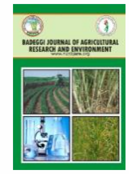
BADEGGI JOURNAL OF AGRICULTURAL RESEARCH AND ENVIRONMENT, 2024, 06(02), 133-143

NCRI Press

Available online: www.ncribjare.org
ISSN: 2695-2122, e-ISSN: 2695-2114
DOI: https://doi.org/10.35849/BJARE202402/193/013
Journal homepage: www.ncribjare.org



Research Article

Exploring Water Source Preferences and Agricultural Water Use in Rural Communities in the Changing Climate in Yobe State

Eze, J. N., Dauda, S. N., Ayanniyi, N. N, Ocheni, B. A., Opaluwa. D and Ekaette, J. E
National Cereals Research Institute, Badeggi, Bida, Niger State. Nigeria
Correspondence e-mail: *jn.eze@ncribadeggi.org.ng*

Abstract

In the face of a changing climate, rural communities in Yobe State, Nigeria, are experiencing increased water scarcity, impacting agricultural productivity and livelihoods. Despite the abundance of studies on rural water use, gaps remain in understanding the interplay between economic factors, traditions, and agricultural practices in shaping these preferences and utilization. Therefore, this study investigates water source preferences and agricultural water use among rural households in Yobe State, examining the implications of climate change on these dynamics. A mixed-methods approach combining surveys, interviews, and focus groups was employed to collect data from 300 rural households. Statistical Analysis, such as logit, and multinomial regressions were used for the data analysis. Results show that rural households prefer traditional water sources (rivers and wells) over modern sources like boreholes and piped water. However, climate change has altered the reliability and quality of these traditional sources, forcing households to adapt their water use strategies. The study reveals a significant shift towards groundwater use for irrigation, increasing the risk of over-extraction and land degradation. The findings highlight the need for climate-resilient water management strategies, improved water infrastructure, and sustainable agricultural practices to ensure food security and livelihood resilience in rural Yobe State. This research contributes to understanding the complex relationships between water sources, agricultural water use, and climate change in rural communities, informing policy and interventions to support climate adaptation and sustainable development.

Keywords: *Agriculture, Changing Climate, Food security, Rural households, Water resources*

Introduction

Yobe State, Nigeria, is experiencing the impacts of climate change, including increased temperature, changing rainfall patterns, and water scarcity (IPCC, 2014; NiMet, 2020). Rural communities, heavily reliant on agriculture, are vulnerable to these changes, affecting their livelihoods and food security (Morton, 2007; Bryan et al., 2013). Access to reliable water sources is crucial for agricultural productivity, but climate change alters the availability and quality of water sources (FAO, 2016; Brown et al., 2019). Understanding water source preferences and agricultural water use is essential for developing climate-resilient water management strategies (Pattanayak et al., 2010; Sood & Pattanayak, 2011). However, limited research exists on rural water source preferences and agricultural water use in Yobe State, particularly in the context of climate change (Adeyanju et al., 2017; Oluwatayo et al., 2019).

Climate change is altering the availability and distribution of water resources, impacting agricultural productivity and food security globally (IPCC, 2014; FAO, 2016). Changes in temperature and precipitation patterns affect crop yields, water requirements, and irrigation

Received on 15th July, 2024; Revised on 17th August, 2024; Accepted on 24th August, 2024 and Published on 30th August, 2024

management (Schmidhuber & Tubiello, 2007; Lobell et al., 2008). Agricultural water use is critical for food production, and understanding its relationship with climate change is essential for developing effective adaptation strategies. Agriculture accounts for approximately 70% of global freshwater withdrawals, and climate change is projected to increase water scarcity and competition for resources (WWAP, 2019). Climate change impacts agricultural water use by altering water availability, changes in precipitation and temperature affect water supply and demand (Brown et al., 2019), crop water requirements: Warmer temperatures and changing precipitation patterns influence crop water needs (Odekunle et al., 2017), irrigation management: Climate change requires adjustments in irrigation scheduling and water allocation (Pattanayak et al., 2010).

