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Small-Scale Irrigation Practices and Their Effects on Farmers' Livelihoods in Jama'are Local Government Area of Bauchi State, Nigeria

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ABSTRACT

This study was conducted on Small-Scale Irrigation Practices and Their Effects on Farmers' Livelihoods in Jama'are Local Government Area, Bauchi State, Nigeria. The data type was derived from both primary and secondary sources, and simple random sampling was used to select a sample of 357. A structured interview schedule was used for data collection, which was analyzed using frequency tabulations, percentages, and the Chi-Square test. The results - presented in tables - revealed that the majority of farmers in Jama'are LGA were males (94%), mostly in the economically active age group, with informal educational qualifications, large household sizes, and were mainly engaged in business and other occupations. Furthermore, irrigation water use in the LGA increased significantly over the last 10 years, with none-shaduf irrigation (80%) for rice production (55%) and highly supported by NPK and Urea (76%) applications, ranging from 1-10 bags. Moreover, the effects of irrigation practices on the livelihoods of farmers in the LGA were positive, as indicated by high (95%) crop profitability, with yield reductions attributed solely to insufficient water supply and numerous welfare effects. It was recommended that the community, governments, NGOs, and other stakeholders support and encourage women farmers in Jama'are LGA to adopt irrigation practices to boost food production in the LGA.

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1 Introduction

Irrigational practices globally play a crucial role in achieving a year-round green revolution, which is essential for meeting sustainable development goals related to food security, socio-economic growth, and rural development (Adelodun & Choi, 2018). Climate conditions play a key role in affecting agricultural output. Additionally, global trends show more frequent and severe droughts and floods in many farming areas, which can damage or destroy crops (Durodola, 2019). However, challenges such as local brokers' involvement in the market value chain and the lack of farmers' marketing cooperatives have diminished the advantages of irrigated agriculture (Maru et al., 2023).

Scientific management of irrigation water provides the best assurance against weather-induced fluctuation in total food production. This is the only way in which we can make agriculture competitive and profitable (Ray & Majumder, 2024). An irrigation policy for water resources management, in addition to efficient utilization of the resources for optimum crop production, should meet the requirements of the growing industry, human and livestock consumption, and provide for flood control, hydroelectric power generation, recreation, and navigation (Li & Troy, 2018). For example, the development of irrigation in Nigeria is growing at an alarming rate compared to the efforts to address the basic problems of soil degradation, social and health

deterioration, insect invasions, plant disease infestations, and, of course, weed invasion (Adelodun & Choi, 2018). Furthermore, irrigation is the key solution to producing sufficient food for Nigeria's population (Adeyolanu & Okelola, 2024). A comprehensive approach to managing Nigeria's water resources must consider several elements, including water availability and quality, location, distribution, climate conditions, soil characteristics, competing demands, and socio-economic factors. Effective water management is critical to ensuring continuous, optimal use, with the current focus on maximizing agricultural output per unit of water, land, and time. Most public irrigation schemes in Nigeria are large-scale. They are expected to transform agricultural production, achieving food self-sufficiency for the country and a higher standard of living for those involved. However, the performance of the schemes has been disappointing (Shanono et al., 2022). Moreover, the most discouraging outcome of the large-scale irrigation strategy adopted over the past four decades is low capacity utilization across the schemes. Not only are there wide discrepancies between irrigable (planned) areas and irrigated areas, but there are also large differences between areas with developed irrigation and those actually irrigated. These differences cut across virtually all the schemes (Adelodun & Choi, 2018).

Jama'are is predominantly reliant on agriculture, with

70% of the population depending on irrigation for their livelihoods (Adamu & Kawugana, 2025). The authors further revealed that irrigation accounts for approximately 65% of household income and that most agricultural production comes from smallholder farmers who rely on seasonal rainfall, which is unpredictable and inconsistent. In this regard, Bauchi State found it necessary to develop small and medium-scale irrigation projects that have been impacting the people and the environment, opening an avenue for enquiry. The objective of this paper is to describe irrigational practices and explain their effects on the farmers' livelihood in Jama'are Local Government Area, Bauchi State. This was achieved by a preliminary reconnaissance survey that identified active irrigation sites and guided an accurate sampling procedure. Field observations captured important seasonal variations in irrigation practices and yields, while the combination of quantitative data and field observations provided the needed comprehensive evidence base on the farmers' livelihood. Descriptive statistics used, offered appropriate analytical depth for the study, and yielded detailed effects of irrigation on the livelihood of farmers in Jama'are LGA. The study provides valuable village-level evidence on irrigation practices and their livelihood implications, contributing new insights to the literature on rural water management and agricultural development in northern Nigeria.

