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Determinants of Red Pepper Productivity in Wera Woreda, Halaba Zone, Southern Nation Nationalities and Peoples Region (SNNPR), Ethiopia.

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Abstract

Ethiopia has favorable climate and soil conditions for cultivating red peppers. This allows the nation to be the leading pepper producer in Africa, holding significant value for both local and export markets. The objective of this study is to examine determinants of Red Pepper Productivity in WeraWoreda, Halaba Zone in Ethiopia. it used a mixed research approach to collect and analyze from 338 farm household. Questionnaire was used as tools of data collection. The Data were analyzed by descriptive statistics and OLS (Ordinary Least square) Regression model. The study used the total red pepper output per hectare and estimated amount used as total productivity measures. The result showed that about 6.57quintals of red pepper per hectare produced in the study area. The finding indicated that sex, age, education level of farmers, land size, oxen in hour, off farm income, seed variety, seed amount, credit access and extension contact are found to be a positive determining factors of red pepper productivity. On the other hands, Red pepper disease, Family size, marketing information and Slope of farm land are negative and statistically significant variables which affect red pepper productivities. Thus, the policy makers should work on accessing smallholders' farmers to agricultural input such as seed Varity, pesticides and crop medicine, accessing for different off farm activities, access more marketing information and create strong institutional support for credit access to increase red pepper productivity in Wera woreda.

Keywords: *Red pepper, Productivity. OLS, Wera, Woreda.*

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1. Introduction

Agricultural advancement is a key instrument to eliminate severe poverty, enhance shared wealth, and nourish an anticipated 9.7 billion individuals by 2050. Agriculture plays a vital role in economic development, accounting for 4% of global GDP and contributing more than 25% of GDP in some of the least developed countries. (World Bank, 2023). Agriculture is also the dominant sector and continues to be an anchor of development for worlds' population especially, in developing countries. Increasing agricultural production and productivity has been the world's primary agenda to ensure increased food supply by using the existing limited land resource by employing improved agricultural inputs to feed the rapidly growing population in developing countries in general and Sub-Saharan Africa (SSA) in particular.(World Bank, 2007; Bechdol et al., 2010; Geleto&Essa, 2022).

In numerous developing nations such as Ethiopia, it is regarded as a critical tool for fostering growth and sustainable development, reducing poverty, and improving food security. The significance of agriculture in Ethiopia is reflected in its contribution to GDP (43%), job creation (80%), export share (70%), and supplying approximately 70% of the raw materials for the nation's industries (Abate et al., 2019; Keba, 2022).Nonetheless, it is marked by low productivity as a result of technological and socioeconomic influences. Primarily, farmers possessing similar resources generate varying outputs per hectare due to minimal input usage, limited adoption of modern farming technologies, reliance on traditional agricultural methods, inadequate supportive and infrastructural service provision such as extension, credit, marketing, roads, and ineffective agricultural policies (Abraham et al., 2014; Tadie et al., 2019). To change the situation, the Ethiopian government has created the Growth and Transformation Plan (GTP-I) and (GTP-II) for the five-year periods (2011–2015) and (2016–2021) respectively.

Pepper originated from the regions of Mexico and Central America and later spread to Africa and Asia. It is the most significant spice globally, offering nutritional benefits to consumers, especially vitamins A and E, while enhancing flavor and coloring food (Alene, 2010; Banchamlak&Seble., 2022; Hamida et al., 2024). Likewise, the leading five red pepper producing countries in Africa include Madagascar with a yield of 6,981 tons, followed by Ethiopia at 4,511 tons, Ghana at 3,767 tons, Rwanda at 2,535 tons, and Uganda at 2,063 tons. Ethiopia features various agro-ecological regions that support horticultural crop production for local, national, and international consumption and commercial use. Over 14 varieties of spices are cultivated in the country, including red pepper, paprika, turmeric, fenugreek, garlic, korarima, coriander, capsicum, ginger, cardamom, black cumin, white cumin, and basil (Girma et al., 2008; Dessie et al., 2019).

The utilization of red pepper in Ethiopia may be among the earliest of any vegetable product. Ethiopians have a deep connection to red pepper, which holds significant value mainly for its intense spiciness. The finely ground aromatic substance is a crucial flavoring and coloring component in the widely used traditional sauce "Wot," while the green pod is eaten as a vegetable alongside other dishes. Many Ethiopians believe that someone who regularly eats hot pepper has increased resistance to different illnesses. The average daily consumption of red pepper by Ethiopian adult isestimated15 gram, which is higher than tomatoes (Ibsa,A., 2019;Gebresilassie& Israel., 2023).

In Ethiopia, vegetable cultivation accounts for 1.64% of the total area devoted to all crops nationwide. Of this vegetable-growing area, a significant majority takes 73.13% is dedicated to red pepper production.

