed to capture the guidance and training received by date producers from the point of land preparation to marketing. Frequent extension contact helps producers to increase knowledge of production methods, new technologies, and marketing skills, which encourage them to produce more and supply to the market (Kassa et al., 2017; Sigei et al., 2014). In this study, access to extension services was expected to be positively related to the probability of market participation and volume of date sold.

**Off-farm employment**: a binary variable that reflects whether (one) or not (zero) date producers were employed on other farms or in activities other than farming. Off-farm employment contributes an additional income source for producers to purchase inputs and diminishes working time available for date cultivation. A study by (Bekele, 2017), found that engagement in off-farm activities did not increase sales capacity because producers’ financial need were already addressed. However, (Regasa et al., 2019) found that off-farm income positively and significantly influenced the market

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**Table 1. Definition and hypothesis signs for explanatory variables.**

| Variables  | Definition                                                                 | Measurement | Expected Sign Market participation | Expected Sign Intensity of participation |
|------------|---------------------------------------------------------------------------|-------------|-------------------------------------|----------------------------------------|
| Edu        | Household head year of schooling                                          | Year        | +                                   | +                                      |
| Gen        | Sex of household head                                                     | 0 = Female, 1 = Male |                                       |                                        |
| Expr       | Farming experience                                                        | Year        | -                                   | +                                      |
| Ext        | Frequency of extension contacts                                           | Days        | +                                   | +                                      |
| Offemp     | Off-farm employment                                                       | 0 = No, 1 = Yes | ±                                   |                                        |
| Ols        | Ownership of livestock                                                    | Tropical livestock unit | ±                                   |                                        |
| Plmtyp     | Date palm type                                                            | 0 = Local, 1 = Improved | +                                   | +                                      |
| HHSIZE     | Household size                                                            | Headcount   | +                                   |                                        |
| Credit     | Access to farm credit                                                     | 0 = No, 1 = Yes | +                                   | +                                      |
| Mrtst      | Marital status                                                            | 1 = Married, 0 = Other, | +                                   | +                                      |
| Distfrm    | Distance to farmland                                                      | Kilometer   | -                                   | -                                      |
| Age        | Household head age                                                        | Year        | +                                   |                                        |
| Plmtree    | Number of palm trees                                                      | Number      | +                                   | +                                      |
| Fmldnd     | Land allotted for date cultivation                                          | Hectar     | +                                   |                                        |
| Mrkdst     | Distance to date market                                                   | Kilometer   | -                                   | -                                      |
| Ntrinc     | Off-farm income                                                           | Birr/year   | -                                   |                                        |
| Mktinfo    | Market information                                                        | 0 = No, 1 = Yes | +                                   |                                        |
| Road       | Access of road                                                            | 0 = No, 1 = Yes | ±                                   |                                        |
| Cmktpr     | Current date market price per Kg                                          | Birr        | +                                   |                                        |
| Lmktpc     | Lagged date market price per Kg                                           | Birr        | +                                   |                                        |
| Mktcha     | Market channel of date product                                            | 0 = Wholesaler, 1 = Retailer, 2 = Final consumer | ±                                   |                                        |
participation of smallholder fruit producers in southwest Ethiopia. Therefore, the association between this variable and the participation decision is expected to be un-deterministic.

**Ownership of livestock**: a continuous variable measured by tropical livestock unit. In this study area, more than 85% of the society are pastoralists. (Kassa et al., 2017) found that ownership of livestock negatively affected participation in the crop market because time and money were preferentially dedicated to feeding and taking care of the livestock. In contrast, livestock is important to improve the production of date because it a source of income for household to buy improved inputs for date production, increasing the chances of a household’s market participation (Oyka and Abebe, 2020). In this study, the effect of ownership of livestock on the probability of market participation and date marketable surplus are expected to be un-deterministic.

**Date palm type**: a dummy variable to identify the type of date palm planted by farmers whether improved (one) or local (zero). Local date palm variety users produced 26–45 kg per tree per year. On the other hand, date producers who planted improved date palm varieties recorded yields ranging from 71 to 80 kg per tree per year (Aregawi Lemlem et al., 2018). Thus, positive associations between date palm type and both market participation and marketable surplus of date are hypothesized.

**Household size**: a continuous variable that reflects the total number of people in one household. A larger household is a source of more family labor that is required for production and marketing functions (Dlamini and Huang, 2019). This study hypothesizes that there is a positive association between household size and market participation.

