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Influence of Farmer's Income Level on Adoption of Agricultural Water Management Practices among Smallholder Farmers in Rongai Sub-county, Kenya

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Water is a resource that cannot be replaced and can only be renewed if it is well managed. It is basic for all forms of life, for every aspects of socio-economic development, and for the

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maintenance of a healthy ecosystem. Agriculture is the biggest water user globally, accounting for 70 percent of total water withdrawals on average. There are different practices that can aid in managing water used for agriculture. Some of these agricultural water management practices are; rainwater harvesting, irrigation, organic farming, and use of drought resistant crops. Farmer's decision to either adopt or reject these practices can be affected by several factors, some of which are socio-economic. Some of the socio-economic factors that may influence adoption of these practices include farmer's educational level, income level and farm size. This study examined the influence of farmer's income level on adoption of agricultural water management practices (Rainwater harvesting, Irrigation Drought resistant crops). Cross-sectional survey design was adopted, while proportionate and simple random sampling technique was used to obtain the respondents. The accessible population was 6,230 smallholder farmers from the target population of 26,804 smallholder farmers in Rongai sub county Kenya. The study was done in August 2023 to November 2023.The study included 120 smallholder farmers in Rongai Sub County. The study used questionnaire to collect data while binary logistic regression was used to analyze the data. The results indicated that adoption of agricultural water management practices is low, only 36% of smallholder farmers had adopted agricultural water management practices. The *P* value calculated for the 120 smallholder farmers was *P*=.033 which is < than .05 and therefore the null hypothesis was rejected concluding that in this study income level had statistically significant influence on adoption of agricultural water management practices among smallholder farmers in Rongai sub-county in Nakuru ,Kenya. The findings may help in emphasizing the necessity of assisting farmers in removing financial obstacles that may hinder adoption of agricultural water management practices.

Keywords: Income level; Agricultural Water Management Practices (AWMP); smallholder farmers; Rongai, Kenya.