Red pepper is extensively growna cross various agro-ecological regions of Ethiopia. A separate study conducted on the spice market potential in Amhara, Oromia, and SNNPRS found that the land area dedicated to pepper cultivation in these three regions is very high.(CSA, 2017; CSA, 2020&Shimelis, 2021). These areas produce large amount of red pepper for their consumption and commercial purposes to deficit area. As reported by Alemayehu et al., 2012, since 2000 there has been significant expansion in pepper cultivation, including area planted, yields, and productivity; however, yields remain low compared to global benchmarks, and overall productivity is extremely vulnerable to climatic shocks, especially drought.

Besides, the trends of production and productivity level of red pepper in Ethiopia showed little increase from 1.63 ton per hectare in 2007 to 1.84 metric ton per hectare in 2015.Nevertheless, the necessary level of productivity is not reached because of several limitations. The yields recorded for the years 2011 and 2015 were 2.201 and 1.84 tons per hectare, respectively (CSA, 2016; Gezahegn, 2020). The primary obstacles that impede the realization of high output levels include the use of saved seeds, diseases, and a lack of pesticides for pest control. Likewise, key factors that led to low productivity of pepper in Ethiopia include the scarcity of enhanced seed varieties, insufficient and appropriate inputs (such as pesticides), and the absence of superior varieties of red pepper. In addition, shortage of irrigation system, low rainfall, disease and pests adversely affect red pepper productivity, improper use of farming land and rainfall dependent agriculture are the main influential factors for low red pepper productivity (Ahmed et al., 2013;Degineh et al., 2020;Rahayu et al., 2023). To tackle these issues, the research aimed to respond to two questions: what are the key factors influencing red pepper productivity and what are the primary challenges faced by farmers in enhancing their red pepper productivity in WeraWoreda

2. Literature Reviews

Theoretically, Economic Theory of Production is an economic framework that analyzes how individuals transform resources such as labor, capital, and raw materials into products that are goods and services. It provides a critical basis for understanding the Optimization of Resource Utilization and making decisions about resource combinations, production levels, and technology adoption (Varian, 1992: Getamesay et al., 2023). It enables to analysis the use the theory to estimate how changes in input prices, amount, technology and policies affect production and productivities for long-term strategic planning by identifying the optimal scale of production (Smirnov and Wang, 2021).

To tackle these problems, the research examined various production function theories, including the Cobb-Douglas production function theory, which illustrates the connection between output and production inputs (commonly referred to as factor inputs). It is employed to assess the relationships between inputs for optimized production and to analyze technological advancements in production techniques (Onalan & Basegmez, 2018; Smirnov & Wang, 2021). Secondly, the theory of production with constant elasticity of substitution is a neoclassical production function that indicates a consistent elasticity of substitution. In other terms, in a production technology, the ratio of inputs(like labor and capital) varies at a consistent rate because of changes in the marginal rate of technological substitution(Tabe-Ojong&Molua, 2017: Gautam, 2024).

Fixed-rate production function theory is also a type of production function in which inputs are used in a fixed proportion to produce output. This theory assumes that there is a strict relationship between the quantities of labor, capital, materials, services etc. and the output. This means that in order to increase production, it is necessary to increase all entries at the same speed, taking into account the fixed ratio. This is a scenario where it is impossible to replace the entry or the replacement rate is zero (Smirnov & Wang, 2021: Orolando, G., 2023). Among these theories, the Cobb-Douglas production function theory is more suitable for estimating productivity in agricultural production due to its high flexibility in using one or more variables in partial or total productivity measurement. It is based on the assumption of substitutability of factors and ignores complementarity of factors. Moreover, it only works if economies of scale are constant. Finally, it becomes possible to measure agricultural productivity as a partial measure that captures the returns to individual inputs. For example, crop yield (production volume/land area).

Empirically, various researchers have conducted studies to investigate the factors influencing red pepper production and productivity in developing countries(Adeoye, et al., 2014; Hossain , 2016; Asravor, et al., 2016; Fatima et al., 2017; Arya, et al.,2019; Hayran&Gul , 2019 ; Rosli, et al., 2020;Lidya et al ., 2023; Hamidaet al., 2024 From their finding, the variables of extension contacts to farm households, off-farm income, cooperative partnership, credit usage, record keeping, and soil test ,Oxen, fertilizer application, credit access, plots of land are the main determinants of red pepper production and productivity in their study areas.

