ISSN 2581-6853 | 4(4) Dec 2021

Grassroots Journal of Natural Resources, Vol.4 No.4 (December 2021)
ISSN 2581-6853 | CODEN: GJNRA9 | Published by The Grassroots Institute
Website: http://grassrootsjournals.org/gjnr | Main Indexing: Web of Science

OPEN ACCESS Freely available online

M – 00276 | Research Article

The Determinants of Agricultural Crop Productivity among Smallholder Households in Haramaya Distinct, Eastern Ethiopia

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How to cite this paper: Nuno, D.B. and Baker, M.M. (2021). The Determinants of Agricultural Crop Productivity among Smallholder Households in Haramaya Distinct, Eastern Ethiopia. *Grassroots Journal of Natural Resources*, 4(4): 146-153. Doi: https://doi.org/10.33002/nr2581.6853.040410

Received: 08 November 2021
Reviewed: 27 November 2021
Provisionally Accepted: 30 November 2021
Revised: 15 December 2021
Finally Accepted: 20 December 2021
Published: 31 December 2021

Abstract

The agricultural crop is a backbone in Ethiopia since the country's economy is mainly dependent on agriculture, which is dominated by subsistence smallholder farmers who are partially integrated into the market. The objective of this study was to identify the determinants of crop productivity among smallholder farmers in Haramaya distinct, Eastern Ethiopia. A two-stage random sampling procedure was employed to detect a sample containing 260 smallholder households in the study area. Data was collected through semi-structured questionnaire schedules administered to the selected household farmers. The features of smallholder farmers were analyzed through descriptive statistics and multiple linear regression models. The results indicated that the length of farming experience of the household head, number of economically active members in family, amount of organic fertilizer applied, irrigated land area, and soil fertility status of farmland were the significant determinants of agricultural crop productivity. To increase the production and productivity of smallholder farms, the farmers were provided with land irrigation. Based on these findings, the study recommends the provision of organic fertilizer to farmers. Policies should also target supplying improved technology and improved seed to enhance agricultural crop production in Ethiopia.

Keywords

Farming; Fertilizer; Hararge zone; Irrigation; Linear regression

Introduction

Ethiopia is an agrarian country where the economy mainly depends on agriculture, which is dominated by subsistence smallholder farmers who are partially integrated into the market (Mohammed *et al.*, 2018). In less developed countries, in general, and Sub-Saharan Africa, in particular, economic policy is highly dependent on agriculture. Poverty reduction and income growth can mainly be achieved by agricultural growth (Takele and Negese, 2020). Agriculture, in general, and crop production, in particular, are the backbone of the Ethiopian economy. It contributes a greater share to the country's GDP as well as employment creation (Tessema, 2015; Kakar, Kiani and Baig, 2016; Beriso, 2018). Ethiopia's crops are complex, comprising significant variation in crops grown across the country's different regions and environmental conditions. Cereal crops were grown on 73.4% of the total area cultivated by a total of 11.2 million farmers. Together, these farmers produce on an average 12 million tons of cereals/year, which is 68% of total agricultural production (Alemayehu, Paul and Sinafikeh, 2011). Ethiopian agriculture provided commodities for exports, domestic food supply, industries output and encourage the market for domestic manufacturers (MoFED, 2012; Admassie, Berhanu and Admasie, 2016; Zewdie, 2020).

As reported by United Nations Development Programme, the agricultural sector in Ethiopia employs 85% of the population, contributes 44% to the country's GDP, and 85% of the country's export earnings. The country's aspiration for achieving overall economic growth largely depends on the performance of the agriculture sector (Aynalem, Nand and Seema, 2018). The sector account for about 50% of gross domestic product (GDP), 90% of the total export revenue, 85% of employment of the country's labor force and accounts 70% of raw materials requirement of the country's industries, which is very important for the countries sustainable development (MoFED, 2012). The agriculture sector, in Ethiopia, consists of different sub-sectors. But the crop sub-sectors account for the lion's share of agricultural output. Even though agriculture is a crucial sector in the national economy, its production and productivity are not sufficient. So, an important way to increase crop productivity is to reduce the constraints of agriculture. These constraints were reduced through the diffusion of improved seed, land management practice, and training of farmers (CSA, 2000). Many studies have been conducted focusing on the different dimensions of smallholder farm households in Ethiopia (Shujie, 1996; Alelign *et al.*, 2016; Takele and Negese, 2020). However, most of these studies were limited to a specific area and production aspects. Systematic and adequate information on the determinants of crop production and productivity were not well identified and determined. Furthermore, in the study area, there is no empirical study conducted on the determinant of crop productivity of smallholder farm households. Therefore, this study was conducted to assess and identify determinants of crop productivity among smallholder farmer households in Haramaya distinct, Eastern Ethiopia.

