



Examining the Influence of Irrigation Farming on Sustainable Livelihoods in Rural Communities of Zamfara North Senatorial Zone

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Abstract

Agricultural production has become the major source of food production to enhance food security and for socioeconomic independence. This study aims to evaluate the impact of irrigation farming on food security in rural communities of Zamfara North senatorial zone and to examine the influence of irrigation farming on the standard of living in rural communities of Zamfara North senatorial zone. The research adopted cross sectional survey research design, with a sample size of 370, using purposive sampling techniques for the study. Data were collected through the use of structured questionnaires designed in a five likert scale, data were analysed using partial least square structural equation model PLS-SEM by using measurement model to measure the reliability and validity of the construct and using structural model to test the hypothesis. The findings shows that irrigation farming significantly contributes to improving food security in rural communities in Zamfara North senatorial zone and Irrigation farming has a significant impact on improving the standard of living for farming households in Zamfara North senatorial zone. The study concludes that Irrigation farming is a critical enabler of both food security and an improved standard of living in rural communities in Zamfara North senatorial zone. The study recommends that Governments and development agencies should prioritize building and upgrading irrigation infrastructure and establish training programs and workshops focused on efficient water use, crop diversification.

Keywords: irrigation, farming, food security, standard of living and infrastructure.

1.1 Introduction

Agriculture remains a vital component of rural livelihoods in Nigeria, particularly in Zamfara North senatorial zone, where the majority of the population depends on farming for sustenance and income. However, conventional rain-fed farming is often subject to climatic uncertainties, affecting productivity and food security. Irrigation farming, as an alternative, has the potential to mitigate the risks posed by weather variability, increase crop yields, and promote sustainable livelihoods (Umer, et al., 2024).

Irrigated agriculture is considered a key strategy in most developing nations by providing food security, generate employment and reduce poverty, hence achieving the Sustainable Development Goals (SDGs) aims to Promote sustained, inclusive and sustainable economic growth, full and productive employment, and decent work for all (Hilson, 2020). The problems of food insecurity, malnutrition, hunger, employment and poverty have drawn more attention from researchers due to factors such as land degradation, biological diversity loss, soil nutrient mining, and climate variability and change. Many developing nations contend that improving food and nutrition security, expanding agriculture to generate employment, and reducing poverty are all made possible by investments in irrigation infrastructure to better the standard of living (Geda, 2023).

Khondoker, (2023) stated that feeding growing populations has traditionally been a major function of irrigation, and this function will increase in the future. In regions with dry seasons, it is not only increasing the yields of particular crops but also extends the length of time that crops can be produced effectively. This allows for multiple cropping, which allows for the production of two, three, and occasionally four crops annually, when otherwise only one crop could be cultivated. Since irrigation offers security, it becomes economically viable to add more inputs to increase productivity.

A sustainable livelihood is a concept used in development to understand how people, especially those in rural communities, make a living in a way that is sustainable, resilient, and capable of withstanding external shocks (Hemathilake & Gunathilake, 2022). It emphasizes the ability of individuals, households, and communities to sustain their means of living without depleting the natural resources that they depend on. Irrigation farming plays a critical role in promoting sustainable livelihoods in rural communities, especially in regions that face water scarcity, erratic rainfall, or climate change-related impacts. It directly enhances the availability, reliability, and quality of water for agricultural production, which in turn supports livelihoods, boosts food security, and contributes to rural economic development (Khondoker, 2023).

Irrigation farming plays a crucial role in sustaining rural livelihoods, increasing food production, enhancing standard of living and reducing poverty in developing countries. Studies in Ghana, Bangladesh, Nepal, and South Africa demonstrate that small-scale irrigation systems can significantly improve food security, income generation, and overall household welfare (Naaderi & Dinye, 2017; Brabben et al., 2004; Gidi, 2013; Baddianaah et al., 2021). Irrigation enables crop diversification, increased agricultural production, and higher incomes compared to dry land farming (Gidi, 2013). This study looks at irrigation farming from socioeconomic perspective through which Sustainable Livelihoods is measured by food security and standard of living. These become the driving force of sustainable development in Rural Communities of Zamfara North senatorial zone. This study seeks to examine the influence of irrigation farming on sustainable livelihoods in the rural communities of Zamfara North senatorial zone, focusing on its impact on food security and the standard of living of rural households.