In Ethiopia, various studies have explored the primary factors influencing red pepper cultivation and yields across different regions and study areas. Based on those studies (Rehima&Dawit., 2012;Bayisa et al.,2017;Dessie,et al.,2019;Dagnaygebaw& Tariku., 2019;Girmalem et al.,2019; Ibsa,A.,2019;Kibret, &Abebo, 2019; Tadieet al., 2019; Tesfay&Tadele, 2019; Wubalem., 2019; Deginehetal., 2020; Geleto& Essa,,2022;Shimelis, 2021; Banchamlak&Seble,2022; Mulualem, 2022;Gebresilassie& Israel, 2023) are the main one. The studies found that red pepper productivity is influenced by factors of demographic, socioeconomic, Institutional, Environmental and physical factors in general. Thus, many of the aforementioned studies identified the main determinants of red pepper production and productivities in general aspects. None of them showed that different challenges for affecting red pepper productivities: many of studies considered very few explanatory variables for their works, few of them studied for other agricultural products without considering environmental issues such as different soil types for the same fertilizer uses, slope of land and some of them did not considered different agro ecological type for their production activities. Besides, none of study conducted in WeraWoreda for red pepper productivity in WeraWoreda contexts, major factors and challenges for red pepper productivity in detailed.

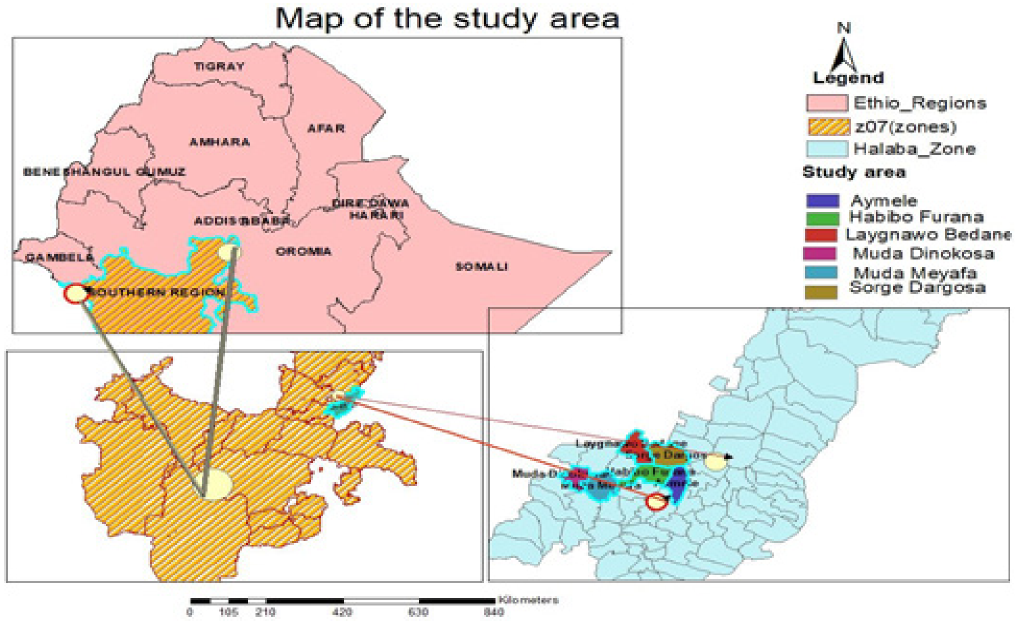
Additionally, this research aimed to pinpoint other research gaps and issues within the study area, advocated for more empirical studies utilizing larger sample sizes with extensive study area coverage for this study. Therefore, it tried to fill those above mentioned gaps by using existing literatures from different studies and conducting study of determinants of red pepper productivity in WeraWoreda, Halaba Zone in Ethiopia.

3. Research Methods and Materials

3.1. Description of the Study Area

The study was conducted in WeraWoreda in Halaba zone Of Ethiopia. It is one of the southern nation, nationality and people regions (SNNPR). The Zone is divided in three woredas and one city administrations. Based (CSA, 2020) Halaba zone has total population of 356,131 people, of which

180,081 men, 176,050 are women and the total household is 69,845.Wera is one of Woreda found in Halaba zone of the SNNPR, bordered by WeraDjoworeda in the North, SanekuraWoreda, in the west ,AtuoteAuloworeda, in the south and BadawachoWoreda in the East.The administrative center Weraworedaisaway245 Km from Addis Ababa on the southern part of Ethiopia, 90 km of from region capital city of Hawassa.



Source: GIS areal Map for study area, 2021.

Figure 1: Map of the study area

The total population for weraWoreda was estimated from the (CSA, 2020) is 124,009 of which 60,764 are men and 63,245 are women, and the total household is 19,179. The area can be divided into three primary climatic zones according to altitude, rainfall, and temperature: 28.17% Dega, 0.17% Woina-Dega, and 71.66% Kolla of the region's overall extent. The average yearly temperature ranges from 23 to 25 °C. Precipitation varies from 857 to 1085 mm. Farming is the primary economic pursuit, and the area features diverse ecological zones from lowland to highland, allowing for the growth of different crops (HZBoA, 2021). The main economic source of livelihood is based on both crop productivity and livestock rising. Crops which are grown for food consumption as well as for income source in the area are red pepper,.