This study has shown that agricultural crop productivity can be influenced by different factors. The study conducted by Samuel *et al.* (2020) in Kenya showed that land size under sorghum, labor farm’s gate price, and sorghum seed varieties had a significant effect on the overall sorghum productivity. An empirical study using a two-stage least squares (2SLS) regression model carried out by Alelign *et al.* (2016) showed that commercial orientation strongly and positively influenced the crop productivity of smallholder farm households. The study conducted by Justin (2015) concludes that the household head's education level was relevant to the commercialization of maize production, meaning that the education level was positively related to higher maize yields. The study conducted by Shujie (1996) in Ethiopia reveals that chemical fertilizers have a statistically significant impact on cereal crop productivity. The study done in Nigeria confirmed that the age, education, labor, non-labor input cost, and type of season were positively related to the total output, whereas the farm size, years of experience, and gender of respondents were inversely related to the total output (Fasoranti, 2008).

Material and Methods

Description of Study Area

The study was conducted in Haramaya Woreda, Eastern Hararge Zone, Oromia Regional State, Ethiopia. Haramaya Woreda is located in the Eastern Hararge Zone, Oromia Regional State, in the Eastern part of Ethiopia about a distance of 525 km from the capital city Addis Ababa. Haramaya district has a total population of 271,394 of which 138,376 are males and 133,018 are females, 50,032 or 18.46% of its population was urban dwellers (CSA, 2011).

Sampling Techniques and Sample Size

A two-stage sampling procedure was performed to select sample households. In the first stage, considering the resources available, from 35 agricultural crop-producing rural kebeles (communes) of Haramaya Woreda, 2 kebeles (Damota and Xinniqe) were selected based on its agroecological conditions. The remaining kebeles of the Haramaya Woreda were selected through lottery method using simple random sampling. In the second stage, 260 respondents were drawn from sampled kebeles using a systematic sampling procedure. The sample size was determined based on the simplified formula given by Yamane (1967). The population is homogeneous in terms of crop production in the sampled kebeles. Based on this, the required sample size was determined as under:

$$n = \frac{N}{1+N\varepsilon^2} = \frac{4126}{1+4126(0.06)^2} = 260 \quad (1)$$

Where n = The sample size, N = The population size (4126 household size), ε = adjust margin of error [$\varepsilon = \frac{(\rho e)}{t} \Rightarrow \varepsilon = \frac{4(0.03)}{1.96} = 0.06$], e = The degree of accuracy = 0.03 for continuous variable, ρ = The number of standard deviations that would include all possible values in the range = 4 for continuous variable, t = t-value for the selected alpha level or confidence level at 95% =1.96 (Anokye, 2020).

Sources of Data and Methods of Data Collection

The data for the study was collected from both primary and secondary sources. Cross-sectional data were collected from the survey of randomly selected smallholder farm households. For the primary data collection specifically, a semi-structured questionnaire was employed based on the objective of the study. Both quantitative and qualitative information was collected. The data collection included households' demographic, socio-economic and environmental factors (age of household head, household's farming experience, number of plots owned by household, number of economically active members, use of organic fertilizer, irrigated land, number of plows before sowing, number of weeding for seasonal crops, access to market information, participation in farmers' training, and soil fertility status of farmland. The secondary data were collected from relevant sources such as published and unpublished documents from the internet, administration offices of the district, and other relevant institutions for a general description. The filed work was carried out in August 2020.

