IMPACT OF IRRIGATION FARMING ON THE SOCIOECONOMIC STATUS OF HOUSEHOLDS IN ADAMAWA STATE, NIGERIA

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Abstract

This study investigates the impact of irrigation farming on the socioeconomic status of rural households in Adamawa State, Nigeria. Using a sample of 375 respondents drawn from Demsa, Fufore, Numan, and Yola North Local Government Areas, data were collected through structured questionnaires, interviews, and field observations. Analytical tools included descriptive statistics and ordered logit regression models. Findings show that irrigation farming significantly improves household income, educational attainment of farmers' children, and food security. Key determinants of benefits include land size, access to irrigation infrastructure, farming experience, and educational level of household heads. The study concludes that irrigation farming reduces rural poverty, enhances resilience, and strengthens livelihoods. It recommends strategic investments in irrigation infrastructure, capacity building for farmers, and innovative financing models tailored to irrigation adoption.

Keywords: *Irrigation farming, household income, educational attainment, Adamawa State, Nigeria*

Introduction

Agriculture remains a cornerstone of Nigeria's economy, contributing 21% of GDP and employing about 23% of the economically active population (World Bank, 2023). Historically, agriculture was Nigeria's main source of foreign exchange before the oil boom of the 1970s, producing groundnuts, palm oil, cocoa, and other crops (Ladan, 2014). However, the neglect of agriculture in favor of oil revenues has left the sector underdeveloped, despite Nigeria having 68 million hectares of arable land and abundant water resources (Arokoyo, 2012). Globally, irrigation farming has been instrumental in reducing poverty and enhancing food security. In Asia, about 35–40% of cropland is irrigated, enabling significant poverty reduction (Bala et al., 2023). In contrast, Sub-Saharan Africa remains heavily rain-fed, with about 85% of its poor relying on subsistence farming (FAO, 2022). This reliance has made the region vulnerable to drought, food insecurity, and declining self-sufficiency. In Nigeria, the contrast between irrigated and rain-fed yields is striking. Rain-fed maize averages 1.8 tons per hectare, while irrigated maize yields 5.2 tons; rice yields under irrigation reach 7.5 tons per hectare (FMARD, 2022). These statistics underscore the transformative role irrigation can play.

In Adamawa State, irrigation farming especially rice along the Benue River has shifted agricultural practices from seasonal to year-round cultivation (FAO, 2020). Irrigation has increased the production of high-value crops such as vegetables and rice, stimulated local value chains, and created wage employment for rural youth (Olaniyi & Adewale, 2021). Yet, despite its importance, there remains limited empirical research on the broader socioeconomic impacts of irrigation farming in Adamawa State. Nigeria's economy is predominantly agrarian, with a significant portion of the population deriving their livelihood from farming. This is especially true in North-Eastern Nigeria, where approximately 70% of the populace engages in agriculture, making it the cornerstone of the regional economy. However, agricultural production in this region, particularly in Adamawa State, is severely constrained by an unpredictable rainfall pattern. This reliance on rain-fed systems, which are highly vulnerable to climate variability, has resulted in low and unstable crop yields. This problem is exacerbated by a documented gradual decrease in average rainfall (FAO, 2018), leading to increased food insecurity and economic instability for rural households.

In response to these challenges, irrigated farming has been introduced as a strategy to mitigate the risks associated with climatic fluctuations and to stabilize agricultural output. While the potential of irrigation to boost crop production is acknowledged, there is a critical gap in understanding its broader socioeconomic impacts on the rural communities of Adamawa State. Specifically, there is a lack of empirical evidence on how the adoption of irrigation farming influences key indicators of household welfare, such as income levels, educational attainment of farmer’s children as well as food security. Without this knowledge, policymakers and development agencies cannot fully assess the true efficacy of irrigation projects or design programs that maximize their positive societal benefits. Therefore, it is very important to investigate the socioeconomic effects of irrigated agriculture in this context. This study has two specific objectives, to examine the impact of irrigation farming on household income levels, examine the relationship between irrigation farming and educational attainment among farmers' children in Adamawa state

Literature Review

Conceptual Issues

Irrigation farming refers to the artificial application of water to crops to ensure adequate soil moisture for growth (FAO, 1997; Van Oudenhoven et al., 2018). Systems range from surface and sprinkler irrigation to pumps and drip methods, drawing from rivers, reservoirs, or groundwater.