3.2. Sampling Techniques and Estimation

Multistage sampling method used to choose participants among red pepper farmers in the research area. In the first stage, purposively WeraWoreda was selected and from three Woreda of Halaba Zone due to high potentials of red pepper production. The study area has similar agro-ecological and demographic conditions. Out of 32 rural kebeles administration in WeraWoreda, 18 red pepper producer kebeles were selected. In the second stage, a total of four sample kebelesfrom 18 red pepper producer kebelesin the woreda were randomly selected. Four enumerators, including the researchers, were hired to gather data. The choice depended on their proficiency in halabgia and Amharic, an educational background of at least twelve grades. Therefore, the study used Yamane for sample size estimation. The Yamane formula was formulated by a Japanese-American economist known as Yamane Taro in 1967. It is used statistically to define the finite population in research methods. A finite population is a population whose size can be determined. The formula is mainly used to determine the size of a sample from a heterogeneous population. Thus, the study used this formula for three reasons: the formula gives a reasonable amount of sample that can be studied in a population. Secondly, it is easier to utilize for sample size calculation than other sample size determination methods, and it is the most commonly used formula for calculating sample size when the population number is limited(Yamane1967: Emaikwu, 2013).It can be estimated as

$$n = \frac{N}{1 + N(e)^2} = \frac{2,219}{1+2,219(0.05)2} = \frac{2,219}{6.55} = 338Hhs$$

Where: n = 338, number of sample size selected from N= 2,219 ,e = 0.05, error of margin with 95% level of precision or confidence level.

Table 1: Sample Distribution.

No	Kebele names	Total households	Total hhs*0.1523=338/2219	Sample hhs
1	MudaMeyafa	533	533*01523	81
2	Aymele	536	536*01523	82
3	HabiboFurana	620	620*01523	94
4	LaygnawoBedane	530	530*01523	81
Total		2,219hhs		338hhs

Source: Wera Districts Agricultural Office and Own computation, 2023.

3.3. Source of Data and Methods of Data Collection

Data were generated using both primary and secondary sources. The data set included comprehensive details on the demographic traits of households, characteristics of farms, use of inputs, outputs generated, and variables related to institutions. A semi-structured interview framework encompasses land area for red pepper, yield obtained from red pepper fields, fertilizer and oxen power consumption, seed quantity, and overall labor employed in various farming tasks for red pepper productivity (cross-sectional data from the crop year 2020/2021). Additionally, secondary data were gathered from research undertaken and records compiled at different tiers of the Central Statistical Agency and Agriculture and Development Offices within the study region.

The data collection procedures involved: first, the questionnaire was developed in English, followed by translation into Amharic and then translated back to English to ensure language consistency. Secondly, all data collection instruments underwent pilot testing to ensure their reliability and validity prior to the actual data gathering. Thus, based on the pilot study data, reliability was assessed using Cronbach's alpha, which yielded a value of 0.764, signifying strong reliability. The outcome, which is founded on the minimum acceptable value of 0.7 for Cronbach’s alpha test, indicated that the result was satisfactory

3.4. Model Specification and Estimation

The economic concept of production serves as the basic analysis for many studies aimed at evaluating production and productivity. To address this issue, production functions were used to understand and evaluate the relationship between the resources used in the production process and the products produced (Varian, 1992). Therefore, the Cobb-Douglas production function serves as one functional form for our study model. It is a specific type of production function commonly utilized to depict the technological connection between the quantities of two or more inputs (Labor, capital, land, and Entrepreneurship) and the output that can be generated by these inputs. It may also serve to determine the production quantity based on a specific level of input utilization (Varian, 1992: Getamesay et al., 2023) Thus, The function consider all the factors of productivity like Labor, capital, etc

$Yit = A (Lit\beta1 \; Kit\beta2)\mu\mu it$-- (1)

Where: Yit= represents the value of the total farm output from the ith household in Qt during Period t.

Lit represents the ith labor input utilized in time period t.

Kitis represents the ith capital inputs during a time t

β1 andβ2 are denotes slope of labor and capital

μit is denotes the residual term

Transforming equation (1) into its logarithmic form yields:

$lnYit = \beta0 + \beta1lnLit + \beta2lnKit + \mu it$--- (2)

Where, lnYit = the logarithm of total agricultural output generated by ithhhs in time period t,

lnLitis denotes the ithhousehold Red pepper labor use during period t

lnKitis denotes the ithhousehold Red pepper capital use during period t

β0is denotestheIntercept

μitisdenotesthe residual term

From Equation (2) moves to equation (3), we can easily derive red pepper productivities formula. It can be calculated by dividing total production per hectare from where the production came as follows $ln (Yit/h)=\beta0+ \beta iXit+ \mu it$---(3)

Where: ln (Yit/h)= is the dependent variable natural log of Red pepper output/Hectare is denotes all independent variable.