**Access to farm credit**: a dummy variable aimed at addressing the effect of agricultural credit on date production and marketing. Access to credit is a solution for the financial constraint of farmers to expand on improved inputs, thereby increasing production, which is reflected in increased market participation (Tura et al., 2016). Therefore, a positive relationship is expected between access to credit and market participation, and market surplus.

**Marital status**: a two category, that is married and others (single, divorced, and widowed). The variable captures the effect of marriage support in decision-making from production to marketing. Married farmers have a broad chance for decision-making, thus marital status is suggested to have a positive effect on sales decisions with regard to a married marital status (Dlamini and Huang, 2019). This variable and market decision are expected to have a positive relationship.

**Distance to farmland**: a continuous variable representing the distance from the farmer’s home to farm plot measured in kilometers. When farm plots are far away from home, it is difficult to protect dates from animals, humans, and other pests, and more time is required for date planting and cultivation. For instance, (Hailu et al., 2014) found a negative relationship between the distance from farmland to producers’ home and the probability of market participation decision. Distance to farmland is expected to have a negative effect on market participation and on participation intensity.

**Household head age**: a continuous variable representing the farmer age. Older people might have date farm experience, accumulated capital, a long-term relationship with their clients, preferential access to credit, or increased availability of land (Sigei et al., 2014). Therefore, this study hypothesizes that as date producers age, they will increase their participation in the date market.

**The number of date palm trees**: a continuous variable that reflects the total number of date palm trees per household. The household that has a large number of date palm trees will produce too much to consume within the household (Aregawi Lemlem et al., 2018). There is therefore a positive association expected between the number of date palm trees and the market participation, and the marketable surplus.

**Land allotted for date cultivation in hectares**: a continuous variable that captures the total amount of land allotted to date plantation in hectares. The land is a vital input for date production and as more hectares of land are allotted for date cultivation, there is more likelihood of a marketable surplus of date. (Abadega, 2021) and (Kaso, 2015) found that increased land allocated for potato and wheat drove increased farmer market participation. This variable and market participation intensity are expected to have a positive relationship.
**Distance to date market**: a continuous variable that represents the estimated distance from the farmer’s location to the date marked in kilometers. (Rehima and Dawit, 2012) found that market participation among smallholder pepper producers was negatively associated with distance to the market. Households located far away from the market incur high transportation and other transaction costs, which reduce the likelihood of market participation (Tarekegn and Yosefe, 2017). This variable and market decision are expected to have a negative relationship.

**Income from off-farm activity in birr**: a continuous variable that reflects the income of date producers from activities other than farming; expressed in birr, the currency of Ethiopia. An additional income is a solution to financial constraint for farmers, which can in turn reduce the willingness of those farmers to participate in the date market. (Lefebo et al., 2016) and (Yohanes, 2015) found that an increase in non-farm income of kocho and potato producer households leads to a decrease in the probability of market participation. This variable and market decision are expected to have a negative relationship.

**Market information**: a dummy variable representing whether (one) or not (zero) the household receives market information like price, supply quantity, and demand quantity of date before selling. Access to date market information is vital because it enables farmers to make maximum decisions on at which market to sell, when to sell, and at what price (Ahmed et al., 2016b). (Kassa et al., 2017; Muzemil, 2020; Sigei et al., 2014) revealed a positive association between this variable and marketable surplus. In this study, market information and marketable surplus are expected to have a positive relationship.

**Access of road**: a dummy variable that reflects farmers’ access (one) vs. lack of access (zero) to national highways, state highways, district roads, rural roads, or any village roads used for vehicle transportation. A study by (Kassa et al., 2017) found that proximity to the main road improves farmers’ access to market information and transportation. (Kassa, 2015) also found that that nearness to road encouraged market participation due to its effect of reducing marketing costs. Therefore, this variable and market decision are expected to have a positive relationship.

**Current date market price per Kg**: a continuous variable that measures the market price of date in the nearest market in the 2021 production season. As farmers receive a high market price for date output, they may become eager to produce more and increase market surplus. Higher market prices enhance the farmer’s willingness to produce more rice, increasing the amount of rice to be sold in the market by smallholder farmers (Muzemil, 2020). Therefore, this variable and market decision are expected to have a positive relationship.

**Lagged date market price per Kg**: a continuous variable that measures the market price of date in the nearest market in the 2020 production season. A high market price for date output for last year’s production season is an incentive to produce more and market surplus for the coming production season (Abadega, 2021). Therefore, this variable and market decision are expected to have a positive relationship.