1.2 Statement of Problem

Currently, the government is concerned about addressing the challenges of food security in Nigeria (Onoja, 2024). This food insecurity is associated with low levels of agricultural productivity (Pawlak & Kołodziejczak, 2020). Seasonal weather variability and climatic changes during the rainy season have led to the recognition of irrigation farming as a viable supplement for agricultural productivity. Several studies like Albahri, et al., (2023). Behera, et al., (2024), Mutengwa, et al., (2023). Subedi et al., (2023). have highlighted the potential of farmer-led irrigation to improve income, enhance food security, raise living standards, alleviate poverty, and generate employment. Rural communities in Zamfara North senatorial zone face persistent challenges related to poverty, food insecurity, and low living standards, often exacerbated by unpredictable weather conditions that hinder normal agricultural production during the rainy season. While irrigation farming has been promoted as a solution to these challenges, its actual impact on food security and the standard of living of local communities has not been adequately explored. Understanding the extent to which irrigation farming contributes to sustainable livelihoods through food security and improved living standards is crucial for policymakers, development partners, and local stakeholders to design effective agricultural interventions. However, significant research gaps remain, as most related studies have been conducted in other regions, not in Zamfara North senatorial zone. Moreover, existing studies exploring the links between irrigation use and livelihoods often present arguments without empirical support or fail to account for selectivity bias. Based on this context, this research aims to examine the influence of irrigation farming on sustainable livelihoods in rural communities of Zamfara North senatorial zone. This research work raised the following questions.

1. How does irrigation farming impact food security in rural communities of Zamfara North senatorial zone?
2. What is the effect of irrigation farming on the standard of living of farming households?

1.3 Objectives of the Study

The primary objective of this study is to assess the influence of irrigation farming on sustainable livelihoods in rural communities of Zamfara North senatorial zone. Specifically, the study seeks:

1. To evaluate the impact of irrigation farming on food security in rural communities of Zamfara North senatorial zone.
2. To examine the influence of irrigation farming on the standard of living in rural communities of Zamfara North senatorial zone.

1.4 Research Hypotheses

The hypotheses were design in null form.

H₁: Irrigation farming has no positive and significant impact on food security in rural communities of Zamfara North Senatorial Zone.

H₂: Irrigation farming has no positive and significant effect on the standard of living in rural communities of Zamfara North Senatorial Zone

2.0 Literature Review

2.1 Irrigation farming

Irrigation farming refers to the practice of artificially supplying water to crops, typically through channels, pipes, sprinklers, or drip systems, to support agricultural production (Attri, et al 2022). This method supplements natural

rainfall, ensuring that crops receive adequate water even during dry seasons, periods of drought, or in regions with irregular or insufficient rainfall. One of the most important tools for sustainable agricultural intensification is irrigation, which stimulates improved farming methods. Among rural farmers, this method is essential for increasing agricultural productivity and efficiency. In order to sustain constant food production, irrigation mostly consists of the intentional application of water to the soil in addition to natural rainfall (Kuyah et al., 2021). In areas where precipitation is insufficient to meet crop needs, this human-driven involvement in water resource management becomes especially important. Growing crops under irrigation is a crucial part of any plan to boost the world's food supply. Irrigation's advantages have led to faster agricultural and economic growth, increased employment, and decreased food prices. Grain production has tripled globally during the 1950s, largely due to the expansion of irrigation.

Irrigation is known to enhance food production, minimize food insecurity and improve the farmers income to boost their standard of living. It is a calculated strategy to managing agricultural production that gives farmers more control over crop production, reduces food insecurity, and increases farmer income to improve living standards (Kassie, & Alemu, 2021). In addition to increasing food production, this agricultural intensification also improves economic stability, food security, and the standard of living for farmers in rural areas. There are significant differences in the way irrigation techniques are implemented, ranging from conventional approaches to sophisticated, water-efficient systems. As agricultural technology advances and the importance of sustainable resource management increases, this strategy seeks to maximize crop yields while optimizing food production (Khan, et al., 2021).

2.2 Sustainable Livelihoods

Sustainable livelihoods refer to the means by which individuals or households secure the necessities of life, such as food, water, shelter, and income, in a way that is environmentally, socially, and economically sustainable. The concept emphasizes the importance of ensuring that these needs are met not just in the short term but also in ways that can endure over time without depleting or damaging the natural resources or social systems on which they depend (Roy et al., 2024). Humanity has the ability to achieve sustainable development, ensuring that it meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development goes hand in hand with improving the lifestyles of the least fortunate. Ellis (2000) postulates that livelihoods consist of assets, activities, and access to these, which together determine the living standards of households or individuals. Rural people frequently move between rural areas and towns or cities to seek work, market their produce, and purchase manufactured goods. Through livelihood diversification, rural families construct a diverse portfolio of activities and social support systems to survive and improve their standard of living. Small-scale irrigation schemes are one of the many options available to support this effort.