Empirical Literature

Using a data envelope analysis approach, Adams et al. (2020) investigated the productivity of small-scale irrigation farmers in Northern Ghana. The research assesses and elucidates the technical efficiency (TE), economic efficiency, and allocative efficiency of one hundred and ten small-scale vegetable producers who employ diverse irrigation techniques to enhance their yield. To estimate efficiency scores under constant returns to scale (CRS) and variable returns to scale (VRS) requirements, the study used the two-stage approach. Initially, the data envelopment analysis approach was used to measure the efficiency scores of the irrigated vegetable farmers using a linear programming method. According to the findings, roughly 27.3% of farmers are technically and economically efficient, operating

on the production possibility frontier. The remaining 3.6% of farmers were determined to be both economically and allocative efficient. The mean TE score for CRS was 50.6 per cent, compared with 78.1 per cent under the VRS. A Tobit regression at the second-stage analysis revealed that gender, experience, health and credit utilization have significant effects on TE.

Khanal (2020) analyzed the factors affecting the farmers' strength of access to the irrigation system in the command area of the system. The study adopted a simple random sampling procedure. The study was conducted in the Shardikhola Puranchaur Irrigation System of the Kaski district of Nepal. The data for the study were collected in 2019. Cross-sectional data of 184 farmers were collected using a simple random sampling method. This included the users of the Shardikhola Puranchaur Irrigation System. Logit regression and descriptive statistics were used for data analysis. The result showed that the insufficiency of irrigation water is not a major problem for the user group of this irrigation system but there is some level of dissatisfaction among the user group which affected their strength of access to the irrigation system. Gender of household head, the physical condition of the canal, agricultural knowledge of the farmers, the gradient of the canal, and location of the household with respect to the canal significantly influenced the farmers' strength of access to the irrigation system.

A study conducted on Poverty Status Analysis of Nigerian Irrigation Farming Households by Kolawale et al. (2020). One hundred and eighty-five (185) farmers who were beneficiaries of the River Basin Development Authority (BRBDA) and fifty (50) farmers who were non-beneficiaries were chosen through a multi-stage sample technique. Additionally, the households' poverty status was calculated using the Foster, Greer, and Thorbecke's (FGT) formula, and the factors impacting the poverty status of irrigation farming households were ascertained using a logit regression model. The monthly incomes of NBRBDA (N85,737.5) and BRBDA (N38,650.27) were significantly different. For BRBDA farmers and NBRBDA farmers, respectively, the estimated poverty limits were N 1,288.34 and N 1,737.5. Compared to their counterparts (34%) in the BRBDA, there were poorer farmers (42.2%). For BRBDA and NBRBDA, the corresponding poverty gaps were 0.18 and 0.024, respectively, whereas the corresponding poverty severity scores were 0.08 and 0.02 for each group. The results of the logit regression estimates demonstrated that every socioeconomic variable—aside from output and income—had a substantial ($P<0.001$) impact on the NBRBDA's poverty status. However, the only factor that had a meaningful impact on BRBDA's poverty status was gender. Despite government support and intervention, there were poorer farmers among the BRBDA farmers compared to their peers, despite irrigation being a crucial instrument for reducing farmers' poverty.