βi is Slope; β0 is denotes Intercept; μitis denotes the residual term

Finally, the following model was developed as the final version by applying various assumptions of economic theory and estimating using multiple linear regression model taking into consideration its applicability, quantitative analysis capabilities, ability to pinpoint important factors, control of relevant variables, assessment of model fit, ease of interpretation and ability to test key assumptions (Gujarati, 2009): Hence, this study used ordinary least squares (OLS) regression model for estimation.

ln (Yit/h)= β0 + β1Sex +β2 Age + β3 Education + β4Family Size+β5Land size+ β6Fertilizer +β7Red pep disease +β8Oxen + β9Labor inhr + β10TLU + β11Off Farm In + β12Seed Var+ β13Seed +β14Credit Access+β15Extension + β16Mark Infor+ β17Soil ferti +β18Slope+ ui---(4)

Where: Where: Annual red pepper production/Hectare

To address the red pepper productivity at farm household level in WeraWoreda considered eighteen explanatory variables are the main determinants of red pepper productivities model

Table 2:Nomenclature variables, classification, explanation, and anticipated indication

No	Variable	Type	Description of variables	Expected sign
1	Sex	Categorical	1 if the HH head is male, and 0 if not	+
2	Age	Continuous	Age of the Household Head	-
3	Education	Ordinal	Educational attainment of Agricultural Family	+
4	Family size	Continuous	Count of household members	+
5	Land size	Continuous	Land size for red pepper production	+
6	Fertilizer use:	Categorical	1 if uses fertilizer and 0 otherwise	+
7	Red Pepper disease	Categorical	1 if there is red pp disease at least one type and 0 otherwise	-
8	Oxen	Continuous	Oxen power in hour	+
9	Labor	Continuous	Labor in man-Day	+
10	TLU	Continuous	Estimated of Tropical livestock unit.	-
11	Non-farm income	Categorical	1 if the farmer earns income from outside the farm and 0 if not	+
12	Seed Varity	Categorical	1 if the farmer used seed Varity and 0 otherwise	+
13	Seed	Continuous	Amounts of seed in KG	+
14	Access to Credit	Categorical	1 if the household has accessed credit, and 0 if not	+
15	Numbers of Extension Contact	Continuous	The frequency of extension workers contacts	+
16	Market Information	Categorical	1 if the household possesses market information and 0 if not	+
17	Soil fertility	Categorical	1 if the soil is fertile and 0 if not	+/-
18	Slope	Categorical	1 if the land has a slope and 0 otherwise.	+

Source: Own Computation, 2023.

4. Results and Discussion

4.1. Descriptive analyses

The research employed continuous and binary variables for its descriptive analyses. For the continuous variable, we take into account the average of the variables and their standard deviation, representing the dispersion or spread of variable(s), while for categorical variables, we utilized the frequency count of their occurrences and percentages. Survey findings indicate that the ages of household heads involved in the study varied from 28 to 64 years, with a mean age of 42.23 years. The typical household size was 6.46, with a low of 2 and a high of 14. The total count of individuals and their arrangement within the household influence the availability of labor force necessary for red pepper production. The typical land area owned by the sample farmers in the study region is around 0.94 hectare for each household. The smallest and largest size of land ownership was 0.25 hectare and 3 hectare, respectively. An additional key input variable for red pepper yield is chemical fertilizer (both Urea and DAP), with farmers applying an average of 415.17 kg per hectare. Additionally, the least and greatest quantity of chemical fertilizer utilized was 100 and 1250 kg per hectare.

Table 3: Descriptive analysis for continues variables

No	Name of Variable	No of Observation	Mean	Std. Devation	Minimum	Maximum
1	Age	338	42.23	6.653587	28	64
2	Family size	338	8.46	2.204662	1	14
3	Land size	338	0.94	0.452490	0.25	3
4	Fertilizer	338	415.17	202.8478	100	1250
5	Oxen in hour	338	153.18	34.32255	84	288
6	Labor in Hour	338	4332.09	3800.78	222.4	42229.5
7	TLU	338	6,26	2.183986	2.46	18.78
8	Seed	338	8.46	3.936439	2	24
9	Extension Contact	338	2.05	0.8279933	1	4
10	Red pepper output	338	6.57	3.630074	1	24

Source: Own Computation, 2023.