**Market channel of date product**: a categorical variable to capture the effect of the different market channels (wholesalers (zero), retailers (one), and final consumers(three)) on the extent of market participation and marketable surplus. Face-to-face transactions with a final consumer increased relationship market participation compared to retailer and wholesaler, because final consumers have lower bargaining power on the price of the product compare to wholesalers and retailers (Dlamini and Huang, 2019). Therefore, this variable (final consumers) and market decision are expected to have a positive relationship.

**Results and Discussion**

**Descriptive Analysis**

The descriptive comparison of categorical variables over dependent variables based on frequency counts and the chi-squared test is presented in Table 2. The variables palm type, credit access, marital
status, market information, and road access had significant effects on market participation decisions (Table 2).

Among participants, 29.08% used improved palm tree type, compared to 8.27% among non-participants (Table 2). However, the majority of producers tended to use local palm trees over the improved varieties (78.13%) (Table 2). The introduction and adoption of improved date palm trees could bring increased productivity and pest-resistance/tolerance (Aregawi Lemlem et al., 2018). Therefore, the results suggest a positive relationship between date marketing decision and palm tree type.

Farm credit is vital for startup capital for farm investment in production and marketing processes, thus promoting farm productivity and marketable surplus, which in turn increase the propensity for market entry and the intensity of market participation (Dlamini and Huang, 2019). The results reveal that only some of the farmers within the present study sample (39.84%) had access to farm credit (Table 2). However, among the participant subsample, 68.49% had credit access, compared to 22.26% among non-participants (Table 2). This suggests a positive association between access to credit and involvement in date marketing.

In total, the number of married producers (80.47%) was higher than the number of others (single, divorced, and widowed) date producers (19.53%) (Table 2). This reflects a wider human resource base for decision-making and labor for participants, thus increasing the marketable surplus (Dlamini and Huang, 2019). The analysis revealed that 84.06% of participants were married compared to 15.94% of others (single, divorced, and windowed). The results suggest that human resource for management and decision-making functions plays important role in market participants (Dlamini and Huang, 2019). Therefore, there is a positive association between marital status and sales decisions concerning married.

All information regarding date demand, price, and supply in the nearest market plays an important role in market participation. Among the total date market participants, 89.76% had date market information, compared to 26.32% of non-participants (Table 2). Therefore, there is a positive association between market information and sales decisions.

Among the participants, 67.33% had road access compared to non-participants (13.53%) (Table 2). However, 51.30% of the sample population had no access to the road (Table 2). Road infrastructure is important for farmers to reduce transaction cost, easily access market information, and meet customer on time, all of which encourage the farmer to produce more and participate in the market. Therefore, the date producers who had access to road infrastructure were eager to participate in and supply to the market.

Male date producers dominated in date farming and marketing, making up 68.23% of the total sample (Table 2). Even though out of the total sampled producers, 31.77% were female producers, only 21.51% engaged in date marketing compared to 78.49% within the male population (Table 2). This

| Table 2. Cross-tabulation of market participation decision with categorical independent variables. |
|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| Variables               | Category       | Market participation decision               | Total                           | Chi-square value |
|-------------------------|----------------|-----------------------------------------------|-----------------------------------------------|
|                         |                | Not Participated (n = 133)     | Participated (n = 251)    |                           |                               |
| Palm type               | Local          | 122(91.73%)                          | 178(70.92%)                      | 300(78.13%)   | 22.03***          |
|                         | Improve        | 11(8.27%)                             | 73(29.08%)                       | 84(21.88%)    |                                |
| Credit access           | No             | 185(77.73%)                          | 46(15.50%)                       | 231(60.01%)   | 24.07***          |
|                         | Yes            | 30(22.26%)                           | 100(68.49%)                      | 153(39.94%)   |                                |
| Marital status          | Married        | 98(73.68%)                           | 211(84.06%)                      | 309(80.47%)   | 31.52**           |
|                         | Others*        | 35(26.32%)                           | 40(15.94%)                       | 75(19.53%)    |                                |
| Market information      | No             | 98(73.68%)                           | 27(10.76%)                       | 125(32.55%)   | 156.76***         |
|                         | Yes            | 35(26.32%)                           | 224(89.24%)                      | 259(67.45%)   |                                |
| Road access             | No             | 115(86.47%)                          | 82(32.67%)                       | 197(51.30%)   | 100.7***          |
|                         | Yes            | 18(13.53%)                           | 169(67.33%)                      | 187(48.70%)   |                                |
| Gender                  | Female         | 68(51.13%)                           | 54(21.51%)                       | 122(31.77%)   | 35.17***          |
|                         | Male           | 65(48.87%)                           | 197(78.49%)                      | 262(68.23%)   |                                |

***, **, and * stand for significance at p < 0.001, P < 0.05, and P < 0.1, respectively. N.B: E is single, divorced, and widowed.
show that female-led household are passive in date market participation compared to their counterpart. Therefore, there is an association between gender and sales decisions concerning males.