1. INTRODUCTION

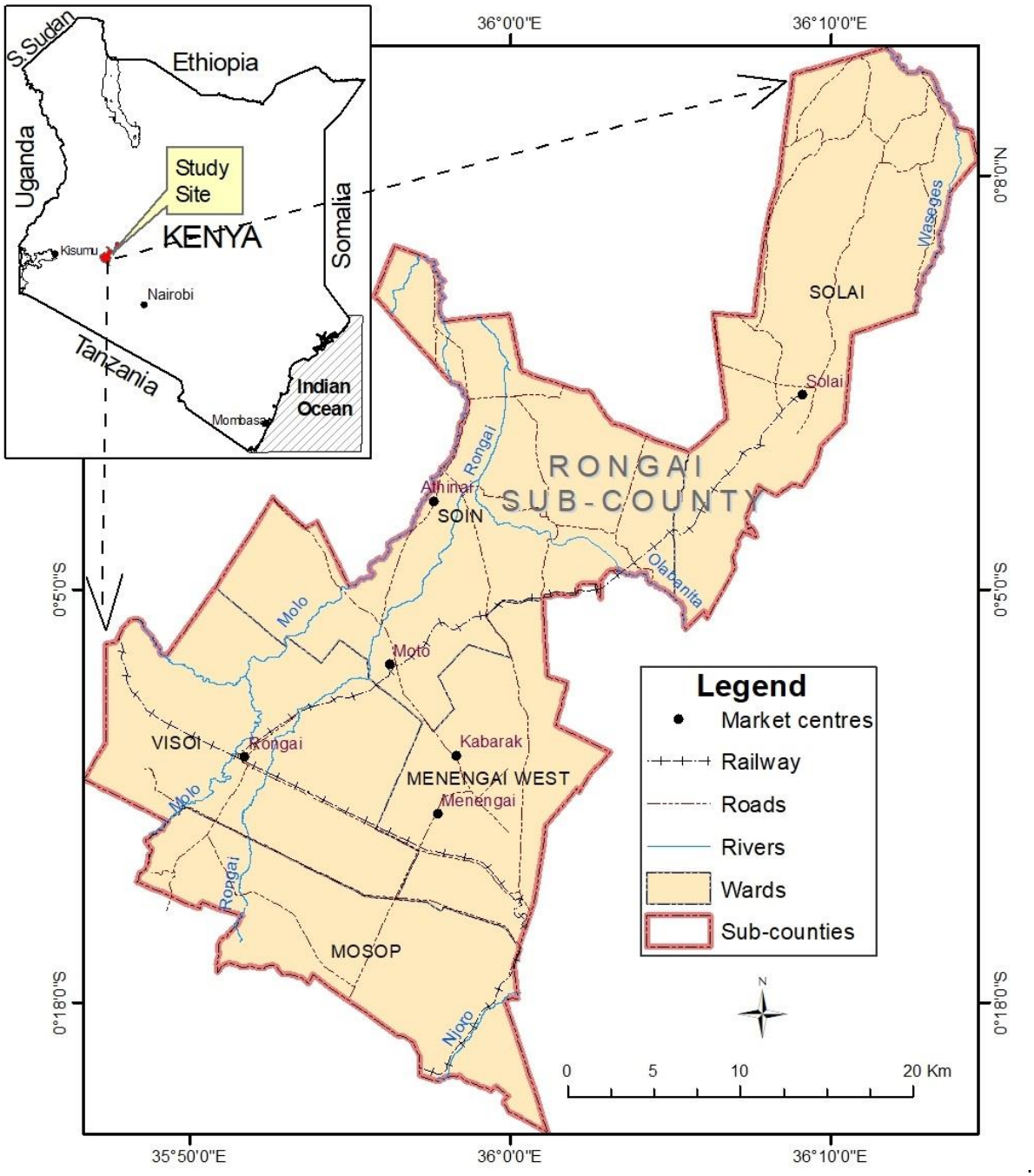
Adoption of Agricultural Water Management Practices by smallholder farmers can increase crop yields and improve farm profitability [1]. Despite this potential, the adoption rate remains low and especially among smallholder farmers, more so, in developing countries. Several factors influence the adoption of this practices and among the factors are socio-economic factors. Socio-economic factors significantly influence how well and how long we live [2] Some of the socio-economic factors that influence adoption of agricultural technologies include level of education, farm size, farming experience, employment, income level and labor among others [3]. According to research, income has shown a positive impact on technology adoption. This is because income acts as an important strategy for overcoming credit constraints faced by smallholder farmers. The attitude of the farmers to pay for agricultural technologies is often influenced by the cost of the technologies, therefore, farmers with high income are more likely to access agricultural technologies compared to farmers with low income [4]. Effects of climate change have made farmers diversify their income-generating activities to compensate for their losses in times of unfavorable climatic conditions. This implies that many farmers prefer diversification of income-generating activities to realize financial stability and therefore, influencing their decision to adopt agricultural water management practices [5]. Many parts of Rongai Sub County of Nakuru County in Kenya, receive rainfall of 500-800mm per annum, which is below the county average of 800-1000mm per annum. This leads to scarcity of water for domestic and agricultural purposes, thereby leading to low agricultural production and consequently, food insecurity. It was not clear about the factors that may have affected the adoption of agricultural water management practices and, therefore, the study sought to determine the influence of income level on adoption of agricultural water management practices in the area.

2. METHODOLOGY

2.1 Study Location

The study was carried out in Rongai sub-county, Nakuru County in Kenya. Rongai is made up of five wards namely, Soin, Solai, Mosop, Visoi and Menengai west. Rongai sub-county covers an area of 988.1 square kilometres, and has a population of 199,906 people with a population density of 202 per square kilometer. The major economic activities in Rongai include livestock

production, crop farming and trade and investment [6]. Rongai sub-county experiences variations in seasonal rainfall and is susceptible to droughts. The rainfall received is approximately 500-800mm per annum which is below the average rainfall of 800-1000mm per annum in Nakuru County. The Kenyan government, through agricultural extension service providers, has made various efforts to control the effects of drought in the area. This has been done by creating awareness on the importance of water harvesting during rainy season especially, construction of water pans and use of drought resistant crops. However, despite these efforts the adoption of agricultural water management practices has been fairly low [7]. The study covered two wards, namely Soin and Visoi wards as they experience low seasonal rainfall, of 400-600mm per annum [6]. (See Map 1).