Method of Data Analysis

The study employed both descriptive and econometric methods for data analysis. Accordingly, descriptive statistics were used to provide an overview of the overall data. The ordinary least square (OLS) estimation technique was applied to identify the determinants of agricultural crop productivity (Peprah and Mensah, 2017). The most common cereal crops in the study area namely, sorghum, maize, and wheat were considered. The agricultural crop productivity model includes the following explanatory variables in the

Grassroots Journal of Natural Resources, Vol.4, No.4 (December 2021), p.146-153 | ISSN2581-6853 | CODENGJNRA9
Doi: https://doi.org/10.33002/nr2581.6853.040410 OPEN ACCESS Freely available online

form of multiple linear regression function:

$$ACP = F(fexp, nplot, ecam, ofer, iirl, plbs, wsc, accm, pft, sf) \quad (2)$$

$$ACP_i = \beta_0 + \beta_1 fexp + \beta_2 nplot + \beta_3 necam + \beta_4 ofer + \beta_5 iirl + \beta_6 nplbs + \beta_7 nwsc + \beta_8 acmi + \beta_9 pft + \beta_{10} sfs + U_i \quad (3)$$

Where, ACP is agricultural crop productivity, *fexp* is a household farming experience in years, *nplot* is a number of plots owned by household, *necam* is a number of economically active members, *ofer* is the use of organic fertilizer in kg, *irrl* is irrigated land area in hectare, *nplbs* is a number of plow before sowing, *nwsc* is a number of weeding for seasonal crops, *acmi* is access to market information, *pft* is participation in farmers training and *sfs* is soil fertility status of farmland and *Ui* is error term (residual term).

Result and Discussion

Descriptive Statistics and Characteristics of the Respondents

Table 1 indicates that the minimum and maximum year of household farming experience were 3 and 58 years, respectively, whereas the average year of farming experience of household head was 23.68 year. The minimum and the maximum number of plots owned by households were 1 and 5 plots of land while the average number of plots owned by households was 2.25. The average number of economically active members of household head was 3, whereas the minimum and maximum economically active persons of household head were 1 and 6, respectively. The results also showed that the average amount of organic fertilizer that the household head used was 582.5 kg, and the minimum and maximum organic fertilizer applied were 0.01 kg and 2,000 kg, respectively. The minimum and maximum irrigated areas of land ownership by household head were 0 and 1.125 hectares, respectively, whereas the average irrigated area of land was 0.19 hectares. The average number of plows before sowing by household was 1.51, while the minimum and maximum plows before sowing were 0 and 3, respectively. The minimum and the maximum number of weeding for seasonal crops were 2 and 4 times, respectively, whereas the average number of seasonal crop weeding was 2.63. The higher variation has occurred in the age of household head and the lower variation among household head was presented in the land irrigated area of the household head.

Table 1: Descriptive statistics for continuous variables

Variables	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Farming experience of the household head	3	58	23.68	10.164
Number of plots owned by household	1	5	2.25	1.087
Number of Economically active members	1	6	3	1.00779
Organic fertilizer applied in kg	0.01	2,000	582.5	5.1127
Irrigable land area in hectors	0.000	1.125	0.19531	0.14505
Number of plows before sowing	0	3	1.51	0.680
Number of weeding for seasonal crops	2	4	2.63	0.496

As presented in table 2, from all sampled household heads 62% had participated in farmers' trainings because participating in farmers' training was important for sharing knowledge and experience. Out of the total sampled household heads 63.5% had experienced soil fertility of the land, and from overall sampled households 36.2% had access to market information since access to market information was the central determinant of agricultural crop productivity and profitability.

The Determinant of Agricultural Crop Productivity

According to the estimation results (Table 3), out of all variables included in the model, year of farming experience of household head, number of economically active members, amount of organic fertilizer applied, irrigated land, and soil fertility status of farmland became statistically significant effects on agricultural crop productivity of smallholder farm households at 0.05 probability level of significance. On the other hand, the number of plots owned by the household head, number of plows before sowing, number of weeding for seasonal crops, access to market information, household participation in farmers' training were statistically insignificant at 0.05 significance level.

Table 2: Frequency table for categorical variables

Variables	*Variable category*	*Number of respondents*	*%*
Participation on Training	Not participated	76	38
	Participated	124	62
Soil Fertility	Not fertile	73	36.5
	Fertile	127	63.5
Access to Market	No	127	63.8
	Yes	73	36.2

As shown in table 3, the farming experience of the household head had negative and significant effects on agricultural crop productivity. The negative sign of the year of experience showing an inverse relationship with crop production is unexpected. This might be because farmers with long years of farming experience used traditional materials, traditional seeds, and outdated methods of farming that do not accrue high production. This was confirmed by Fasoranti (2008), and Alelign *et al.* (2017). The results (Table 3) show that the economically active members of the household harmed agricultural crop productivity. Accordingly, when the number of economically active members of household increased by 1, the agricultural crop productivity decreased by 141.621 kg when other factors were constant. The inverse relationship between output and economically active members (labor) is unexpected. This could be due to poor labor management by households.