Understanding the complex relationships between climate change, agricultural water use, and crop productivity is crucial for developing climate-resilient agricultural practices and ensuring food security. Climate change affects water availability, quality, and distribution, impacting agricultural productivity and food security (Schmidhuber & Tubiello, 2007; Lobell et al., 2008). In Yobe State, changing rainfall patterns and increased evaporation due to rising temperatures alter the water balance, affecting crop yields and livestock productivity (Odekunle et al., 2017; Oguntunde et al., 2018).

Rural households in Yobe State rely on various water sources, including rivers, wells, boreholes, and piped water (Adeyanju et al., 2017). However, climate change alters the reliability and quality of these sources, forcing households to adapt their water use strategies (Brown et al., 2019). Understanding water source preferences and agricultural water use patterns is crucial for developing effective adaptation strategies. Agricultural water use is critical for food security and livelihoods in rural Yobe State (Morton, 2007). However, climate change impacts agricultural productivity, affecting crop yields and livestock productivity (Schmidhuber & Tubiello, 2007; Lobell et al., 2008). Understanding agricultural water use patterns and preferences is essential for developing climate-resilient agricultural practices.

This study aims to explore water source preferences and agricultural water use among rural households in Yobe State, examining the implications of climate change on these dynamics. By investigating water source choices and agricultural water use patterns, this research will contribute to understanding the complex relationships between water sources, agricultural productivity, and climate change in rural communities, informing policy and interventions to support climate adaptation and sustainable development.

Materials and Methods

This research covered all the seventeen Local Government Areas (LGAs) in Yobe State. These LGAs are Bursari, Damaturu, Geidam, Bade, Gujba, Gulani, Fika, Fune, Jakusko, Karasuwa, Machina, Nangere, Nguru, Potiskum, Tarmuwa, Yunusari, and Yusufari (Figure. 1). Based on the nature of the communities/environment and target population in the study area, two sampling technique were used (Purposive and simple random sampling). In every LGA, 4 communities were selected. However, in every community, 5 households were selected for interview (i.e. 5×4= 20 households per LGA in Yobe State). Therefore, 20 households were selected and interviewed per LGA, amounting to interviewing 340 numbers of households in Yobe State (20 × 17 = 340). Two stakeholders were selected via simple random sampling for in-depth interviews in each LGA of Yobe State (i.e. 2×17=34 stakeholders in the state). Stakeholders interviewed were farmers, agricultural extension officers and traders.

In this research, three major means of data collection were employed. These are documentary/library research, in-depth interview (oral), and questionnaire. Data were collected from households using a questionnaire while that of stakeholders were in-depth interview. Questionnaires were used to generate baseline socio-economic and also information on water sources and utilization and demographic data. In-depth interview was used to generate, in greater details, information on water sources and utilization in local government areas and the adaptation strategies used in the study area.

Primary data were collected and used for this study. The data were sourced through a well-designed questionnaire which was administered to three hundred and forty (340) rural households. The questionnaire sought general information on the socio-economic characteristics of the respondents and also information on water sources and utilization.

A multistage sampling procedure was adopted for the study. The first stage of the technique involved a purposive selection of communities in each Local Government Areas (LGAs). The second stage involved a random selection of households in each of the selected communities. A total number of three hundred and forty (340) respondents were selected and used for the analysis of the study. The analytical tools were used including binary logistic, and multinomial logistic regressions.

The logit model was used to determine factors influencing the use of water for agricultural purposes in the area. In this study, the binary dependent variable *Y* is the probability of being an agricultural water user or non-user. The dependent variable *Y= 1* is the probability of a farmer being mainly using water for agricultural purposes and 0, otherwise.