Table 3 presents a descriptive mean comparison of continuous variables between date market participants and non-participants. All variables exhibit that the mean difference between market participant and non-participant are statistically significant, except distance from farmland (Table 3).

Education, experience, and age were higher and statistically significant determinants of date market participation in the study area (Table 3). Education enhances farm management, productivity, and marketing through the development of skills and knowledge, thus increasing date marketing. Experience and age capture the effect of social networks and links that accrue over time to improve the search for trading partners and better the marketplace (Sigei et al., 2014).

The frequency of extension contact to market participants was significantly greater than the frequency of extension contact to non-participants (Table 3). This suggests that increased extension frequency increases propensity for market participation and intensity of market surplus. Extension agents provide training on cultivation methods, knowledge about the use of improved palm tree varieties, and support the farmers from land preparing and production up to the marketing of date. Each of these supports may have a positive effect on market participation and marketable surplus.

The market was available 11.16 and 21.36 km away from the producer’s dwelling on average, for participants and non-participants, respectively (Table 3). This result showed that distance to the market had a significant negative effect on the market participation decision of date producers. If the market is far away from the dwelling, producers face higher transaction costs and are not able to get updated market information on time; in general this has a negative effect on market participation and market supply.

Household size was significant, and results reveal that market participants have larger households size compared to non-participants (Table 3), thus emphasizing that this variable has a positive and significant effect on sales decisions. Sufficient availability of labor for production up to the marketing stage may support the farmers to produced more and participate in date marketing.

The amount of palm trees and hectares of land for market participants was statistically and significantly greater than non-participants (Table 3). Palm tree and date farmland are vital inputs for date production. Producers who own many palm trees and large acreages create a chance to produce more date product than their counterparts, and in turn, increase market supply and participation decisions.

The average off-farm income was 4528 and 13579 birr for participants and non-participants, respectively (Table 3). Off-farm income is statistically negatively related to market participation.

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Table 3. Market participation decision with continuous independent variables.

| Variables                      | Participated | Not participated | t-value | Total |
|-------------------------------|-------------|-----------------|---------|-------|
|                               | Mean        | Std.Dev.        | Mean    | Std.Dev. |       |       |
| Education (Year of schooling) | 2.79        | 3.887           | 0       | 0       | -8.28***| 1.82   | 3.410 |
| Experience (Year)             | 31.50       | 10.387          | 24.00   | 2.564   | -8.19***| 28.90  | 9.244 |
| Extension service (Days visiting) | 8.94      | 1.411           | 4.06    | 1.396   | -32.40***| 7.25   | 2.719 |
| Distance to farm land (Km)   | 1.58        | 0.829           | 1.67    | 0.691   | -1.18**  | 1.61   | 0.708 |
| No of palm tree (Number)      | 38.09       | 19.972          | 9.52    | 4.427   | -16.27***| 28.2   | 21.270 |
| Date farm land (Hectare)      | 1.04        | 0.588           | 0.76    | 0.159   | -5.34*** | 0.95   | 0.502 |
| Distance to the market (Km)   | 11.16       | 3.938           | 21.36   | 1.932   | 28.12*** | 14.7   | 5.91  |
| Off-farm income (Brir)        | 4528        | 10250           | 13579   | 18348   | 5.26***  | 10444.2| 16570.2 |
| Ownership of livestock (TLU)  | 38.49       | 12.296          | 59.6    | 0.981   | 16.45*** | 45.805 | 15.620 |
| Household size (Number)       | 7.41        | 1.56            | 5.16    | 1.706   | -12.97***| 6.63   | 1.936 |
| Age (Year)                    | 42.62       | 12.43           | 34.32   | 2.432   | -7.61*** | 39.74  | 10.894 |

***, and ** stand for significance at p < 0.001, and P < 0.05, respectively
Where: Std.Dev (Standard Deviation); TLU(Tropical Livestock Unit)
decisions and market outlays. Off-farm income can mitigate financial constraints for producers, and therefore reduce their willingness to participate in date market.