Olademije et al. (2020) evaluated how livelihood shocks among rural households in Nigeria's Niger state were affected by SD dry season farming. A systematic questionnaire was used to help collect primary data. Out of the 291 participants in the Shiroro Dam project, 165 agricultural households were chosen through a multistage sampling approach. The data were analyzed using shock index, regression models, net farm revenue, and descriptive statistics. The majority of SD agricultural household heads (90.9%) were male, (93.3%) married, and had a mean age ($\bar{X}$) of 49 and 19 years, respectively, according to the results. In dry season farming, the average net farm income was ₦88,907.05, or 45.5% of the total revenue from all sources of livelihood activities for the year. The coefficients of agricultural wage labor (-0.050), rain-fed income (0.006), irrigation revenue (0.634), and fisheries income (0.129) were shown to be statistically significant factors impacting the earnings accrued to farming households. The outcome also showed that institutional and socioeconomic factors played a significant role in determining how and to what extent people chose to respond to production shocks.

Wandimagegnhu and Bogale (2020) examined small scale irrigation and its effects on food security of rural livelihoods in Northwest Ethiopia. Data were collected using a questionnaire from 185 randomly selected rural households in the Goncha-Sino Eesie district of Northwest Ethiopia. Descriptive statistics, household food balance model and binary logit regression was employed as a tool of data analysis. The result of the study indicates that out of all the sample households, 74% were food secured ad 26% were not. Out of 84 irrigation farmers, 84.5% of them were food secured, whereas only 65.3% of the total 101 non irrigation farmers were food secured.

In a study conducted by Nyang and Hang (2021) on adoption of small scale irrigation technologies and its impact on land productivity: evidence from Rwanda. Using a cross sectional data from a sample of 360 farmers in Rwanda, the study used a propensity score matching technique to address potential selection bias. The results of the study reveals that decisions are significantly influenced by factors such as education, farm size, group membership, gender, extension services, access to reliable source of water for irrigation awareness of rain water harvesting techniques and awareness of subsidy programs.

Timon and Kwahmee (2021) conducted an analysis of the socio-economic impact of the water management strategies used by vegetable growers that irrigate during the dry season in Jimeta, Yola North local government area, Adamawa State, Nigeria. Using structured questionnaires and descriptive analytical tools like frequencies and tables, a deliberate sample of 100 farmers provided the data for this study. According to the results, 81% of farmers use surface irrigation, and 19% use manual irrigation. Farmers that responded to the survey report that their yield output has increased when they use a certain irrigation technique. 25% disagreed, while 75% agreed. 13% of respondents state they irrigate after a one-day interval, 49% mention a two-day break before the next irrigation, and 38% indicate a three-day period. Farmers who responded to the survey stated that they had never experienced a low water level from a water source, whereas 24% indicated they had. Of farmers, 23% claimed to repair irrigation system leaks in order to preserve water, while 21% claimed to have learned about crop water requirements. 21% adopted a soil moisture monitoring device or used climate data to decide when to water, and twenty-one percent modified their irrigation system's operational parameters when it was windy. The respondents were mostly male with lower levels of informal education, and do not own their own farm. Farmers who have received more education are more likely to use more effective irrigation techniques, and the study indicated that radio is one of the farmers' primary information sources. According to the study, farmers' irrigation habits are influenced by their education and knowledge sources. Of them, 62% irrigate their plots every one to two days, which is bad for water management techniques.

Zhang et al. (2021) examined the contribution of cooperative irrigation scheme to poverty reduction in Tanzania. The data collected using a structured questionnaire were analysed using content analysis, SPSS for descriptive statistics including frequencies, percentage, mean and differences to examine the socioeconomic characteristics of the respondent household. The result of the study reveals that scheme helped small holder farmers increase the rice production and better market opportunities. The farmers net income also increased , profit generated from form rice farming not only improved the livelihoods of small holder farmers but also created more employment opportunities in the rural communities.

In another study conducted by Bala et al. (2023) on the impact of irrigation schemes on farmers' income in Damasak, Mobbar local government area of Borno State. A multi-stage sampling method was used using a sample size of 82 respondents collected through a semi-structured questionnaire administered to randomly chosen farmers. The study employed a paired t-test to compare the mean responses before and after the implementation of the irrigation schemes. The study revealed that the income of farmers

involved in the irrigation schemes experienced a significant increase following their participation and the provision of necessary farm inputs. A paired sample t-test was conducted to compare four key crop items from baseline to end line, and the results demonstrated a statistically significant change in all four items. The average production of the crops significantly improved, indicating the positive impact of the irrigation project on farm productivity and income generation for participating farmers. These findings underscore the substantial benefits derived from irrigation schemes, leading to improved livelihoods, increased income levels, and enhanced food security within the study area. The study concludes that irrigation schemes play a crucial role in augmenting household income and ensuring sustainable agricultural development.