The probability function is expressed in equations 1 and 2 below.

$$(y = 1) = P = \frac{e^{(\beta_0+\beta_1X_1 \ldots\ldots+\beta_nX_n)}}{e^{(\beta_0+\beta_1X_1 \ldots\ldots+\beta_nX_n)+1}} \ldots$$

$$P(y = 0) = 1 - P = 1 - \left\{\frac{e^{(\beta_0+\beta_1X_1 \ldots\ldots+\beta_nX_n)}}{e^{(\beta_0+\beta_1X_1 \ldots\ldots+\beta_nX_n)+1}}\right\}$$

From the equations above,

$y = 1$ represents the probability of being a user, and equals P

$y = 0$ represents the probability of being a non-user, and equals $1 - P$

β = Coefficient

X = Explanatory variables

Therefore, the binary logit regression model in equation 3 is derived from the two equations above.

$$\ln\left[\frac{p}{1-p}\right] = \beta_0 + \beta_1X_1 \ldots\ldots\ldots + \beta_nX_n \ldots$$

$\ln\left[\frac{p}{1-p}\right]$ can be written as in the equation 4 below:

$$\ln\left[\frac{Y_i}{1-Y_i}\right] = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4, \ldots\ldots\ldots \beta_nX_n, +\varepsilon_i$$

Where,

Y = Probability of being a user (agricultural water usage)

1-Y = probability of being a non-user

i = i^{th} observation in the sample

β_0 = the intercept,

β_1 - β_n = the coefficients,

X_1 - X_{12} = independent variables

ε_i = the error term.

The independent variables are specified below:

X_1 = Access to water source (1= well/tube well, and 0, otherwise)

X_2 = Livestock farming (yes = 1, and 0, otherwise)

X_3 = Technology adoption (Irrigation =1, and 0, otherwise)

X_4 = Location (steepy=1, and 0, otherwise)

X_5 = Soil type (sandy =1, and 0, otherwise)

X_6 = Farm size (hectares)

X_7 = Fish farming (yes=1; otherwise=0)

X_8 = Farm income (N)

X_9 = Crop farming (yes=1; otherwise=0)

X_{10} = Farming experience (years)

X_{11} = Education (years)

X_{12} = Distance to the nearest water source (Kilometer)

Multinomial logit (MNL) regression analysis was employed to ascertain the variables influencing the preference for water sources in the area.

The Model Specification: Let πj denote the multinomial probability of an observation falling in the jth categories of fish forms option, to find the relationship between this probability and the p -explanatory variables, X_1, X_2,…, Xp, the multinomial logistic regression model is given in equation 5 as thus:

$$\log\left[\frac{\pi_j(x_i)}{\pi_k(x_i)}\right] = a_{0i} + \beta_{1j}x_{1i} + \beta_{2j}x_{2i} + \ldots\ldots + \beta_{pj}x_{pi},$$

where j=1, 2… (k-1), i = 1, 2… p.

k = number of responses or dependent categories (water source options).

P = number of explanatory variables included in the model.

Since all the π add to unity, this reduces to equation 6 as:

$$\log \pi_j(x_i)) = \frac{\exp(a_{0i} + \beta_{1j}x_{1i} + \beta_{2j}x_{2i} + ... + \beta_{pj}x_{pi})}{1 + \sum_{j=1}^{k-1} \exp(a_{0i} + \beta_{1j}x_{1i} + \beta_{2j}x_{2i} + ... + \beta_{pj}x_{pi})}$$

For *j = 1, 2, ...(k-1)*, the model parameters are estimated by the method of multinomial logit.

The explicit function is represented in the equation (7).

$U_i = \beta_o + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + e_i$

Where: U_i = Water sources (1= Rainfall water; 2 = Borehole/Tap water; 3 = Well/tube water; and 4 = Stream/river water), while the independent variables were:

X_1 = Usage (1= for agricultural purposes, and 0, otherwise)

X_2 = Time spent (minutes)

X_3 = Extension service (Access =1, and 0, otherwise)

X_4 = Technology adoption (Irrigation = 1, and 0, otherwise)

X_5 = Soil type (sandy =1, and 0, otherwise)

X_6 = Farm income (N)

X_7 = Farming experience

X_8 = Education

X_9 = Distance to the nearest water source (Kilometer)

e_i = disturbance error

Results and discussion

Table 1 indicates that on the average, sampled population engaging in one agricultural enterprise or the other have had experiences for about 25 years. This implies that respondents had adequate experience that would guide their decision-making on water utilization in the area properly. The common soil type was sandy soil (62%) followed by clay and then loamy soils. The result is in line with the findings of (Huang and Hartemink, 2020) who stated that sandy soils are widely distributed across the world. The result on the shows that an average income of N669, 177.0 per annum was observed and the majority (40.4%) of them earned less than N400,000 per annul. This finding aligns with the study by (Gbadegesin and Olorunfemi, 2007) that low-income earnings in rural areas imply that willingness to pay for the provision of water supply in the communities is low. It will also affect their willingness to contribute to the management of the existing water supply in most of these communities.