2 Materials and Methods

2.1 Study Area

Jama'are LGA is located in the northeastern part of Bauchi State, Nigeria, within the Sudan Savanna ecological zone and characterized by a Tropical Savanna climate. It is situated about 200 kilometres northeast of Bauchi, the state capital, between latitudes $11^{\circ}30'30''$ and $11^{\circ}55'30''$ North and longitudes $9^{\circ}45'$ to $10^{\circ}15'$ East (Fig. 1) and shares boundaries with Itas/Gadau LGA to the west, Katagum LGA to the north, Giade LGA to the east, and Shira LGA to the south (Bauchi State Government, 2017; National Bureau of Statistics (NBS), 2019).

The headquarters of Jama'are LGA is in Jama'are town. The LGA has a surface area of 493 square kilometres with a population of 117,883 (Aliyu et al., 2019). The area is characterized by predominantly flat to gently undulating terrain, traversed by the Jama'are River, a major tributary of the Hadejia-Jama'are River system that plays a vital role in supporting floodplain (*Fadama*) agriculture and dry-season irrigation farming across the LGA (Hadejia-Jama'are River Basin Development Authority (HJRBDA), 2016). Alluvial and loamy soils dominate the LGA's floodplains, which are well suited for irrigated crop production, particularly rice and vegetables (FAO, 2020).

The southwest wind and the cold, dry northeast

harmattan winds influence the climate of Jama'are. The area experiences a tropical continental climate with a distinct wet season from May to October and a dry season from November to April. Mean annual rainfall ranges between 600 and 900 mm, while temperatures remain high throughout the year, often exceeding 30°C , especially during the dry season (Nigerian Meteorological Agency (NiMet), 2020). These climatic conditions, combined with rainfall variability, make irrigation an essential livelihood strategy for sustaining agricultural production in the area (FAO, 2015).

The soils in the area are deep, with sandy textures and low water-retention capacity (Muhammad, 2016). Vegetation is typical of the Sudan Savanna, consisting mainly of grasses interspersed with drought-resistant tree species such as *Acacia spp.* and *Parkia biglobosa* (Olofin et al., 2008). Land use in Jama'are LGA is predominantly agrarian, with the majority of the population engaged in crop farming, irrigation agriculture, fishing, and small-scale trading (NBS, 2019). The physical environment and hydrological characteristics of the area provide favourable conditions for small-scale irrigation practices, making Jama'are LGA a suitable location for studies on irrigation farming and rural livelihoods in semi-arid northern Nigeria (Shehu et al., 2021).