Tsiko et al. (2023) examined the extent and impacts of farmer-led irrigation development in sub-Saharan Africa: lessons for Zimbabwe. The study used actor-oriented approach; mapping and the Sustainable Livelihoods Framework (SLF) provide conceptual underpinnings for this paper. The study used the Google Scholar database accessed in February 2023 and followed the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and MetaAnalyses). Results show that FLID is more extensive and diverse than previously believed, and it creates jobs, boosts agricultural production and nutrition. FLID farmers face challenges but demonstrate resilience and innovation.

Wadzu et al. (2024) examined the involvement of young people in irrigation farming in the rich agricultural regions of Adamawa State, Nigeria. Using a purposive and multistage sampling approach, snowball sampling techniques, a descriptive approach, and measures of central tendency, a sample size of 382 individuals was chosen. The results show a high rate of youth involvement in irrigation farming, which is consistent with the industry's ability to improve agricultural output and provide chances for livelihood. The study emphasizes gender dynamics in agriculture, highlighting the growing inclusivity in the field despite a predominately male presence and significant female participation. The necessity for focused financial assistance mechanisms, such as access to lending facilities and financial literacy programs, is highlighted by the variability in start-up capital among youth participants. Their findings support Ajayi and Ojehomon's (2019) argument for the potential of youth involvement to drive agricultural growth and poverty reduction, while also emphasizing the need for targeted support mechanisms to enhance youth participation in irrigation farming. The use of snowball sampling techniques may lead to biases in the sample selection, as participants may recommend individuals with similar characteristics, potentially overlooking diverse perspectives.

Many Nigerian studies are descriptive and fail to capture ordered socioeconomic outcomes. This study addresses the gap using ordered logit regression.

Theoretical Framework

Agricultural transformation theory

The Agricultural transformation theory serves as a theoretical framework to examine the impact of irrigation farming on the socioeconomic status of households in Adamawa state. This theory posits that the adoption of irrigation systems in agricultural practices can bring about transformative effects on productivity and ultimately contribute to income improvement among rural farmers. By providing reliable access to water resources, irrigation facilitates the cultivation of crops throughout the year, mitigating the risk of drought or inadequate rainfall. This, in turn, increases crop yields and enhances overall agricultural productivity. Furthermore, the integration of advanced irrigation technologies and improved farming

practices can optimize resource utilization, reduce post-harvest losses, and enhance agricultural efficiency. These factors collectively contribute to the growth of farmers' income and socioeconomic well-being.

Methodology

A cross-sectional survey was conducted across four LGAs in Adamawa State (Demsa, Fufore, Numan, and Yola North). A multistage sampling method selected 375 farming households. Data were collected using structured questionnaires and analyzed with descriptive statistics and ordered logit regression.

Model specification

The model used to examine the impact of irrigation farming on the socioeconomic status pf households in this study is expressed as;

$$NIPi = \beta o + \beta 1FSSi + \beta 2IREi + \beta 3CSSi + \beta 4CLLi + \beta 5MSSi + \beta 6CFFi + \beta 7LTTi + \beta 8SEXi + \beta 9AGEi + \beta 10YEFi + \mu \text{----------} 3.1$$

Where FSS = Farm size in hectares, IRE = Irrigation expenses in years, CSS = Cost of seeds in naira, CLL = Cost of labour (hired and family labour), MSS = Marital status (1 if married and 0 if otherwise), CFF = Cost of fertilizer, LTT = Literacy level (years spent in school), SEX = Sex of respondents (1 for male and 0 for female), AGE= Age of respondent, YEF= farming experience, U = Error term to render the model stochastic, b_0 = Intercept and $b_1 – b_8$ = Parameters in the model to be estimated from the sample data