About 35% of the respondents had at least primary school education, showing that a larger proportion of the respondents were illiterate. The low literacy level of the respondents won't allow the respondents to understand and adopt technology and management involved in the utilization of water to achieve good health and hygiene. This finding in line with the study of (Owolabi, 2017) that the more respondents are in the educated category the more they patronize pipe-borne water and mechanized boreholes as sources of water. The result in Table 1 also revealed that on the average, sampled respondents trek about 2.7km to fetch safe water while the time taken was an average of about 40 minutes. Andualem et al. (2021) also reported that the distance of the water source impacts the household's access to improved drinking water. Moreover, about 45.2% of the sampled population had access to a safe water sources. However, the sampled population preferred the following available water sources such as well (36.5%), rain (19.2%), boreholes (27.5%), and stream/river (16.8%). The average farm size was 4.03ha per household. 51% of the sampled population opted for irrigation technology adoption in the area. In addition, about 75% of the sampled population used water for crop farming, 15% used water for fish farming, and 10% used water for livestock farming. The result agrees with the study by (Huang and Hartemink, 2020) that the majority of household heads are employed in the crop sector which constitutes 80.5%. This indicates the importance of water to agriculture and rural economy.

In Table 2, the results show that the R^2 which is 0.705 implies that approximately 71% of the probability of using water for agricultural purposes is explained by the variables in the model. In the table, seven out of twelve variables were statistically significant in addressing water use for agricultural purposes in the study area. The coefficient representing the population that has access to safe water sources is positive and significant at a 5% level. This implies that having access to safe water sources will increase the likelihood of using water for agricultural purposes by 11.4% compared with those who do not have access. This suggests that having access to improved water sources encourages rural dwellers to engage in diverse agricultural activities.

Also, the result in Table 2 indicates that adopting irrigation technology gave a positive and significant relationship at a 5% level with water utilization for agricultural purposes. This implies that farmers who are practising an irrigating system of farming are more likely to use water for by 10.6% than those who do not adopt an irrigating system. The variable of soil type had a positive and significant coefficient at a 5% level in addressing agricultural water use. This implies that those respondents with sandy soil may likely utilize water for agricultural purposes by 15.5% more than those that have other types of soil, all things being equal. This emphasizes the influence of soil characteristics on water utilization patterns in agricultural practices.

In addition, the coefficient of fish farming was positive and significant at a 5% level, indicating that practising fish farming might increase the likelihood of utilizing water for agricultural purposes than those that do not by 16.5%. This is expected because fish cannot survive without adequate water facilities, thereby making water more useful for fish farmers than other types of farming. Likewise, the coefficient of crop farming was positive and significant at a 5% level. This implies that practicing crop farming might increase the probability of utilizing water for agricultural purposes by 3.4%. Food crop farmers need water to grow their crops as most of the crops are wholly dependent on water to survive within a short period. The coefficient of farming experience had a positive and significant relationship with water use for agricultural purposes. This shows that an increase in the year of farming experience will increase the probability of utilizing water for agricultural purposes by 1.7%, all this being equal. This implies that the respondents are likely to make better decisions on water management to enhance productivity and the best choice of adaptation practices to access potable/drinking water. This finding aligns with the study by (Koech et al, 2015) that experience is a key factor in improving the level of production. Also, the coefficient of the distance to the nearest water source was negative and statistically significant in addressing the water use in the area. This can be interpreted as the longer the water source the less likely it could be considered for agricultural purposes by 0.7%. The result was also supported by (Akinniran et al. 2017). It was observed that other variables which are not significant but positive could influence the use of water for agricultural purposes while the negative variables will do otherwise.