A farmer used on average hours of labor used during red pepper production season was 4332.09 hours with standard deviation 3800. The use of oxen power by the selected farmers was calculated by considering daily work duration of 8 hours for each pair of oxen. The farmers utilized oxen power between 84 to 288 hours with a team of oxen. The average oxen power utilized by the sampled farmers was 153.18 oxen hours. The study also indicates that the average red pepper seed used was 8.46 kg with the ranges of 2 kg on the minimum and 24 kg per hectare on the maximum. The average number of extension workers contact made by extension experts with red pepper farmers for crop related information is 2.05 ranging from 1 to 4. The Tropical livestock unit of the sample respondent was 6.26 TLU in average and ranges from 2.46 to18.78. Finally, the survey findings show that the mean output of red pepper was 6.57 quintals per hectare and it ranges from 1 to 24 quintals per hectare. This demonstrates that there is significant diversity in the results produced by farmers.

Table 4 indicates, sex of the respondents of red pepper farmers out of 338 respondents 220(65.09%) are male headed and 138(34.91%) are females. It shows that most of respondents are male headed. It indicates that, there is a significantly greater male composition than female in participation of red pepper farm participation. Out of 338 households, the education level of farm households ranges Unable to read and write 177(52.37%), Education at the primary level comprises 86 (25.44%), while those with secondary school and higher account for 75 (22.19%) respectively. In terms of off-farm income, 179 (52.96%) of the surveyed farmers engaged in non-farm activities to earn additional income, while 159 (47.04%) did not take part in such activities. In seed variety users, only 159 (47.75%) of the participants utilized the improved seed variety for their red pepper cultivation.For Red pepper disease, the survey revealed that approximately 204 (60.36%) respondents acknowledged the presence of red pepper disease on their farms, while the remaining did not report any occurrence of the disease on their land.

Regarding access to credit, approximately 144 (42.60%) of surveyed farmers indicated that they did not receive credit from lending institutions, while the other 194 (57.40%) of sampled households did obtain credit. From the findings, approximately 254 (75.15%) of the sampled farm households lacks detailed information regarding all marketing activities related to their red peppers. In conclusion, 283 (83.73%) of the respondents indicated that their soil type is fertile and only 55 (16.27%) reported that their soil type is not fertile.

Table 4: Descriptive analysis for categorical variables

No	Variable name	Category	Frequency	Percent
1	Sex	Female	118	34.91%
		Male	224	65.09%
		Total	338	100.00%
2	Education	Primary	117	54.37%
		Secondary	86	25.44%
		Tertiary	75	22.19%
		Total	338	100.00%
3	Red pepper disease	No	134	39.64%
		Yes	204	60.36%
		Total	338	100.00%
4	Non- farm income	No	159	47.04%
		Yes	179	52.96%
		Total	338	100.00%
5	Seed Varity	No	179	52.96%
		Yes	159	47.04%
		Total	338	100.00%

6	Access to Credit	No	144	42.60%
		Yes	194	57.40%
		Total	338	100.00%
7	Mark information	No	254	75.15%
		Yes	84	24.85%
		Total	338	100.00%
8	Soil fertility	No	55	16.27v
		Yes	283	83.73%
		Total	338	100.00%
9	Slope	No	156	46.15%
		Yes	182	53.85%
		Total	338	100.00%

Source: Own Computation From Field Survey Data, 2023.

4.2. Determinants of Red pepper Productivity

Prior to executing the OLS regression model, various post-estimation diagnostic tests were conducted to verify the effectiveness of the chosen model utilizing the STATA 14.0 software package. The Spearman matrix or diagonal correlation coefficient matrix was estimated to test the presence of multicollinearity problems between discrete explanatory variables. Its results were less than 0.80, indicating that there was no multicollinearity problem. The Breusch-Pagan test is also utilized to check for heteroscedasticity, indicating the absence of constant variance in εi. The outcome of the Breusch-Pagan test is Chi2 (1) = 22.08 with probChi2 = 0.000. This shows that we must reject the null hypothesis of equal variances of the error terms since the p-value exceeds 0.05. Consequently, the research addressed this issue in the model by making standard errors more robust for reliability

In the case of normality, normality of residuals must be checked to ensure the results are valid and reliable. Residuals represent the disparities between the actual and estimated values of the response variable, indicating the accuracy of the model's fit to the data. The normality of residuals implies they are symmetrically distributed around zero, lacking skewness or excess kurtosis. This indicates that the model identifies the key patterns and sources of variability in the data, with errors being random and independent. Therefore, for our regression analysis considered/assumed the residuals are normal, random and independent terms due to the study used large number of sample size for its regression.