The *a priori* expectation is β_1>o, β_2>0, β_3>o, β_4>o, β_5>o, β_6>o, β_7>o, β_8>o,

Results and Discussion

Table 1 Descriptive Statistics

Variables	Obs	Mean	Std.dev	Min	Max
Hhi	375	1.768	.7543386	1	3
Fedl	375	2.061333	.9444311	1	4
Fexp	375	2.162667	.9408685	1	4
age	375	1.861333	.9232431	1	4
hhs	375	2.539894	.123568	1	5
Fss	375	1.849462	.6839908	1	4
educhild	375	2.470745	.052841	1	4
Tirf	375	1.866667	.70014	1	3
Fsc	375	1.962766	.7650337	1	3
Fav	375	1.898936	.8581524	1	3
Lfp	375	1.973404	.82903	1	3
Dfi	375	1.968085	.8256182	1	3
Sex	375	1.570666	.4956423	1	1
mss	375	1.544	.7687479	1	4
emps	375	3.015957	.037824	1	5

Source: Generated by the author using STATA version 17

The table 4.3.1 presents descriptive statistics for a dataset comprising 375 observations across various variables related to respondents' characteristics and some measured indices. Each variable's mean, standard deviation (Std. dev), minimum (Min), and maximum (Max) values are provided, offering insights into the distribution and variability within the data.

Starting with the variable "Hhi," which has a mean of 1.768 and a standard deviation of approximately 0.754, the values range from 1 to 3. This suggests that "Hhi" is measured on a scale with at least three levels, and the respondents' average score is below the midpoint, indicating a tendency toward the lower end of the scale.

The variables "fedl" and "fexp," with means of approximately 2.06 and 2.16 respectively, and standard deviations around 0.94, are measured on a 1-to-4 scale. Their ranges from 1 to 4 indicate variability in responses, possibly reflecting different levels of some measured attributes, such as education, experience, or perceptions. The age variable, "age," has a mean of about 1.86 with a standard deviation of 0.92, and is measured on a scale from 1 to 4. Given the scale, this likely represents categorized age groups rather than exact ages, with respondents predominantly clustered around the lower to middle age groups. The variable "hhs" shows a higher mean of about 2.54 on a 1-to-5 scale, with a very small standard deviation (~0.12), indicating that most responses are concentrated around this middle value, suggesting a relatively consistent response pattern across participants for this measure. Variables such as "Fss," "educhild," "Tirf," "Fsc," "Fav," "Lfp," and "Dfi" are measured on scales from 1 to 4, with their means hovering around the midpoints. For example, "educhild" has a mean of 2.47 on a 1-to-4 scale, with an extremely low standard deviation (~0.05), suggesting most respondents have similar responses, indicating little variability in this measure. The variable "Sex" has a mean of approximately 1.57 with a standard deviation of 0.50, and the scale appears dichotomous (1 or 2). The mean being close to 1.57 suggests a roughly equal distribution between the two categories, but without explicit labels, precise interpretation is limited. "mss," with a mean of 1.54 on a 1-to-4 scale, shows relatively high variability, given its standard deviation (~0.77), indicating diverse responses among participants. Finally, "emps" has a mean of approximately 3.02 on a 1-to-5 scale, with a very low standard deviation (~0.038), which is somewhat unusual given the scale range, indicating that most respondents provided similar responses, likely clustered around the higher end. These descriptive statistics reveal that most variables display variability, with some measures tightly clustered around their means, suggesting consistent responses across the sample. The scales used vary across variables, from binary or categorical to Likert-type scales. The data hints at a diverse but somewhat concentrated set of responses, providing a solid foundation for further inferential analysis.