The sustainable livelihoods framework is designed to help understand and analyze the livelihoods of people living in poverty. A livelihood is considered sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, and ensure sustainability for future generations, all while preserving the natural resource base. The sustainable livelihoods approach has emerged as a crucial concept in international development, focusing on improving the well-being of the poor by understanding and enhancing their livelihood opportunities (Serrat, 2008). The framework organizes factors that influence livelihoods and shows their relationships, aiding in planning and assessing development activities (Serrat, 2008). Current research characterized some major themes in sustainable livelihood interventions, including economic well-being, climate and natural resources, and policy design (Kumar et al., 2022).

2.3 Food Security

Food security refers to the ability of individuals to access basic nutritious food. According to the United Nation's Committee on World Food Security, food security means that all people should have physical, social, and economic access to sufficient, safe, and nutritious food that meets their preferences and dietary needs for a healthy and active life (United Nation's Committee on World Food Security, as cited in Ayinde et al., 2011; Ughaelu, 2017; Ikem, 2018). The World Food Summit in 1974 defined food security as the availability of adequate supplies of basic foodstuffs at all times to support an increase in food consumption and to compensate for fluctuations in production and prices (World Food Summit, as cited in Ayinde et al., 2011).

The term food security is an important phenomenon with a global recognition. It was first discovered as a concept of food supply in which at that time, food crisis led to concerns that global food supply shortages might bring about political instability (Simmons and Saundry, 2012). Food security is defined as a state of affairs in which anyone, at any time, has physical, social, and monetary access to sufficient, safe, and nutritious food that meets their nutritional needs and meal options for a healthy and active lifestyle. Food security refers to the condition in which all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life. It is a critical component of sustainable development and human well-being, aiming to eliminate hunger and malnutrition.

2.4 Standard of living

Standard of living refers to the level of wealth, comfort, material goods, and necessities available to an individual, group, or population in a specific geographic area. It is a measure of the economic and social well-being of people, often used to compare the quality of life between different countries, regions, or time periods. The concept of standard of living has evolved from a simple measure of consumption to a complex, multifaceted construct. Initially focused on income-based consumption analysis, it now encompasses broader aspects of welfare and quality of life. Standard of living is reflected in various quantifiable metrics such as income, education, housing, and access to necessities (Arutyunyan et al., 2022). It equally involves the quantity and quality of available goods and services, as well as their distribution among the population (Arutyunyan et al., 2022). Standard of living remains a crucial measure for comparing different regions or countries and understanding the overall well-being of populations (Arutyunyan et al., 2022).

According to the opulence view of Deutsch and Silber (1999), the standard of living refers to the quantity and quality of goods and services that the individual is free to use. The third strand of conceptualization of standard of living led by Sen (1984) considers the standard of living as the freedom to carry out something and the ability to live comfortably well. This current study aligns with Pigou's view of the standard of living, which relates standard of living to real income, a term considered to be relatively much more measurable. Hence, the economic dimension of living standard, which is in the form of the portion of real income in the economy that an individual has as his or her own share, can be said to indicate his share of the country's economic welfare.

2.5 Empirical review

The following research work were reviewed with respect to the variables under study

Pamela (2024) conducts a study on Comparing the impacts of different irrigation systems on the livelihoods of women and youth: evidence from clustered data in Ghana. The study aims to examine the impact of irrigation on the multiple dimensions of livelihoods such as incomes, food security, education, health status and to examine whether women and youth benefit differently from irrigation and if these gender and generational differences depend on the role taken by these groups in improving their water use for agriculture. The study used survey research design, using primary data to justify the study, data were analysed using a rigorous propensity score matching analysis applied to clustered data from two state-led and two farmer-led irrigation examples in Ghana to quantitatively evaluate the intersectional impacts of different types of irrigation on multiple dimensions of farmers' livelihoods. The results of our study indicate that although farmer-led irrigation enhances farmer incomes, this does not necessarily translate into poverty alleviation and prosperity. Furthermore, impacts on young men, young women and adult women are of a different nature.

Habtamu and Koyachew (2022) study the Impact of the Koga Irrigation Project on the Livelihood Improvement of the Rural Community in Mecha District, Amhara Region, Ethiopia. The study aims to investigate the contribution of the Koga irrigation project to the improvement of household livelihoods. The study used a mixed approach to data collection. Sample households were identified using a systematic random sampling technique. Using primary data, Average, percentage, and frequency were used to describe the demographic and socio-economic characteristics of the respondents. Independent t-test analyses were conducted to see the socio-economic impact of the irrigation project. Moreover, a logit regression model was used to identify the impact of the Koga irrigation project on the livelihood of the rural community. Crops annual production, productivity and consumption under irrigation was significantly ($P < 0.01$) higher compared to rain-fed condition. Irrigation user farmers expend significantly ($P < 0.05$) more cost for inputs compared to non-irrigation user farmers.