In Table 3 the statistically significant Likelihood Ratio (LR) at the 1% level suggests that the explanatory variables collectively influence households' choices regarding preferred water sources. The Table also revealed that variables such as agricultural usage, soil type, farm income, experience, and distance are significant in affecting the rainfall water source, while time spent in collecting water, access to extension services; technology adoption, soil type, and distance are significant in addressing borehole source. In the case of well water, access to extension services, technology adoption, experience, and distance are the main important factors while agricultural usage, access to extension services, technology adoption, soil type, and experience were statistically significant factors in the case of stream water source. In interpreting the results, utilizing water for agricultural purposes will likely influence the preference for rainfall and stream water sources by 7.8% and 1.6%, respectively compared with those that do others.

The coefficient of time spent fetching water was positive and significant at a 5% level with the borehole source, indicating that a minute increase in the average time of fetching water will reduce the probability of sourcing water from the borehole by 0.1%, all things being equal. This result supports the findings of (Ogunbode and Ifabiyi, 2014) that the majority of the farming households had to fetch water from outside their household yards which made it more difficult to meet their daily requirement. The access to extension services significantly influenced the preference for the source of water. It means that having access to extension services will increase the likelihood of sourcing water from boreholes and wells by 1.7% and 0.8%, respectively but reduces the chance of sourcing water from the stream by 4.7% compared with those who do not have access.

The coefficient of technology adoption was significant in addressing preference for water sources, indicating that adopting irrigation techniques/systems in farming will increase the chance of sourcing water from boreholes and streams by 4% and 1.7% more than those that do otherwise. The results could also be interpreted as respondents with a sandy soil type might reduce the likelihood of sourcing water from rainfall, borehole, and stream by 23.9%, 10.5%, and 5.3%, respectively compared with those that are with other types of soil, *ceteris paribus*. This implies that farmers with other soil types might likely source rain, boreholes, and streams in the area. This insight is crucial for understanding regional preferences based on soil characteristics.

The coefficient of farm income was only significant with rain sources, indicating that a unit increase in farm income reduces the probability of sourcing water from the rainfall source. The coefficient of farming experience was statistically significant and positive under rain, well, and stream water sources. It is an indication that as the year farming increases, the chance of souring water from rainfall, well, and stream sources increases by 2.6%, 1.0%, and 0.6%, respectively. Also, the coefficient of distance to the nearest source of water was negative but significant under rainfall, boreholes, and well sources. This means that the more the distance to the source of water, the less the likelihood of sourcing water from rainfall, boreholes, and well sources by 5.5%, 2.6%, and 2.1%, respectively.

The results of the in-depth interviews indicate that on water source preferences, the majority of rural households (70%) prefer traditional water sources (rivers, wells, and ponds) for agricultural purposes, while 30% prefer modern sources (boreholes and piped water). The results indicate a strong preference for traditional water sources among rural households in Yobe State, despite the challenges posed by climate change. This preference may be due to factors such as accessibility, affordability, and cultural attachment (Adeyanju et al., 2017).

On the agricultural water use, crop irrigation is the primary use of water (60%), followed by livestock watering (30%) and domestic purposes (10%). The dominance of crop irrigation in agricultural water use highlights the importance of water for food security in the region. However, the impacts of climate change on rainfall patterns and water availability necessitate adaptation strategies to ensure sustainable agricultural water use (Schmidhuber & Tubiello, 2007).

Climate Change Impacts: 80% of respondents reported changes in rainfall patterns, affecting crop yields and water availability. The findings suggest that rural communities in Yobe State are vulnerable to climate change. Thus, there is a need for climate-resilient agricultural practices and water management strategies to enhance food security and livelihoods (IPCC, 2014).

Conclusion

This study explored water source preferences and agricultural water use in rural communities in Yobe State, Nigeria, in the context of a changing climate. The findings indicate a strong preference for traditional water sources, despite the challenges posed by climate change. Crop irrigation is the primary use of water, highlighting the importance of water for food security in the region. The study reveals that rural communities in Yobe State are vulnerable to climate change, with changes in rainfall patterns affecting crop yields and water availability. To enhance food security and livelihoods, climate-resilient agricultural practices and water management strategies are essential.