The average amount of livestock owned by participants (38.49) was significantly lower than non-participants (59.6) (Table 3). A household with livestock will required more time and money for feeding and taking care of the livestock, and may also use their livestock are a solution for households financial constraints (Bekele, 2017). This may cause the farmer to be less likely to participate in the production and marketing of date.

Econometric Results

There was no strong collinearity between explanatory variables, the variance of error term was constant conditional on the chosen value of the explanatory variables, and there were no omitted variables in the model (Tables 4–6). As well, the LR test comparing the Double hurdle model and the Tobit model rejected the Tobit model specification (Table 7). This supported the existence of two separate decision-making stages in which individuals first make independent decisions regarding market participation, and second make decisions on the volume of marketed surplus (Table 7).

Determinants of Market Participation

Four variables (education, off-farm employment, livestock ownership, and access to credit) were found to significantly influence the farmer’s decision to participate in the date market, based on the Probit model estimated in the first step of the Double hurdle model equation (Table 7).

The probability of participating in the date market increased by 0.19 percentage points per year of education in marginal effects, all other factors held constant (Table 7). This finding agreed with the results of (Sigei et al., 2014; Sori et al., 2017), (Ahmed et al., 2016a) and (Abadega, 2021) who found that the education level of the household head has a positive effect on the farmers’ participation decision in the potato output market. (Hagos et al., 2020) also revealed that education is crucial to enhancing market participation rate as it allows producers to obtain new ideas, information, and modern techniques of agricultural production and therefore increases the market surplus. Education enhances skills and knowledge to improve competence in production and marketing processes. Education also allows producers to access more information and new opportunities for their product, and enables them to analyze that information with respect to cost, benefit, and choice of appropriate market channel (Dlamini and Huang, 2019).

Ownership of livestock was found to influence date market decision negatively and significantly (Table 7). Ownership of livestock decreased the probability of participating in the date market by 0.04 percentage points per Tropical Livestock Unit (Table 7). This result was consistent with the results of (Tura et al., 2016) who found that ownership of livestock significantly and negatively

| Variable                     | VIF  | 1/VIF |
|------------------------------|------|-------|
| Education                    | 1.4  | 0.7143|
| Experience                   | 2.56 | 0.3906|
| Current market price         | 1.24 | 0.8065|
| Lagged market price          | 1.39 | 0.7194|
| Extension service            | 2.79 | 0.3584|
| Distance to farm land        | 2.8  | 0.3571|
| No of palm tree              | 1.44 | 0.6944|
| Date farm land               | 2.37 | 0.4219|
| Distance to the market       | 3.23 | 0.3096|
| Off-farm income              | 3.08 | 0.3247|
| Ownership of livestock (TLU) | 2.55 | 0.3922|
| Household size               | 2    | 0.5000|
| Age                         | 1.72 | 0.5814|
| Mean VIF                    | 2.1976 |
influenced the intensity and market participation of teff. A similar result was also reported by (Bekele, 2017) who found the negative influence of large ownership of livestock on the market participation of cattle. Household-owned livestock require time dedicated to feeding, keeping, and grazing animals. Livestock can also be used to mitigate financial constraint, this in turn means that date producers are less likely to participate in date production and marketing. However, this is not true in all conditions, as (Usman, 2016) found that as farmers’ livestock ownership increased, it led to an increase in wheat supplied to the market.

Market participation of date producers who had access to credit was increased by 0.22 percentage points compared to their counterparts (Table 7). This result was compatible with the findings of (Abadega, 2021; Bekele, 2017; Tura et al., 2016). Similarly, a study by (Usman, 2016) showed that access to credit positively and significantly influenced the likelihood of farmers participating in the wheat market. Credit is important for mitigating cash-constraints for producers so that they are able to meet their production activity cash requirements on time. This brings incremental improvements to productivity and production. Farm credit also drives the economic power required for large mechanized farming, by allowing producers to buy advanced and improved inputs of production.

**Determinants of the Intensity of Market Participation**

To determine the factors influencing the intensity of date market participation, a truncated model was estimated in the second step of the Double hurdle model equation (Table 7). Education, extension services, date palm type, access to credit, number of palm trees, farmland, market distance, road access, information, current market price, and market channel to retailer were found to significantly influence the intensity of market participation (sales volume) in the date market (Table 7).