Map. 1. Map of Rongai sub county

2.2 Sampling Procedure and Sample Size

Two wards, namely Visoi and Soin, were purposively selected out of the five, because of their low seasonal rainfall that leads to inadequate water in the area [8]. Proportionate sampling method was used to determine the number of respondents from the purposively sampled wards, while simple random sampling was used to obtain the individual respondents from the two wards. The study incorporated one hundred and thirty (130) respondents.

The following formula as stated by Nassiuma (2000) was used to come up with an appropriate sample size for the study:

$$n = \frac{NC^2}{C^2 + (N-1)e^2}$$

$$\frac{6230x(0.21)^2}{(0.21)^2 + (6230-1)x(0.02)^2} = 108$$

n= the required sample size
N= the population within the study area,
C= Coefficient of variation
e= Standard error.

The sample was obtained using the coefficient of variation of 21%, a standard error of 2%. The accessible population within the study area of 6230 smallholder farmers in Rongai sub-county. This meets Nassiuma's (2000) assertion that in most surveys a coefficient of variation occurs within the range of 21%≤C≤30% and that standard error occurs within the range of 2%≤e≤5%. The study expected 95% confidence (5% sampling error).

The sample size was108 but as advised by Kaur, [8] Jami [9] to cater for non-responses, attrition and for the purposes of representative sample, the researcher revised the sample size to 130 by adding 20% of 108.Therefore, the study incorporated 130 smallholder farmers as shown in Table 1.

2.3 Instrumentation

The study employed a semi-structured questionnaire. The questionnaire was chosen to collect data from the farmers because of its effectiveness especially when used in a study with large samples. Language post a barrier however the questionnaire was translated to local language for better understanding.

2.4 Validity

The questionnaire's face and content validity were ascertained by experts from the Egerton University's Faculty of Education and Community Studies. Recommendations given were applied to enhance the instrument's validity.

2.5 Reliability

Piloting the questionnaire enabled the researcher to estimate its reliability. Piloting involved 30 smallholder farmers in Lare ward of Njoro Sub County in Nakuru County. Lare Ward has similar climatic and agricultural characteristic to Rongai sub county [10]. Cronbach Alpha Scale was used to estimate the reliability. The instrument was thereafter modified accordingly for data collection.

2.6 Data Collection

Upon receiving a research authorization letter from the Board of Postgraduate Studies of Egerton University and the University Research and Ethics Committee, a research permit was sought from the National Commission for Science, Technology and Innovations (NACOSTI). Data was collected by visiting the farmers, administering the questionnaire, and collecting it thereafter.

2.7 Data Analysis

Data was cleaned, coded, scored and entered into the Statistical Packages of Social Sciences (SPSS version 22). After cleaning out of the 130

Table 1. Summary of the distribution of sample size

Ward	Number of smallholder farmer	Proportion	Sample size
Visoi	3156	50.66	66
Soin	3074	49.34	64
Total	6230	100	130

questionnaires only 120 questionnaires were used in data analysis. Each score was assigned a specific weighting for meaningful interpretation for the hypothesis. Descriptive analysis was used to determine the frequency of income level of smallholder farmers as well as the level of adoption of agricultural water management practices. Binary logisticregression test was used to predict the influence of education level on adoption of agricultural water management practices. The test of significance were computed at α=0.05 significance level. The Binary Logistic regression model that was used is:

$$y = ß0 + ß1X1 + ε.$$

Where: y= Adoption of Agricultural Water Management Practices (Dependent variable)
Indicators: Low adoption, High adoption

ß0 = intercept, ß1, = coefficient of determination

Xn = X1 (Independent variable);
X1= Farmer's income level

Indicator: Amount of money earned from on farm and off farm activities.