The study recommends; promoting modern water sources, such as boreholes and piped water, to supplement traditional sources. Implementing climate-smart agricultural practices, such as drip irrigation and conservation agriculture. Enhancing water harvesting and storage techniques to reduce dependence on rainfall. Strengthening community-based water management institutions to ensure equitable water distribution. By addressing the complex relationships between water sources, agricultural water use, and climate change, this study contributes to the development of effective adaptation strategies for rural communities in Yobe State and similar regions. Future research should focus on: Assessing the economic viability of climate-resilient agricultural practices. Evaluating the impact of climate change on water quality and human health; and exploring innovative water technologies and management approaches. By prioritizing water security and climate resilience, we can ensure sustainable agricultural development and improved livelihoods for rural communities in Yobe State and beyond.

References

Adeyanju, S. O., et al. (2017). Water sources and irrigation practices among smallholder farmers in Niger State, Nigeria. Journal of Agricultural Extension, 21(1), 1-12.

Akinniran TN, Raufu MO, Ishola A (2017) Effect of risk attitude on household poverty of food crops farmers in Surulere Local Government Area of Ogbomoso, Oyo State, Nigeria. International Journal of Agriculture, Environment and Bio-research 2(01). Retrieved from https://ijacb.org/uploads/AEB-02-04.pdf

Andualem Z, Dagne H, Azene ZN et al (2021). Households access to improved drinking water sources and toilet facilities in Ethiopia: a multilevel analysis based on 2016 Ethiopian Demographic and Health Survey. BMJ open *11*(3), e042071.

Bryan, E., et al. (2013). Agricultural adaptation to climate change in Africa: A review of the evidence. Climate Change, 117(1-2), 1-22.

Brown, C. A., et al. (2019). Climate change impacts on water resources in Nigeria. Journal of Hydrology, 569, 1-13.

FAO (2016). The impact of climate change on water resources and agriculture. Food and Agriculture Organization of the United Nations.

Gbadegesin AS, Olorunfemi F (2007) Assessment of rural water supply management in selected rural areas of Oyo State, Nigeria (No. 49). Nairobi: African Technology Policy Studies Network.

Huang J, Hartemink AE (2020) Soil and environmental issues in sandy soils. Earth-Science Reviews 208, 103295.

IPCC (2014). Climate Change 2014: Impacts, Vulnerability, and Adaptation. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

Koech KE, Mutai KB, Kibet KL, Kosgei KG (2015) Determinants of market facilitators choice by smallholder farmers in Laikipia County, Kenya. Journal of Agriculture and Veterinary Science 8(1): 78-82.

Lobell, D. B., et al. (2008). Prioritizing climate change adaptation needs for food security in 2030. Science, 319(5863), 607-610.

Morton, J. F. (2007). The impact of climate change on smallholder agriculture in Africa. International Journal of Agricultural Sustainability, 5(1), 1-14.

NiMet (2020). Climate Change in Nigeria: Impacts, Vulnerabilities, and Adaptation Options. Nigerian Meteorological Agency.

Odekunle, T. O., et al. (2017). Impacts of climate change on agriculture in Nigeria. Journal of Agricultural Science and Technology, 17(4), 851-863.

Ogunbode TO, Ifabiyi PI (2014) Determinants of domestic water consumption in a growing urban centre in Osun State, Nigeria. African Journal of Environmental Science and Technology 8(4): 247-255.

Oguntunde, P. G., et al. (2018). Climate change and agriculture in Nigeria: A review. Journal of Environmental Science and Water Resources, 7(1), 1-12.

Oluwatayo, I. B., et al. (2019). Assessment of water sources and agricultural productivity in rural areas of Niger State, Nigeria. Journal of Water Resources and Environmental Engineering, 11(1), 1-10.