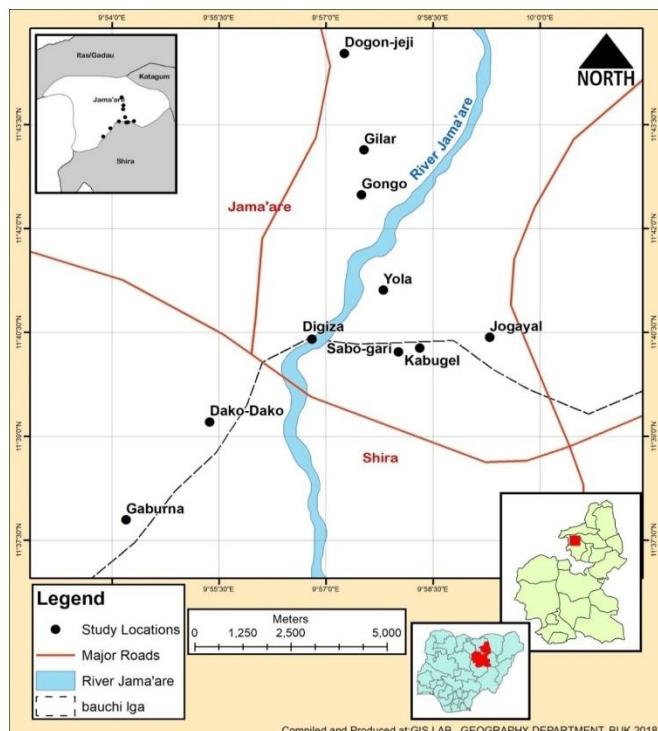


Figure 1: Location of the Study Area

2.2 Data Sources

The required data to meet the research objectives were obtained quantitatively: methods used, crop types grown, type of fertilizer used, positive effects, profitability of planted crops, and production costs. These data were



obtained from the farmers.

2.3 Data Collection

Field observations were conducted during the dry and rainy seasons to note the types of agricultural activities carried out in each season. These include the cropping pattern, the types of crops grown, and their estimated yields per hectare. The observations also included noting the new irrigation facilities provided in the area and the participants' prevailing social behaviour and economic trends. (a) Farm size: data was obtained from the farmers on the sizes of their different plots. (b) Fertilizer; data was gathered on the type used, (c) Output; data was obtained on the total weight produced and harvested per plot, (d) Production cost and sales; data on the cost of production and market price was also obtained.

2.4 Sampling Size and Technique

The population of this study comprises the inhabitants of the Jama'are Local Government Area of Bauchi State, namely participants in irrigation farming and those who are either directly or indirectly affected by irrigation activities. Table 1 shows the number of villages, populations, and samples. Krejie and Morgan (1970) used a table to obtain 357 samples from the population of 4206 farmers. The samples were later proportionately distributed to the sampled villages.

Table 1: Villages, Population, and Samples

Village	Population Number	Samples
Gaburna	780	66
Yola	2000	169
Dako-Dako	320	27
Gongo	601	50
Digiza	285	24
Jogayel	250	21
Total	4206	357

The multi-stage sampling technique was employed for this study. In this regard, fifteen (15) villages are involved in irrigation (i.e., Dogonjeji, Gaburna, Dako-Dako, Digiza, Yola, Sabon-gari, Jogayel, Kabugel, Gongo, Jurara, Guda, Galdimari, Hanafari, SabonKafi, and Gilar). Of the 15 villages, 6 (Gaburna, Yola, Dako-Dako, Gongo, Digiza, and Jogayel) were purposively selected for their high representativeness of irrigation practices in the study area. Descriptive statistics were used to analyse data on demographic and socio-economic characteristics, irrigation practices, and their effects on farmers' livelihoods in the study area.

2.5 Data Analysis

Frequency tabulations and percentages were used to analyze data on demographic and socio-economic characteristics, as well as irrigation practices in Jama'are

LGA. Regarding the effects of irrigation on farmers' livelihoods, frequency tabulations and percentages were also used. Furthermore, Chi-square (χ^2) was used to test for the association between farmers' livelihood (Very High, High, Low, and Very Low as well as Water insufficiency, Inadequate use of Fertilizers, and Soil Infertility) and effects of irrigation (Positive Effects, Crops' Profitability, Welfare Effects, and Crop Yield Reduction). This was guided by the null hypothesis that there is no association between irrigation activities and farmers' livelihoods in Jama'are LGA.

2.6 Ethical Consideration

Institutional clearance and approval were obtained from the Bauchi State Ministry of Agriculture and Natural Resources research ethics committee. Also, local permission from Jama'are Local Government authorities/community leaders was secured. Hence, participants were informed of the study's purpose, their rights, and the confidentiality of their responses prior to the interviews. For confidentiality, all interview data were anonymous, protecting participants' identities.