The intensity of participation in the date market increased by 0.25 quintal per year of producer schooling, all other factors held constant (Table 7). This result was in line with the findings of (Dlamini and Huang, 2019; Oyka and Abebe, 2020; Sebatta et al., 2014). (Edward et al., 2012) found that for each additional year in education, the respondents were more likely to increase cassava commercialization intensity because of improved marketing skills and knowledge of market circumstance. Formal education increases the readiness of producers to accept new ideas and innovations, and to obtain supply, demand, and price information; together these enhance farmers’ willingness to participate in markets and increase the value of sales (Bekele, 2017). In addition, educated farmers also develop

| Table 5. Contingency coefficients test. |
|----------------------------------------|
| Palm type | Credit access | Marital status | Market information | Road access | Gender | Market information |
|-----------|---------------|----------------|-------------------|-------------|--------|-------------------|
| Palm type | 1.000         |                |                   |             |        |                   |
| Credit access | −0.2651 | 1.000         |                   |             |        |                   |
| Marital status | 0.0145 | 0.3965        | 1.000             |             |        |                   |
| Market information | 0.3689 | −0.2983       | −0.1547           | 1.000       |        |                   |
| Road access | −0.2456 | 0.1548        | 0.2687            | 0.3154      | 1.000  |                   |
| Gender | 0.4785 | −0.1548       | −0.1548           | −0.1254     | −0.1548 | 1.000             |
| Market information | 0.3658 | 0.2365        | 0.2154            | 0.4125      | 0.2654 | 0.2542            | 1.000 |

| Table 6. Heteroskedasticity and omitted variables test. |
|--------------------------------------------------------|
| Breusch-Pagan test for heteroskedasticity               |
| chi2(1) | 1.8600 |
| Prob > chi2 | 0.9580 |
| Ramsey RESET test for omitted variables                |
| F(3, 367) | 1.63   |
| Prob > F | 0.1815 |

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Table 7. Estimates from the Double hurdle and Tobit models.

| Variables                  | Double hurdle model |                      |                      |                      |
|---------------------------|---------------------|----------------------|----------------------|----------------------|
|                           | Coef.               | Std.Err.             | ME                   | Coef.               | Std.Err.             | Coef.               | Std.Err.             |
| Education                 | 0.56                | 0.092                | 0.19***              | 0.25***              | 0.174                | 0.088                | 0.42                 |
| Gender                    | 0.12                | 0.219                | 0.04                 | 0.61                 | 0.441                | 6.46***              | 1.064                |
| Extension service         | 0.18                | 0.120                | 0.06                 | 0.27***              | 0.040                | 5.72***              | 0.776                |
| Off-farm employment       | −0.49               | 0.299                | −0.16                | −0.03                | 0.019                | 9.12**               | 3.619                |
| Livestock ownership       | −0.13               | 0.082                | −0.04***             | −0.018               | 0.019                | −0.03                | 0.048                |
| Date palm type            | 0.42                | 0.333                | 0.15                 | 0.52**               | 0.240                | 5.45**               | 1.647                |
| Household size            | 0.19                | 0.056                | 0.06                 | 0.35                 | 0.116                | 0.43                 | 0.294                |
| Access to credit          | 0.63                | 0.266                | 0.221***             | 0.62***              | 0.178                | 3.05**               | 1.446                |
| Mrtst                     | 0.81                | 0.417                | 0.621                | 0.41                 | 0.920                | −3.4                 | 2.03                 |
| Distance to farm land     | −0.11               | 0.106                | −0.040               | −0.34                | 0.216                | 0.41                 | 0.534                |
| Age                       | −0.05               | 0.015                | −0.017               | −0.10**              | 0.057                | −0.77***             | 0.101                |
| No of date palm tree      | 0.47                | 0.018                | 0.165                | −0.33***             | 0.155                | −0.86**              | 0.47                 |
| Farm land                 | 0.57                | 0.380                | 0.200                | 0.29**               | 0.057                | 2.94**               | 1.495                |
| Distance to the market    | 0.13                | 0.067                | 0.045                | 0.17                 | 0.059                | −0.41***             | 0.072                |
| Road access               | 0.05                | 0.338                | −0.017               | −0.10**              | 0.057                | −0.77***             | 0.101                |
| Experience                | 0.05                | 0.349                | −0.017               | −0.33***             | 0.155                | −0.86**              | 0.47                 |
| Off-farm income           | 0.05                | 0.023                | −0.019               | −0.34***             | 0.054                | 0.10**               | 0.055                |
| Market information        | 0.05                | 0.019                | −0.019               | −0.54***             | 0.009                | −0.54***             | 0.009                |
| Current market price      | 0.05                | 0.029                | −0.029               | −0.54***             | 0.009                | −0.54***             | 0.009                |
| Lagged market price       | 0.05                | 0.029                | −0.029               | −0.54***             | 0.009                | −0.54***             | 0.009                |
| Mktcha = Retailer         | 0.05                | 0.029                | −0.029               | −0.54***             | 0.009                | −0.54***             | 0.009                |
| Mktcha = Consumer         | 0.05                | 0.029                | −0.029               | −0.54***             | 0.009                | −0.54***             | 0.009                |
| Constant                  | −0.71               | 0.13                 | −0.401               | −0.401               | 0.200                | 12.01                | 11.896               |
| Sigma                     | 0.97(0.090)         |                      | 7.97(0.721)          |                      |                      |                      |                      |
| Log-Likelihood            | −679.7              |                      | −841                 |                      |                      |                      |                      |
| Prob > chi2               | 0.0000              |                      | 0.0000              |                      |                      |                      |                      |
| Pseudo R2                 | 0.31                |                      | 0.207               |                      |                      |                      |                      |