Bernard (2012) The Impact of Small Scale Irrigation Schemes on Rural Livelihoods: The Case of Panganai Irrigation Scheme Bikita District Zimbabwe. The study aims to assess the impact of small scale irrigation scheme on the people's livelihoods in Panganai Communal area. The study engaged both quantitative and qualitative methodologies in the investigation, Data was collected using interviews, questionnaires and observation. Analyses were done using descriptive statistics. Tables and graphs were employed in presentation and analysis. Results were that the irrigation scheme has managed to create employment, income generation, supply water throughout the year, acquisition of assets such as scotch carts and livestock by farmers and school fees generation by the community as a whole

The study of Akudugu, et al., (2021) assessed The Livelihoods Impacts of Irrigation in Western Africa: The Ghana Experience. Sustainability. The study aims to examine the role of irrigation in the drive towards a transformation of smallholder agriculture in Africa. The study engaged survey research technique, informant interviews and individual questionnaires were employed for the data collection. The data were analyzed using the regression adjustment (RA) technique. The results indicate that irrigation has significant and positive impacts on farm incomes, employment, consumption, food security and non-farm businesses, all of which are necessary conditions for a successful transformation of smallholder agriculture in Africa.

2.6 Theoretical frame work

This study will be underpinned by the Sustainable Livelihoods Framework Theory (SLF). The SLF is a widely recognized framework for analyzing the means by which people access and utilize resources to sustain their livelihoods (UNDP 2017). This framework is particularly relevant for examining how irrigation farming influences rural livelihoods in Zamfara North senatorial zone. The SLF provides a comprehensive approach to understanding livelihoods by considering five key asset categories: human, social, natural, physical, and financial capital. Irrigation farming, as a livelihood strategy, directly affects natural capital (land and water), physical capital (infrastructure like irrigation systems), and financial capital (income from agricultural productivity).

The SLF highlights how livelihood assets interact with policies, institutions, and processes to influence livelihood outcomes such as food security and improved living standards. This aligns with the study's aim to assess the impact of irrigation farming on these key outcomes. The SLF addresses the vulnerability context (such as climatic shocks) that affects livelihoods. Given that irrigation farming is a response to the vulnerability posed by weather variability, SLF provides an ideal lens to analyze how this farming approach enhances resilience and promotes food security.

3.0 Methodology

A cross sectional research design will be adopted quantitative approaches to ensure a comprehensive analysis of the subject matter. The study is conducted in selected rural communities of Zamfara North Senatorial District. The region is known for its agricultural potential, but it also faces challenges related to food insecurity and low living standards. The population comprises of 10,000 smallholder farmers, gotten from the record of agricultural extension officers and local leaders across the four local governments who engaged in irrigation farming and non-irrigation farmers for comparison purposes. A multistage sampling technique will be used to select respondents from rural communities in Zamfara North senatorial zone. The sample size of 370 respondents were determined using sample table of Krejcie and Morgan (1970) Primary data were collected through the use of structured questionnaires, The questionnaires captured information on household demographics, farming practices, food security status, and household living standards. Key informants, including agricultural extension officers and local leaders, will provide qualitative insights into the context of irrigation farming in Zamfara North Senatorial District. Data were analyzed using both measurement and structural model contained in Partial Leas Squire Structural Equation Model PLS-SEM.

4.0 Data Analysis.

4. 1 Table I: Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Food Security	0.891	0.899	0.920	0.697
Standard of Living	0.897	0.908	0.924	0.709
Irrigation Framing	0.896	0.933	0.927	0.761

Source; PLS-SEM output, 2024

The measurement data evaluates three constructs: Food Security, Standard of Living, and Irrigation Framing, using metrics for reliability and validity.

Food Security; Cronbach's Alpha of 0.891 and Composite Reliability of 0.920 indicate high internal consistency, meaning the items measuring Food Security are closely related. AVE of 0.697, which is above the threshold of 0.50, shows that the majority of the variance in the items is explained by the construct itself. rho_A of 0.899 further supports the reliability of the construct. The Food Security construct is reliable and valid, suggesting the measurement items effectively represent the concept of food security.

Standard of Living; Cronbach's Alpha of 0.897 and Composite Reliability of 0.924 are both high, indicating strong internal consistency among the items measuring Standard of Living. AVE of 0.709 exceeds the threshold, confirming that the construct explains a substantial portion of the variance in the items. rho_A of 0.908 adds to the evidence of reliability. The Standard of Living construct is well-measured, with strong reliability and validity.