3 Results

3.1 Demographic and socio-economic characteristics of the irrigation farmers

The demographic and socio-economic characteristics of irrigation farmers in Jama'are LGA were analyzed, and the results are shown in Table 2. The table revealed that the majority of respondents were male, with 94% (Yola), 92% (Gongo), 91% (Gabirna), and 100% in Dako-Dako, Digiza, and Jogayel. This aligns with Shehu et al. (2021), who found that 97% of respondents in their study on farmers' perceptions of seasonal variations in Northern Nigeria were male. Most respondents were aged 25-64 years, representing 78% (Gabirna), 74% (Yola), 80% (Dako-Dako and Gongo), 72% (Digiza), and 57% (Jogayel). The gender and age distribution is not unexpected, given the male dominance in farming in the Hausa region, with the age group reflecting those active in the economy.

In addition, most respondents across the sampled areas had completed O-Level education (20%), while only about 3% held a PhD. This suggests that many of the farmers are rural dwellers who focus more on irrigation activities and have little interest in pursuing education beyond secondary school. This indicates that the majority of respondents had informal educational qualifications. The household sizes of the respondents were large, ranging from 1 to 20, with Gabirna at 71%, Yola at 77%, Dako-Dako at 69%, Gongo at 80%, Digiza at 79%, and Jogayel at 78%.

Table 2: Demographic and Socio-Economic Characteristics of Respondents

Variables	Gabirna % n = 66	Yola % n = 169	Dako-Dako % n = 27	Gongo % n = 50	Digiza % n = 24	Jogayel % n = 21
Sex	Male	91	94	100	92	100
	Female	9	6	0	8	0
	Total	100	100	100	100	100
Age (Years)	< 25	17	24	22	8	23
	25 - 44	46	24	26	40	38
	45 - 64	30	50	44	40	35
	65 >	7	2	8	12	4
	Total	100	100	100	100	100
Highest Qualification	None	18	47	37	30	58
	PSLC	18	12	19	20	9
	O'Level	20	9	15	6	0
	Dip/NCE	18	5	15	4	0
	Degree	15	2	4	0	0
	M. Sc.	5	1	0	0	0
	PhD	3	0	0	0	0
	Qur'anic	3	24	10	40	33
	Total	100	100	100	100	100
Household Size	1 - 10	30	41	37	30	54
	11 - 20	40	36	29	50	26
	21- 30	23	12	34	12	8
	31 - 40	5	6	0	8	8
	40 >	2	5	0	0	4
	Total	100	100	100	100	100
Other Occupations	Business	46	41	37	40	42
	Civil Service	37	36	26	30	4
	Trade	17	23	37	30	54
	Total	100	100	100	100	100

Lastly, in Gabirna (84%) and Yola (76%), most respondents were involved in business and civil service, while in Dako-Dako, Gongo, Digiza, and Jogayel, the majority were engaged in business and other occupations (63%, 70%, 46%, and 72%, respectively). In northern Nigeria, household sizes typically range from 1 to 20, according to the United Nations (2019). Based on this data, it can be concluded that the majority of farmers in Jama'are LGA are male (94%), primarily within the economically active age group (90%), have informal educational qualifications (65%), large household sizes (1–20) (75%), and are mainly involved in business and other occupations (62%).

3.2 Irrigational Practices

The irrigation practices in Jama'are LGA were analyzed, focusing on factors such as water pump usage, previous irrigation methods, crop types, fertilizer usage, irrigation area size, association membership, and access to credit. The result is shown in Table 3.