ME denotes the marginal effect of the explanatory variables***, ** and * indicates statistically significant at p < .001, p < .05, and p < .1, respectively.

know how to diversify their source of income and improve family living standards. (Kefyalew, 2012) found that farmers with higher levels of education tend to have greater access to product and market information, hence expect to produce market-oriented cash crops.

The coefficient of access to extension services was statistically significant and positively related to a household’s intensity of market participation (Table 7). Farmers increased the proportion of date sales by 0.27 quintal per extension contact (Table 7). The result was in line with the work of (Belayneh et al., 2019; Kassa et al., 2017; Rehima and Dawit, 2012; Tarekegn and Yosefe, 2017) who mentioned that access to credit had a positive and significant association with market intensity. Extension workers provide new techniques and market information, training on cultivation methods, up-to-date information on agricultural technologies like improved varieties, recommended uses of fertilizer and pesticides, and support land preparations up to the point of marketing (Mulatu, 2021). This in turn increases productivity and market outlay of date.

Farmers who had access to credit had a marketable supply of date 62 quintals greater than their counterparts, ceteris paribus (Table 7). This result resembled the results of (Kassa et al., 2017; Kefyalew, 2012; Muzemil, 2020). (Bekele, 2017) also revealed that access to credit positively affects the supply of cattle to market. This is because farm credit is a crucial source of finance for promoting farm productivity and yielding marketable surplus, which in turn, increases the farmer’s propensity for market entry and the extent of market participation (Dlamini and Huang, 2019).

Date producers who had access to market information increased marketable supply by 0.68 quintals compared to their counterparts (Table 7). This finding corresponded with research by (Ahmed et al.,
improves with because proximity increased (increased outputs relively, in quintal place, and; 2016a, Table Table Table, -2016a, Table Table). The Marketing Date of farmers, direct of who market between travel time, and without access to market information, negatively and significantly (Table 7). As the distance between the marketplace and a farmer’s dwelling increased by 1 km, participation of market intensity decreased by 0.33 quintal (Table 7). Previous studies have found a negative effect of market distance on the level of market participation (Regasa et al., 2019; Tura et al., 2016). According to (Edward et al., 2012), distance to market is an indicator of travel time and an increase in transportation cost leads to decreasing market outlay. Long distances between the market place and farmers’ dwellings increase transaction costs, reduce access to updated market information, and force farmers to sell their products at the farm gate price (Tarekegn and Yosefe, 2017). Each of these factors makes the farmers less likely to participate in the production as well as the market outlay of date.

Date producers with access to road infrastructure increased their amount of date supplied by 0.29 quintal relative to their counterparts (Table 6). Most of the population in the study area were dwelling in rural and remote areas without access to transportation (Table 2). (Kassa, 2015) noted that proximity to the main road would enable better access to information about the market, leading to increased market outlay of fruit. Road access affected maize intensity of market participation positively, because timely labor input was available during peak harvesting season and output disposal, and because it was more easy to access extension services (Mulatu, 2021). Road infrastructure is important for farmers to reduce transaction costs, access market information, meet the customer on time (date is a perishable product), and sell the product at market price rather than farm gate price; all of this improves productivity and encourages farmers to supply the market (Tarekegn and Yosefe, 2017).