Pattanayak, S. K., et al. (2010). Water source preferences and demand for water treatment in rural India. Journal of Environmental Economics, 60(2)

Figure 1: Map of the Study Area (Yobe State showing the 17 LGAs) (Source: Yobe State Ministry of Land and Survey)

Table 1: Selected demographic profile of the respondents in the area

Variable	Mean	SD	Min	Max	Majority (%)
Income	669, 177.0	411,901.2	11,000.0	3,200,000	<400,000 (40.4%)
Experience	23.7	39.2	1	67	11 - 20 (25.6%)
Education	0.35	0.21	0	1	Educated (35.0%)
Distance	2.07	2.21	0.3	7	<1 (63.5%)
Soil types	1.54	0.51	1	3	Sandy (54.2%)
Time spent	19.65	21.71	1	63	40 - 45 67.5%)
Technology adoption	0.21	0.45	0	1	Yes (20.7%)
Crop farming	0.75	0.53	0	1	Yes (75.%)
Fish farming	0.15	0.55	0	1	Yes (15%)
Farm size	4.01	5.38	0.56	15	< 4ha (69.8%)
Livestock farming	0.10	0.43	0	1	Yes (10%)
Well water	0.36	0.22	0	1	Yes (36.5%)
Borehole water	0.27	0.32	0	1	Yes (27.5%)
Rainwater	0.19	36.1	0	1	Yes (19.2%)
Stream/River	0.16	28.3	0	1	Yes (16.8%)

Table 2: Marginal Effects of the Determinants of Using Water for Agricultural Purposes in the Area

Variable	Marginal Effects	Std. Err	P-value
Water source (well)	**0.114****	**0.046**	**0.013**
Livestock farming	**0.001**	**0.003**	**0.710**
Technology adoption	**0.106****	**0.220**	**0.373**
Location	**-0.024**	**0.049**	**0.632**
Soil type	**0.155****	**0.073**	**0.035**
Farm size	**-0.004**	**0.138**	**0.977**
Fish farming	**0.165****	**0.087**	**0.050**
Farm income	**-1.06e-07**	**2.11e-07**	**0.616**
Crop farming	**0.034****	**0.017**	**0.045**
Experience	**0.017*****	**0.003**	**0.000**
Education	**0.005**	**0.006**	**0.431**
Distance	**-0.007***	**0.004**	**0.069**

Log likelihood = -75.757; Number of observations = 120, LR chi2 (12) = 11.49; Prob > chi2 = 0.0048; Pseudo R^2 = 0.705; *, ** & * mean significant at 10%, 5% & 1%, respectively.**

Table 3: Results of Marginal Effects of MNL as the Determinants of Preference for Water Source

Variable	Rain		Borehole		Well		Stream/River	
	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
Usage	0.078***	0.001	0.035	0.498	0.032	0.421	0.016*	0.075
Sex	0.038	0.803	0.018	0.73	0.014	0.798	0.011	0.720
Time spent	0.003	0.527	0.001**	0.013	-0.001	0.522	-0.001	0.578
Extension service	-0.081	0.988	0.017*	0.096	0.008**	0.012	-0.047**	0.023
Technology adoption	-0.094	0.203	0.040**	0.037	0.030	0.129	0.017***	0.006
Household size	-0.066	0.553	-0.027	0.564	-0.020	0.607	-0.009	0.690
Marital status	0.140	0.326	0.063	0.292	0.057	0.178	0.030	0.362
Soil type	-0.239**	0.037	-0.105*	0.056	-0.076	0.138	-0.053*	0.071
Income	-4.06e-07*	0.075	-1.79e-07	0.148	-1.43e-07	0.126	-8.00e-08	0.300
Education	0.020	0.823	0.011	0.776	0.015	0.614	0.008	0.683
Experience	0.026***	0.004	0.012	0.118	0.010**	0.028	0.006**	0.011
Distance	-0.055*	0.082	-0.026*	0.096	-0.021*	0.076	-0.015	0.198

Log likelihood = -110.753; Number of observations = 120, LR chi2 (36) = 62.630; Prob > chi2 = 0.0039; Pseudo R^2 = 0.2204; *, ** & *** mean significant at 10%, 5% & 1%, respectively.