3. RESULTS AND DISCUSSION

The objective of the study was to determine the influence of farmer's income level on adoption of Agricultural Water Management Practices (AWMP) among smallholder farmers in Rongai sub- County, Kenya. Income level refers to the amount of money, property, and other transfers of value received over a set period by individuals or entities as compensation for services, payment for products, returns on investments, and pension distribution gifts [8,11]. The study defined income level as the total combined income from all sources available to the farmer. It was measured in terms of money earned from the farm and other off-farm activities. The results obtained from this study were analysed and discussed as follows:

3.1 Farmer's Income Level from Farming

Agriculture is the main source of income among smallholder farmers in rural communities [11] Bajaj et al. [12] Table 2 illustrates the income level of smallholder farmers in Rongai Sub-County from farming:

Results from Table 2 indicate that majority of the smallholder farmers earned less than Kshs 50,000 from their farms, at 62.5%, while only 26.7% of smallholder farmers earned between Kshs 50,001and Kshs100, 000.00. About 6.7% of smallholder farmers earned more than Kshs 150,000 and only 4.2% of the smallholder farmers earned between Kshs 100,001-150,000 from their farms.

These results indicate that majority of smallholder farmers in Rongai make less than Kshs 50,000 per year from farming. This indicates a significant financial constraint for many smallholder farmers in Rongai sub-county. These financial limitations may lead to low adoption of agricultural technologies, as highlighted by a study that found out that the financial ability of farmers to participate in sustainable agricultural technologies, depends on their income level Bajaj et al. [12] Tatis et al. [13]. The implication is that farmers with high incomes are more likely to adopt agricultural technologies than those with lower ones.

3.2 Smallholder Farmers' Earnings from Off-farm Activities in Rongai Sub-County

Off-farm sources of income are critically important as agriculture has evolved over the years to fully benefit the farmer. Off-farm income is important strategy for overcoming credit constrains faced by smallholder farmers [13,14]. Table 3.

Table 2. Income from farming per year in Rongai Sub-County

Income per year	**Frequency** (n=120)	**Percent**
Less Kshs 50,000	75	62.5
Kshs 50,001-Kshs100,000	32	26.7
Kshs 100,001-150,000	5	4.2
More than Kshs 150,000	8	6.7
Total	120	100.0

Table 3. Smallholder farmers' earnings from off-farm activities

(n=120)

Earnings	Frequency	Percent
No earnings	54	45.0
Less than Kshs 5000	23	19.2
Kshs 5,001-10,000	26	21.7
Kshs 10,001-15,000	10	8.3
More than Kshs 15,000	7	5.8
Total	120	100.0

presents distribution of off-farm earnings among smallholder farmers in Rongai Sub-County.

Table 3 shows that 45% of smallholder farmers did not have earnings from other sources. However, 21.7% of smallholder farmers earned between Kshs 5,001-10,000 monthly from off-farm activities, while 19.2% of the farmers earned less than Kshs 5000 per month. 8.3% of the farmers earned between Kshs 10,001-15,000 while 5.8% of the farmers earned more than Kshs 15,000 per month.

The fact that 45% of the farmers had no income from other sources highlights how vulnerable farmers who make farming their only source of income may be. While diversifying into non-farm pursuits is sometimes viewed as a risk management tactic, certain farmers may be more vulnerable to financial instability if they do not get income from other sources especially in drought prone areas. This is consistent with the idea that smallholder agricultural systems are more resilient when they have a variety of revenue streams as well at good position to adopt modern agricultural technologies that may require extra money especially for drought prone areas like Rongai county [15,16].