Irrigation Framing: Cronbach's Alpha of 0.896 and Composite Reliability of 0.927 show excellent internal consistency among the items measuring Irrigation Framing. AVE of 0.761 is the highest among the three constructs, signifying that Irrigation Framing strongly explains the variance in its measurement items. rho_A of 0.933 reinforces the reliability of the construct. Irrigation Framing is the most robust construct in terms of reliability and validity, with the highest AVE and rho_A.

Table II: R Square

	R Square	R Square Adjusted
Sustainable Livelihoods	0.875	0.865

Source; PLS-SEM output, 2024

The R Square value of 0.875 indicates that 87.5% of the variance in Sustainable Livelihoods is explained by the independent variables (Irrigation Framing) in the model. This is a high value, suggesting that the model provides a strong explanation of the variation in Irrigation Framing.

Adjusted R Square value of 0.865 accounts for the number of predictors in the model and adjusts for potential over fitting. It is slightly lower than the R Square of 86.5%, which is expected when adjustments are made for model complexity. The minimal difference (0.01 or 1%) indicates that the model does not suffer from over fitting and that the predictors are highly relevant to the outcome variable.

The high R Square and Adjusted R Square values suggest a robust and effective model for explaining sustainable livelihoods. The independent variables included are highly relevant, and the model can be confidently used for decision-making or further analysis in this domain.

Table III: Path Coefficients

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
Irrigation Framing -> Food Security	0.937	0.936	0.012	79.058	0.000
Irrigation Framing -> Standard of Living	0.815	0.817	0.031	26.492	0.011

Source; PLS-SEM output, 2024

The study uses path coefficients instruments like, T-statistics, and P-values.to test;

Irrigation Framing → Food Security: with a value of 0.937 indicates a very strong positive relationship, suggesting that improvements in irrigation framing have a significant impact on food security. The extremely high T-statistic, well above the critical threshold of 1.96 for 95% confidence, indicating a highly significant effect. A P-value of 0.000 means the result is statistically significant at 95%. confidence level.

The path coefficient (0.937) indicates a strong positive relationship between irrigation farming and food security. The T-statistic (79.058) and P-value (0.000) confirm that this relationship is statistically significant. The null hypothesis (H_1) is rejected, meaning that irrigation farming has a positive and significant impact on food security in rural communities of Zamfara North senatorial zone.

Irrigation Framing → Standard of Living with a value of 0.815 shows a strong positive relationship, indicating that irrigation framing positively affects the standard of living. The high T-statistic, well above the critical threshold of 1.96 for 95% confidence confirming the strong significance of the effect. A P-value of 0.011 indicates significance at the 95% confidence level.

The path coefficient (0.815) shows a strong positive relationship between irrigation farming and the standard of living. The T-statistic (26.492) and P-value (0.011) demonstrate that this relationship is statistically significant. The null hypothesis (H_2) is rejected, meaning that irrigation farming has a positive and significant effect on the standard of living of farming households.

4.2 Discussion of Findings

The findings suggest that irrigation farming significantly contributes to improving food security in rural communities. It enables households to produce food more consistently and in greater quantities, even during dry seasons. This enhances food availability, reduces hunger, and ensures a more stable supply of essential resources.

Irrigation farming has a significant impact on improving the standard of living for farming households. This improvement is likely due to increased agricultural productivity, which boosts income levels, provides access to better resources, and enhances overall well-being.

These findings highlight the critical role of irrigation farming in improving food security and enhancing the standard of living in rural communities. Policymakers and stakeholders should prioritize supporting irrigation farming initiatives to maximize these benefits.

5.1 Conclusion

Irrigation farming is a critical enabler of both food security and an improved standard of living in rural communities. Its significant impact is evident in the statistical results, showing that it addresses essential aspects of agricultural productivity and socioeconomic development. Expanding irrigation farming initiatives will likely have profound benefits for rural areas in Zamfara North senatorial zone and beyond. These findings advocate for policy interventions and investments to enhance irrigation farming as a tool for sustainable rural development.

5.2 Recommendations

Governments and development agencies should prioritize building and upgrading irrigation infrastructure, including drip irrigation systems and water storage facilities. They should also ensure that smallholder farmers have access to affordable irrigation technologies through subsidies or microfinance options.

Establish training programs and workshops focused on efficient water use, crop diversification, and the adoption of climate-resilient farming techniques. Extension services should be made available to help farmers improve their irrigation practices and ensure they can sustainably manage water resources to increase both crop yields and their life style.

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