**Table 3: Irrigation Practices in Jama'are LGA by Farmers' Locality**

Variables	Gabirna % n = 66	Yola % n = 169	Dako-Dako % n = 27	Gongo % n = 50	Digiza % n = 24	Jogayel % n = 21
Water pump usage	10 Years	60	41	26	30	58
	20 Years	23	48	48	60	21
	30 Years >	17	11	26	10	21
	Total	100	100	100	100	100
Method used	None	100	47	74	80	83
	Shaduff	0	53	26	20	17
	Total	100	100	100	100	100
Crop types grown	Tomatoes/Pepper	23	14	11	10	17
	Leafs	8	9	11	2	4
	Maize	9	30	19	8	8
	Rice	53	30	55	50	67
	Wheat	7	17	4	30	4
	Total	100	100	100	100	100
Type of fertilizers used	NPK	15	18	19	12	13
	Urea	9	17	7	6	8
	NPK and Urea	76	65	74	82	79
	Total	100	100	100	100	100
Quantity of fertilizers used	1 - 10 bags	61	59	44	40	42
	11 - 20 bags	14	15	37	32	28
	21 - 30 bags	12	9	7	20	13
	31 - 40 bags	9	11	7	6	13
	40 bags >	4	6	5	2	4
	Total	100	100	100	100	100
Irrigation area size	< 1 hectare	24	17	26	46	29
	1- 5 hectares	72	77	56	50	67
	6 - 10 hectares	4	6	18	4	4
	10 hectares >	0	0	0	0	0
	Total	100	100	100	100	100
Association membership	None	61	77	26	20	83
	RIFAN	22	15	7	10	4
	NECAS	8	3	4	10	4
	ANCO Borrowers	0	1	7	10	0
	Others	9	4	56	50	9
	Total	100	100	100	100	100
Access to credit	None	46	60	56	30	71
	Government	3	6	7	10	13
	NGOs	15	6	4	8	0
	Individuals	30	23	22	40	16
	Banks	6	5	11	2	0
	Total	100	100	100	100	100

From Table 3, it was found that water pump usage was highest in Gabirna (61%) and lowest in Gongo (10%), with the extensive use of pump machines largely attributed to the Federal Government's Agricultural Policy supporting fadama irrigation practices. Most respondents (80%) did not previously use the shaduff irrigation method, and rice was the most commonly grown crop (55%), while wheat was the least (12%). Fertilizer use was dominated by NPK and Urea (76%), with most farmers applying 1-10 bags

(50%).

The majority of farmers irrigated land sizes of 1-5 hectares (66%), and 56% of respondents did not belong to any association. Only 4% had access to ANCO Borrowers, while 48% lacked access to credit.

3.3 Effects of Irrigation Practices on Farmers' Livelihood

The study analysed the effects of irrigation practices on

the livelihoods of farmers in Jama'are LGA, focusing on the positive effects, crop profitability, welfare improvements, and reduced crop yields (Table 4). Results showed that irrigation had a significant positive impact, with the highest positive effects reported in Jogayel (96%) and the lowest (4%). This was attributed to irrigation's role in preventing nitrogen loss and supporting plant growth by optimizing nutrient delivery.

Similar trends were observed for crop profitability, where 95% of respondents reported high profitability

from irrigated crops. Additionally, 95% of respondents recognized numerous welfare benefits linked to irrigation, despite challenges such as rising food prices and weather conditions. These benefits were attributed to the increased demand for quality food crops and farmers' ability to supply them through various distribution channels. However, crop yield reduction was a concern for 80% of respondents in Gongo, although only 10% felt it was not a significant issue.

Table 4: Effects of Irrigation Activities on Farmers' Livelihood in Jama'are LGA

Variables	Gabirna % n = 66	Yola % n = 169	Dako-Dako % n = 27	Gongo % n = 50	Digiza % n = 24	Jogayel % n = 21
Positive Effects	Very High	45	41	44	40	46
	High	32	24	30	30	37
	Low	12	21	15	20	8
	Very Low	11	14	11	10	9
	Total	100	100	100	100	100
Planted crops' profitability	Very High	35	23	37	34	33
	High	37	56	37	46	50
	Low	21	12	15	6	8
	Very Low	7	9	11	8	9
	Total	100	100	100	100	100
Numerous welfare effects	Very High	27	24	29	30	29
	High	46	53	45	50	54
	Low	18	14	11	10	13
	Very Low	9	9	15	10	4
	Total	100	100	100	100	100
Crop yield reduction	Insufficient water	53	0	0	6	13
	Inadequate fertilizers	38	59	74	80	70
	Soil Infertility	9	41	26	14	17
	Total	100	100	100	100	100

Chi-square (χ^2) test was used in analysing the data in Table 4 in order to test for association/dependence between effects of irrigation activities and farmers' livelihood among the sampled localities in Jama'are LGA (Table 5). The result showed that the calculated Chi-square (χ^2) value (1052.3) is greater than the critical value (12.59) at 0.05% level of significance. The test, therefore, revealed a strong association between irrigation activities

and farmers' livelihoods in Jama'are LGA. This led to the rejection of the null hypothesis, confirming that irrigation practices positively affect farmers' livelihoods. Overall, 95% of respondents reported positive effects from irrigation, including improved crop profitability and welfare, affirming the critical role of irrigation in enhancing rural livelihoods in Jama'are LGA.