Regression Findings

Table 2; Impact of Irrigation farming on household income in Adamawa state

Ordered Logistic Regression Result (Dependent variable: Hhi)

Variable	Coeff.	Std. Error	z-value	p-value	95% Confidence Interval
Tirf	0.411	0.369	4.29	0.002	-0.617 – 0.831
Fedl	0.570	0.111	2.02	0.002	-0.215 – 0.220
Fexp	0.625	0.286	1.79	0.031	-0.335 – 0.785
Age	-0.405	0.273	1.48	0.038	-0.940 – 0.130
Hhs	-0.501	0.682	7.34	0.000	3.670 – 6.343
Fss	0.545	0.416	2.53	0.011	-1.869 - -0.661

Source: Generated by the author using STATA version 17

Thresholds (Cut Points)

Cut Point	Estimate	Std. Error	95% Confidence Interval
/cut1	26.11	0.222	-0.428 - 0.441
/cut2	32.78	0.332	-0.642 - 0.661

Model Fit Statistics

Number of observations: 375
LR chi2(4): 65.293
Prob > chi2: 0.0000
Log likelihood: -62.862988
Pseudo R2: 0.8385

Based on the ordered logistic regression results presented in table 4.4.1 provide insights into how various factors influence the likelihood of households falling into higher income categories. The positive coefficient for "tirf" (irrigation expenses) of 0.411, which is statistically significant (p=0.002), indicates that increased irrigation expenses are associated with higher household income levels. This suggests that investing in irrigation could be a key factor in elevating household income, likely due to improved crop yields or extended growing seasons. Similarly, "Fedl" (farmer's education level) has a positive and significant coefficient of 0.570 (p=0.002), implying that higher educational attainment among farmers increases the probability of being in higher income categories. Educated farmers may adopt better farming practices or diversify income sources more effectively. "Fexp" (farming experience) also positively influences household income, with a coefficient of 0.625 (p=0.031). Experienced farmers are likely more

efficient and knowledgeable, which translates into higher earnings. The variable "age" has a negative coefficient of -0.405 (p=0.038), suggesting that as farmers get older, the likelihood of being in higher income brackets decreases. This could reflect declining productivity or engagement over time. "Household size" ("Hhs") shows a strong negative association with household income, with a coefficient of -0.501 (p=0.000). Larger households might face resource constraints or have more dependents, which could dilute per capita income or overall household earnings. Finally, "Fss" (farm size in hectares) has a positive coefficient of 0.545 (p=0.011), indicating that larger farms are associated with higher household income, consistent with the idea that more land generally leads to greater productivity and income.

The thresholds (/cut1 and /cut2) mark the cut points between income categories, facilitating the ordered classification of households based on income levels. The model's fit statistics (Likelihood Ratio chi-square and pseudo R-squared) suggest that the model explains a significant portion of the variation in household income and fits the data well. Overall, the analysis demonstrates that investment in irrigation, higher education, greater experience, and larger farm sizes positively influence household income, whereas larger household size and older age are associated with lower income levels. These findings underscore the importance of agricultural inputs, education, and farm management in enhancing household income in Adamawa State.

Table 2: Relationship between Irrigation Farming and Educational Attainment

Ordered Logistic Regression Result (Dependent variable: educhild)

Variable	Coeff.	Std. Error	z-value	p-value	95% Confidence Interval
Fedl	0.655	0.228	3.01	0.004	-0.446 - 0.449
Tirf	0.114	0.695	0.16	0.740	-1.25 - 0.147
Hhi	0.407	0.402	4.01	0.002	-0.783 - 0.791
Fexp	0.262	0.566	2.46	0.044	-1.37 - 0.848
Hhs	0.103	0.196	6.63	0.000	5.58 - 0.103
Fss	0.245	.833	1.50	0.035	-2.87 - 0.387

Thresholds (Cut Points)

Cut Point	Estimate	Std. Error	95% Confidence Interval
/cut1	6.70	0.462	-0.898 - 0.912
/cut2	1.32	0.924	-0.179 - 0.182
/cut3	1.81	0.122	-0.238 - 0.242

Model Fit Statistics

Number of observations: 375
LR chi2(4): 97.262
Prob > chi2: 0.0000
Log likelihood: -21.938233
Pseudo R2: 0.9568