Furthermore, this study was examined in the Ramsey test to check whether variables in the model were missing or not. It is used to test for endogenous problems. The results show f (3, 316) and prob 0.1556. This indicates that it is not statistically significant, indicating that the selected model does not reject the null hypothesis in response to not abandoning the variables of the model or indirectly endogenous problems. Besides, model fitness was assessed through R-squared or coefficient determination, indicating that the dependent variables in the model were 71.12% by all independent variables. Therefore, the model is effective in determining variables that consider the productivity of red pepper in the research field considerably After checking the diagnostic test and identifying the main factors that affect red pepper productivity by the OLS model, Table 5 revealed that, Sex, age of hhs, Hhs education level, land size, Fertilizer, red pepper diseases, Oxen in hr, off farm income, seed Varity, seed amount, extension contact, Access to credit, marketing data, and land slope are statistically significant factors influencing red pepper productivity in the study area at both 1% and 5% significance levels On other hands, Labor in hour, TLU and soil fertility are statistically insignificant variables for Red pepper productivity. Therefore, the discussions are:

Sex: The coefficient for the sex of the household head is positive and statistically significant at the 5% probability level. It suggests that male-headed households are more inclined to generate higher quantities of red pepper compared to female-headed households. This indicates that when the household head is male, with other factors unchanged, the likelihood of red pepper productivity increases by 5%. It may be women have limited access of land red pepper production in the study area. This outcome aligns with the discovery made by Bayisa et al., 2017; Ibsa, A., 2019 &Gebresilassie& Israel, 2023

Age: The coefficient for age is positive and holds statistical significance at the 1% probability threshold. The findings show that with an increase in household age, the likelihood of red pepper productivity rises compared to that of younger households. This indicates that, if the age of the household rises by one year while other factors remain unchanged, the likelihood of red pepper productivity grows by 1%. This may occur because as the age of the household head rises, they gain more and more experience in activities related to red pepper productivity. This result is consistent with the finding of Asravor, et al., 2016: Arya, et al., 2019&Hamidaet al., 2024.

Education: The coefficient for the level of education in households is positive and has statistical significance at the 1% probability level. It demonstrates that households led by individuals with higher education are more inclined to produce a greater quantity of red pepper compared to those with less education. This indicates that when households transition from primary to secondary or from secondary to tertiary education, while holding other factors constant, their red pepper productivity rises by an average of 4%. This may be because education enhances the production and productivity of red pepper more than in households with lower education levels, thereby boosting red pepper output. This result aligns with the studies of Hayran&Gul, 2019 and Rosli, et al., 2020.

Land size: The coefficient for land size is positive and statistically significant at the 1% probability level. This indicates that an increase in farm land size by one hectare, while other factors remain unchanged, leads to a 21% rise in red pepper productivity. This indicates that possession of more farm land leads to produce more production of red pepper by using different inputs for their big lands, uses mechanization and other technologies for their red paper production than less land holders. This finding is similar to works of Hossain , 2016: Tadieet al., 2019&Banchamlak&Seble, 2022.

Red pepper disease: The coefficient of red pepper dieses is negative and statistically significant at the 1 % probability level. This means that, if there is at least one type of red pepper disease in production activities, keeping other variables constant, and the red pepper productivity declines by 5 %. This can be due to the different red pepper disease directly affects the production and productivities of the red pepper in the study area. The result aligns with the studies of Hossain , 2016; Tesfay&Tadele, 2019: Girmalem et al.,2019&Orolando, G., 2023.

Oxen in hour: The coefficient for oxen is positive and statistically significant at the 1% probability level. This indicates that if the number of oxen increases by one while other factors remain unchanged, Red pepper productivity will rise by 0.1%. The ownership of an ox is essential for farming land, and a household requires a pair of oxen. When farmers possess at least a pair of oxen, they can cultivate and sow their fields at the right moment and additionally expand their cultivation by renting more land. This discovery aligns with the studies by Dagnaygebaw& Tariku, 2019 &Gautam, 2024.

Non-Farm Income: The coefficient for non-farm income is positive and significantly meaningful at the 1% probability level. This implies that if households have greater access to non-farm income, while keeping other factors unchanged, the productivity of red pepper rises by 11%. This may occur because families with increased non-farm earnings are more inclined to invest in different inputs like fertilizers, superior seeds, and pesticides for their production, resulting in enhanced productivity compared to those lacking such earnings. The outcome aligns with the studies by Wubalem, 2019; Geleto&Essa, 2022 &Mulualem, 2022.

Seed Variety: The coefficient for seed variety is positive and statistically significant at the 1% probability level. This indicates that, when the seed variety frequency was raised by one additional type while holding other factors constant, the productivity of red peppers rose by 7%. It suggests that smallholder farmers require various seed types to enhance red pepper production and productivity in the region studied. The outcome aligns with the studies of Asravor et al., 2016; Tabe-Ojong&Molua, 2017 &Shimelis, 2021.

Access to Credit: The regression findings indicate a notable and positive correlation between credit access and red pepper productivity at a 5% significance level. If credit access shifts from non-access, while other variables remain unchanged, red pepper productivity rises by 4%. This indicates that households with increased access to credit can obtain more fertilizer and a superior seed for their agricultural activities The result is coincides with the finding ofOnalan and Basegmez, 2018&Kibret, &Abebo, 2019.