Furthermore, the results indicated that the amount of organic fertilizer applied by household heads had a positive impact on agricultural crop production. Hence, as the farmer used 1 kg of organic fertilizer, the crop productivity of the household increased by 73.328 kg, while retaining other factors constant. Thus, the more the amount of organic fertilizer applied, the higher agricultural crop productivity was achieved. This result was consistent with the findings of Alelign *et al.* (2017) and Takele and Negese (2020). The result in table 3 also show that the irrigated land has a positive and significant impact on agricultural crop productivity. As the area of irrigated land increased by 1 hectare, the crop productivity of farmers increased by 5,294.709 kg, when keeping other factors constant.

Table 3: Coefficients of an estimation regression model

Variables	*Unstandardized Coefficients*		*t-stat*	*Sig.*
	B	*Std. Error*		
(Constant)	2,271.595	1,363.140	1.666	0.097
Farming experience of household in a year	-11.689	39.497	-0.296	0.008
Number of plots own by household	5.973	167.459	0.036	0.972
Number of economically active members	-141.621	187.567	-0.755	0.001
Organic fertilizer applied in kg	73.328	43.255	1.695	0.002
Irrigable land area used in hectors	5,294.709	1,212.590	4.366	0.000
Number of plows before sowing	-218.387	320.549	-0.681	0.497
Number of weeding for seasonal crops	-222.800	369.511	-0.603	0.547
Access to market	-471.536	489.108	-0.964	0.336
Participation in farmers training	285.834	416.604	0.686	0.493
Soil fertility status of farmland	19.729	440.831	0.045	0.004

Consequently, the irrigated land was very important for the farmers in the study area. It implied that the farmers were familiar with the irrigated land use for increasing productivity and profitability. Moreover, the soil fertility status of the farmer had positive impacts on agricultural productivity, thereby, as the soil of the household head became fertile, the agricultural crop productivity increased by 19.729 kg, retaining other variables constant.

Conclusion

Agricultural productivity needs improvement through increasing crop production and productivity to improve the life of household farmers and reduce rural poverty through refining food security. The current study is designed to identify and determine the determinants of agricultural crop productivity in Haramaya District, Eastern Ethiopia. Data was collected and organized from both primary and secondary sources. A multiple linear regression model was employed to analyze the variables under study. The results of the analysis show that year of farming experience of the household head, the number of economically active members, amount of organic fertilizer applied, size of irrigated land, and soil fertility status of farmland were the most potent determinant of agricultural crop productivity.

The results also indicate that the use of irrigation had a positive impact on agricultural crop productivity. Accordingly, the irrigated agriculture was a significant factor for the farmers in the study area to increase production and productivity, and the farmers are expected to use irrigation. Generally, the crop productivity of smallholder farmers is a big concern for changing the overall life of farmers. The study recommended smallholder households to use organic fertilizers, improved technology, and optimal irrigation that support land productivity.

Acknowledgment

The authors highly acknowledge and appreciate Haramaya University to have utilized resources of the university to accomplish this study.

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Authors' Declarations and Essential Ethical Compliances

Authors' Contributions (in accordance with ICMJE criteria for authorship)

Contribution	Author 1	Author 2
Conceived and designed the research or analysis	Yes	Yes
Collected the data	Yes	Yes
Contributed to data analysis & interpretation	Yes	Yes
Wrote the article/paper	Yes	Yes
Critical revision of the article/paper	Yes	No
Editing of the article/paper	Yes	Yes
Supervision	Yes	No
Project Administration	Yes	No
Funding Acquisition	No	No
Overall Contribution Proportion (%)	70	30

Funding
No funding was available for the research conducted for and writing of this paper.

Research involving human bodies (Helsinki Declaration)
Has this research used human subjects for experimentation? No

Research involving animals (ARRIVE Checklist)
Has this research involved animal subjects for experimentation? No

Research involving Plants
During the research, the authors followed the principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora. Yes

Research on Indigenous Peoples and/or Traditional Knowledge
Has this research involved Indigenous Peoples as participants or respondents? No

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)
Have authors complied with PRISMA standards? Yes

Competing Interests/Conflict of Interest
Authors have no competing financial, professional, or personal interests from other parties or in publishing this manuscript.

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