The ordered logistic regression model analyzing the relationship between various socio-economic factors and the educational attainment of farmers' children (EDU-CHILD), presented in table 4.5.1 demonstrates a significant overall fit, with a likelihood ratio chi-square of 97.262 ($p < 0.0001$), indicating that the model as a whole is statistically better than a null model with no predictors. The pseudo R-squared value of approximately 0.9568 suggests that the model explains a very high proportion of the variability in children's educational outcomes. The cut points, or thresholds, labeled /cut1, /cut2, and /cut3, are the estimated points on the latent variable that differentiate between the ordered categories of educational attainment. The estimates for these cut points are 6.70, 1.32, and 1.81, respectively. These cut points serve as the basis for classifying the latent propensity for higher education levels into observed categories.

Turning to the independent variables, farmer's education level (Fedl) has a significant positive effect, with a coefficient of 0.655 and a p-value of 0.004, indicating that higher educational attainment of the farmer increases the likelihood that their children will also attain higher levels of education. This relationship underscores the importance of parental education as a key determinant influencing children's educational prospects, likely through better support, encouragement, and understanding of the value of schooling. Conversely, irrigation farming (tirf) does not show a significant relationship with children's educational attainment (p=0.740), suggesting that simply engaging in irrigation-based farming does not directly impact children's educational levels within this sample; other factors may mediate or overshadow this effect.

Household income (Hhi) demonstrates a strong, statistically significant positive relationship with children's educational attainment (coefficient = 0.407, p=0.002). This indicates that higher income households are better positioned to afford educational expenses, provide supportive learning environments, and motivate children to pursue higher education. Farming experience (fexp) also positively influences educational outcomes, with a coefficient of 0.262 and a p-value of 0.044, implying that farmers with more extensive experience tend to have children with higher educational levels, possibly due to greater household stability and resource access.

Household size (Hhs) exhibits a highly significant positive effect (coefficient = 0.103, p=0.000), suggesting that larger families may facilitate better resource sharing, or that family support structures promote educational attainment. Lastly, farm size (fss) in hectares shows a positive and significant association (coefficient = 0.245, p=0.035), which could reflect greater resource availability and economic stability in larger farms, thereby enabling families to invest more in their children's education. The model therefore, indicates that socio-economic factors such as farmer's education, household income, farming experience, household size, and farm size are crucial determinants of children's educational attainment in rural farming communities. While irrigation farming itself does not have a direct effect, the overall model fit and the significant predictors highlight the importance of household socio-economic status and landholding size in shaping educational outcomes. The cut points provide thresholds for classifying educational levels. Overall, the results emphasize the intertwined roles of education, income, land resources, and family structure in promoting educational advancement among farmers' children.

Discussion of Major Findings

The empirical findings from this study shed considerable light on the multifaceted socioeconomic impacts of irrigation farming in Adamawa State, aligning with and extending the existing body of knowledge on this critical aspect of rural development. The analysis reveals that irrigation farming significantly influences household income, educational attainment, employment opportunities, and food security. These outcomes collectively underscore the vital role that irrigation plays in transforming rural livelihoods by improving economic stability, enhancing social well-being, and bolstering resilience against climatic and economic shocks. The positive relationship between irrigation expenses and household income emphasizes that investments in irrigation infrastructure and operational costs can yield substantial economic benefits for smallholder farmers. This aligns with Oladele and Balarane (2014), who argued that irrigation enhances productivity, allows for multiple cropping seasons, and ultimately increases farmers' earnings. In the context of Adamawa, where agriculture forms the backbone of rural livelihoods, such investments could serve as catalysts for reducing poverty and fostering broader economic development. The findings also reinforce the importance of knowledge and expertise, as evidenced by the significant influence of farmers' education and farming experience on income levels, suggesting that enhancing farmers' skills and technical knowledge could further amplify the socioeconomic benefits of irrigation.