Table 5. OLS Regression Estimation for Red Pepper Productivity

Linear regression Number of obs = 338				
F(18, 319) = 38.80				
Prob> F = 0.0000				
R-squared = 0.7112				
Root MSE = .14579				
lnOutput/hec	Coef	Robust Std. Err.	t	P>|t|
Sex	.0470785	.0182669	2.58	0.010 **
Age	.0061851	.0014557	4.25	0.000 ***
Education	.0359837	.0101788	3.54	0.000 ***
Famsiz	-.094657	.039029	-2.43	0.016 **
Land size	.2117753	.0404089	5.24	0.000 ***
Fertilizer Uses	.0000987	.0000814	1.21	0.226
Redppdisease	-.0534174	.0159145	-3.36	0.001 ***
Oxen in hour	.0010023	. .0003489	2.87	0.004 ***
Labor in hour	9.21e	1.91e-06	0.48	0.631

TLU	-.0052398	.0039313	-1.33	0.184
Non- farm	.1057742	.0217688	4.86	0.000 ***
Seedvar	.0725234	.0220974	3.28	0.001***
Seed	.0151832	.0046242	3.28	0.001 ***
Access to Credit	.0381177	.0156891	2.43	0.016**
Extensionc~t	.0264694	.0095128	2.78	0.006 ***
Mktinfo	.0449419	.0190651	2.36	0.019**
Soilfertil~y	-.0234458	.0192125	-1.22	0.223
Slope	-.0539639	.0151863	-3.55	0.000***
cons	-.1135479	.0829626	-1.37	0.172

Note; ***, **and * represents significant at 1%, 5% and 10* level

Source: Own Computation, 2023.

Extension Contact: The coefficient for extension contact is positive and significant at the 1% probability level. This indicates that when the frequency of extension contact increased by one additional interaction while all other variables remained unchanged, the productivity of red pepper also rose by 3%. This finding suggests that smallholder farmers require customized technical assistance and skills development initiatives to effectively adopt new, improved technologies for enhancing red pepper production and boosting their livelihoods The outcome aligns with the studies by Hayran&Gul , 2019; Deginehet al., 2020&Banchamlak&Seble, 2022.

Market information access:The coefficient for access to market information is positive and statistically significant at a 5% probability level. This implies that, assuming other factors remain unchanged, farmers with greater access to information will see a 5% increase in red pepper productivity. It suggests that Farmers who are better informed about input and output prices are more efficient than those who are not. This is because of access to market information able to make the right decisions on right time on their red pepper productivity. This finding aligns with withworks of Mulualem, 2022 &Hamidaet al., 2024.

Slope of Land: The slope coefficient of the land is negative and statistically significant at the 1% probability level. This indicates that if the land's slope increases and becomes steeper than that of a non-sloped plot, while other factors remain unchanged, the likelihood of red pepper yield drops by 5%. This may occur because the slope significantly affects the long-term agricultural operations and sustainability of the farming system. This indicates that the steeper slope is more susceptible to erosion than the gentle or non-steep slope. Therefore, on the steep slope fields under ongoing cultivation and with minimal fertility management, their fertility declines over time. This results in a decrease in the productivity of agricultural land. This result aligns with studies of Rosli et al., 2020 &Lidya et al., 2023.

5. Conclusion and Recommendation

The study used a multistage sampling technique was employed to establish the necessary sample size. Initially, the researcher purposefully chose WeraWoreda. Subsequently, four kebeles were chosen from the total and primary data was gathered along with a sample of 338 farm households. The outcomes from the descriptive statistics and OLS model showed that many of the proposed variables have a significant impact on red pepper productivity in the studied region. Descriptive statistics indicated that sex, age of households, education level, land area, fertilizer use, red pepper diseases, off-farm income, seed variety, seeds, extension contacts, market information, and land slope are key variables influencing red pepper productivity in the research area

Eighteen explanatory variables are included in the OLS regression model, specifically fourteen variables demonstrated significant variables of red pepper productivity in the researched area. Thus, the finding revealed that sex, age, education level of farmers, land size, oxen in hour, off farm income, seed variety, seed amount, credit access and extension contact are found to be a positive determinant factors of red pepper productivity. On other hands, Red pepper disease, Family size, marketing information and Slope of farm land are negative and statistically significant variables which affect red pepper productivities. The study finding show that majority of variables are the key determinants factors for red pepper productivity in WeraWoreda. Therefore, Due to the important results, the following specific areas for intervention have been pointed out as

- Accessing more pesticides and improved seeds to control Red pepper disease

- Encouraging more use for improved modern agricultural inputs for red pepper production

- Advocating more extension contacts to improve extension services which help to raise red pepper productivity

- Creating more marketing information dissemination through different media as Tv, radio, Mobile and others.

- Creating strong institutional support for accessing of more credit at farm household level

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