As the price of date increased by a birr per kg, the marketed supply of date increased by 0.05 quintal (Table 7). (Abadega, 2021) found that as price increased by one birr, the amount of potato sold increased by 0.04 quintal. Similarly, (Lefebo et al., 2016) showed a positive and significant relationship between bulla price attractiveness and the intensity of market participation for bulla. Output price is the ultimate incentive for sellers, because as the farmers receive a high market price for date output, they are eager to produce more and increase the market surplus (law of supply) (Muzemil, 2020).

Marketing channel refers to the sequence of intermediaries and markets through which date outputs pass en route from producer to final consumer. Selling date products to the final consumer increased the intensity of market participation by 0.6 quintals compared to wholesalers and retailers (Table 7). This result was consistent with the results of (Dlamini and Huang, 2019; Sori et al., 2017) who found that product sold to the final consumers significantly and positively influenced the intensity of market participation. If date producers transact with final consumers, they will have the possibility of have greater bargaining power and can charge an attractive price (Ahmed et al., 2016b). Therefore, direct to consumer market channels offer higher prices and promote the intensity of market participation. However, selling products to wholesalers and retailers leads to loss of bargaining power for producers, because such trade partners have more experience and price negotiation skills compared to final consumers (Dlamini and Huang, 2019).

The average land allotted for date production was less than 1 ha (0.95) in the study area (Table 3). As the area of landholding by farmers increased by 1 ha, the quantity of date supplied to the market increased by 0.43 quintals (Table 7). This result corresponds with results from other studies (Abadega, 2021; Hagos et al., 2020; Kaso, 2015). The land is one of the most important inputs of production and a means to increase the yield of marketed supply (Sori et al., 2017). Larger areas of land are associated with higher productivity and intensity of market participation for wheat (Usman, 2016).
Date producers who used improved date palm varieties increase the intensity of their market participation by 0.52 quintal, relative to local date palm users (Table 7). The introduction and adoption of improved date palm brings pest-resistance/tolerance that improves the production and productivity of date palm (Aregawi Lemlem et al., 2018, 2019). Local date palm variety users produced 26 to 45 kg date per tree per year; on the other hand, date producers who planted improved date palm varieties recorded yields ranging from 71 to 80 kg date per tree per year (El Bouhssini et al., 2018).

The number of palm trees influenced the market intensity negatively and significantly (Table 7). As the number of date palm tree increased by one, market outlay of date decreased by 0.1 quintal. This might be due to the fact that, in the study area, the average land allotted to date was 0.95 ha (Table 3). Planting date palm over and over with this existing limited amount of land may lead to reducing soil fertility, productivity and market supply, along with diminishing marginal returns (Aregawi Lemlem et al., 2018).

**Conclusion and Recommendations**

The objective of this study was to analyze the determinants of market participation and the intensity of date production in the Afar regional state of Ethiopia. Accordingly, the findings of the study showed that the extent of market participation was 65%. This implies that date is the major cash crop produced in the study area. The Double hurdle econometric model estimated that date producers with access to extension service, improved date palm tree varieties, credit, road infrastructure, market information, large areas of land, better market price, better educational status, and direct to consumer market channels were more likely to participate in and supply the date market. Whereas producers who had livestock, dwellings far away from the nearest market, and higher numbers of date palm trees, were adversely affected in their market participation and intensity.

To these ends, the results of this study suggest that developmental policies and program interventions are required for establishing, improving, and strengthening agricultural extension services, rural education, and rural road infrastructure. Regional as well as federal responsible bodies should provide improved date palm tree varieties, credit access, and additional hectares of land for date production. Rural and national development frameworks should establish market centers and institutional supports closer to farm dwellings in order to provide producers with updated market information and stronger bargaining power. These improvements will help the producers to sell their output at a relatively higher price and directly to final consumers. Lastly, extension service providers and other responsible bodies should advise producers about the recommended scientific amount of date palm trees to plant per hectare, and introduce new practices to strengthen mixed farming system.

The significance of this study is to incite policy recommendations on factors that drive participation in the date market within Afar, Ethiopia. However, this work simply give more emphasis quantitative data analysis on assess market and market-related issues in the research domain. Therefore, utilizing this work as a starting point, future research is advised to include a thorough value-chain analysis based on mixed research techniques.

**Disclosure Statement**

No potential conflict of interest was reported by the author(s).

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