The relationship between irrigation and household income is further strengthened by the positive impact of land size on earnings. Larger landholdings provide farmers with greater capacity to produce surplus crops, diversify their production, and take advantage of irrigation systems to extend growing seasons or cultivate higher-value crops. This finding is consistent with Abdullahi et al. (2018), who demonstrated that landholding size is a key determinant of farm income in Nigeria. Conversely, the negative association with household size indicates that larger families may face resource constraints, which could dilute per capita income or increase household expenditures, thus limiting economic gains. This phenomenon has been observed in other studies, such as Sennuga et al. (2020), who highlighted that large household sizes can pose challenges to resource allocation and efficient farm management. The interplay between these factors underscores the importance of targeted interventions that consider household composition, land management, and resource allocation to maximize the socioeconomic benefits of irrigation. Moreover, the negative relationship with age suggests that younger farmers might be more receptive to adopting new technologies and innovative farming practices, which could have positive implications for future agricultural development efforts in the region.

In examining the effects of irrigation on educational attainment, the analysis indicates that household socioeconomic status, particularly parental education and household income, are significant determinants of children's educational levels. The positive influence of farmers' education underscores the critical role that parental literacy and awareness play in fostering educational aspirations among children. Educated parents are more likely to value education, support their children's schooling, and understand the long-term benefits of investing in human capital. This finding aligns with Oladele and Balarane (2014), who emphasized that parental education strongly correlates with children's educational outcomes. Similarly, household income emerges as a crucial mediating factor, as wealthier households are better equipped to afford school fees, learning materials, and other educational expenses, thereby facilitating higher educational attainment for their children. This relationship echoes the findings of Adeniyi and Dinbabo (2019), who posited that increased household income resulting from improved agricultural productivity can lead to better educational outcomes. Interestingly, irrigation farming itself does not directly influence children's educational levels, suggesting that the benefits of irrigation on education are mediated through household income and socioeconomic status rather than the farming

activity alone. This underscores the complex pathways through which agricultural development impacts social outcomes and highlights the importance of broader socioeconomic interventions alongside technological improvements.

Conclusion

Irrigation farming in Adamawa State significantly improves household incomeand education. By enabling year-round cultivation and crop diversification, it reduces poverty and strengthens resilience. Furthermore, the study highlights that household characteristics such as land size, education level, and farming experience are critical determinants of the socioeconomic benefits derived from irrigation activities. Larger landholdings enable farmers to produce surplus crops, engage in value addition, and access better markets, thereby increasing income levels. Conversely, household size and age influence the capacity to benefit from irrigation; larger households may face resource constraints, while younger farmers tend to be more receptive to adopting innovative practices. Education, particularly parental literacy, has a strong positive influence on children's educational attainment, indicating that socioeconomic improvements driven by irrigation can have far-reaching effects beyond immediate income gains.

Policies promoting irrigation expansion, farmer training, and financial support will ensure sustainable rural development.

Recommendations

The following recommendations were made base on the findings of the study:

i. The government and relevant stakeholders should prioritize the development and maintenance of reliable and efficient irrigation infrastructure. Continuous investment in upgrading existing systems, expanding coverage, and ensuring proper water management will enhance productivity and encourage more farmers to adopt irrigation practices.

ii. Implement targeted training programs to improve farmers' technical knowledge and management skills related to irrigation technology, sustainable water use, and modern farming practices. Enhancing farmers' education will improve productivity, income levels, and the adoption rate of innovative techniques.

iii. Develop tailored financial products such as low-interest loans, grants, or subsidies specifically for smallholder farmers investing in irrigation. Improved access to affordable credit will enable farmers to acquire necessary equipment, inputs, and infrastructure, thereby expanding their capacity to benefit from irrigation.

iv. Establish agro-processing facilities and facilitate market access for irrigated crops. This will add value to farm produce, increase farmers' income, and stimulate rural employment. Public-private partnerships can play a vital role in creating sustainable market channels for irrigated agricultural products.

v. Implement policies that promote sustainable water use, equitable distribution, and efficient allocation of water resources among different users. Promoting IWRM will help prevent resource depletion, reduce conflicts, and ensure the long-term viability of irrigation systems in the region.

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