3.3 Frequency of Level of Adoption of Agricultural Water Management Practices in Rongai sub-county in Nakuru County

Adoption of agricultural water management practices was measured in percentage and classified as low adoption, or high adoption. These percentages were calculated from the practices farmers have adopted from the three practices focused in the study (rain water harvesting, irrigation and use of drought resistant crops). From the scores of the three, agricultural water management practices, composite data were generated for use in determining the adoption of agricultural water management practices. Composite data is the average data of the three practices to determine whether the farmer has adopted or not adopted the agriculture water management practices. If more than 50% the adoption level was considered high while less than 50% was considered low Table 4.

According to Table 4, majority of the farmers (64.2%) did not use agricultural water management practices while only 35.8% adopted the practices. Therefore, the level of adoption of agricultural water management practices among smallholder farmers in Rongai Sub County is low.

3.4 Regression Analysis of the Influence of Income level on Adoption of Agricultural Water Management Practices

Based on the objective of the study which was "To determine the influence of a farmer's income level on adoption of agricultural water management practices among smallholder farmers in Rongai sub-county, Kenya," the following hypothesis was generated: H0: There is no statistically significant influence of farmer's income level on adoption of agricultural water management practices among smallholder farmers in Rongai sub-county, Kenya".

The study analysed and documented frequency of combined income level on adoption of Agricultural Water Management Practices to test the hypothesis. The frequency of income level was coded and analysed as follows: Money earned from farming per year,1as less Ksh 50,000,2 as Ksh 50,001-100,000,3 as Ksh 100,001-150,000 and 4 as, more than Ksh 150,000. While money earned from other sources per month was coded as follows:1as no earnings,2 as less than Ksh 5000,3 as Ksh 5001-10,000,4 as Ksh 10,001-15,000 while 5 as more than Ksh 15,000.

Adoption of agricultural water management practices together with the combined income were used in the statistics to determine the influence of income level on adoption of agricultural water management practices. The results of the statistical tests are presented in Table 5.

The p-value generated is .03, less than the significance level of 0.05.and therefore, the null hypothesis was rejected. This suggests that, income significantly influences adoption of

Table 4. Frequency of level of adoption of agricultural water management practices in Rongai Sub-County

Use of Agricultural water management practices	Frequency	Percent
No	77	64.2
Yes	43	35.8
Total	120	100.0

N=120 Source: Own computation of survey data, (2023)

Table 5. Regression analysis between income level and adoption of agricultural water management practices

(n=120)

Income Level	B	S.E.	Wald	Df	Sig.	Exp(B)
Combined income	-.266	.125	4.561	1	.033	.766
Constant	.141	.381	.137	1	.711	1.152

a. Variable(s) entered on step 1: Combined income.

agricultural water management practices. These findings are consistent with a larger body of studies showing how crucial financial factors influence farmers' decisions to use new technologies [15,16]. Previous research indicates that income has a direct relationship with adoption of agricultural technologies [16,17] For example, a study done in Uganda on determinants of smallholder farmers' adaptation strategies to the effects of climate change, concluded that smallholder farmers with a higher annual farm income were more likely to plant improved seeds and to plant trees as adaptation strategies to the effects of climate change, than their counter parts with low farm income [17]. The findings of this study indicate that income has a positive influence on farmer's decision to adopt agricultural water management practices. The findings may help in emphasizing the necessity of assisting farmers in removing financial obstacles that may hinder adoption of agricultural water management practices.

4. CONCLUSION

The study rejected the null hypothesis and therefore Income level of the farmer statistically indicated influence on adoption of Agricultural Water Management Practices. The findings may encourage smallholder farmers to create multiple streams of income, both on and off-farm, that can help in providing funds for use in adoption of agricultural water management practices.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

ETHICAL APPROVAL

The study ensured numerous ethical considerations, which included attaining research authorization letter, research ethical approval and research permit. The research permit was thereafter presented to the Rongai sub-county agricultural office to seek approval for the same. The study was introduced to the farmers, and the principles of voluntary participation and confidentiality of participants were applied. The dignity, norms and culture of the farmers were respected at all times during the research process.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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