Table 5: Association between effects of irrigation activities and farmers' livelihood among the sampled localities in Jama'are LGA

	Value	DF	Asymp. Sig. (2-sided)
Pearson Chi-Square	1052.3 ^a	5	.000
Likelihood Ratio	131.274 ^b	3	.000
N of Valid Cases	304		

^a = 0 cells (0.0%) have expected count less than 5.

^b = 0 cells (0.0%) have expected count less than 5.



4 Discussion

The findings of this work revealed that small-scale irrigation farming in Jama'are LGA is predominantly undertaken by economically active male farmers, reflecting entrenched socio-cultural norms and labour structures, common across northern Nigeria. Male dominance in agricultural activities and economic development in Jama'are LGA is consistent with the findings of Shehu et al. (2021b), who noted that males are the primary agriculturalists in Northern Nigeria. The structure of farming can explain this trend in these communities, where men typically lead agricultural endeavors. Similar demographic patterns have been consistently reported in irrigation and smallholder farming systems where men dominate land access and agricultural decision-making (FAO, 2015). Limited educational attainment aligns with evidence from rural Nigeria, constraining access to extension services, formal credit, and improved irrigation technologies. These indicators confirmed the low level of formal education observed among farmers in the region. (Ayanwale & Alimi, 2016).

Nonetheless, Ellis (2000) and Babatunde and Qaim (2010) outlined that farmers' engagement in multiple livelihood activities reflects adaptive diversification strategies widely documented as buffers against climatic and market risks in semi-arid environments. Overall, rice production was prominent across the region, supported by government-backed irrigation schemes that provided essential inputs and improved crop yields, as confirmed by Ugalahi's (2016) studies. This system, though cost-intensive, offered significant returns for farmers, boosting both their incomes and household well-being. Government-supported Fadama and dry-season farming programs led to the widespread adoption of motorized pump irrigation and the dominance of rice cultivation. The work of Ugalahi (2016) and Oyinbo et al. (2019) indicated that pump-based irrigation enhances dry-season productivity and profitability, particularly for rice, due to its responsiveness to controlled water and fertilizer application.

Overall, irrigation practices significantly enhanced farmers' livelihoods through increased income, crop profitability, and household welfare. This corroborates extensive evidence from Nigeria and sub-Saharan Africa demonstrating that small-scale irrigation improves yield stability, income levels, and food security relative to rain-fed systems (Burney & Naylor, 2012; FAO, 2015). The positive effects of irrigation included increased farm income, employment, food security, and opportunities for non-farm businesses, as noted by Akudugu et al. (2021). However, concerns over yield decline mirror sustainability challenges, including soil nutrient depletion, inefficient water management, and limited

extension support (IFPRI, 2019). These findings highlight the need for strengthened institutional support and sustainable land and water management to sustain irrigation-driven livelihood gains.

4.1 Limitations

The study, however, is limited by its purposive selection, which may compromise generalizability. Reliance on self-reported yield and income data may introduce recall bias among respondents. Furthermore, the predominantly male sample's representativeness limits gender representation, and the cross-sectional design and reliance on mainly descriptive statistics constrain causal inference. Environmental and market-related variables were considered limitations because they were not directly measured, thereby limiting the depth of analysis of sustainability and value-chain impacts.

5 Conclusion

The findings reveal that the majority of farmers in Jama'are LGA are male, mostly within the economically active age group (90%). This outcome suggests a promising future for the region, with more farmers likely to increase crop production, contributing to food self-sufficiency in Jama'are LGA and neighbouring areas. Moreover, irrigation is a central pillar of agricultural production in the area, with most farmers (80%) cultivating rice and other crops using pump-based irrigation systems supported by fertilizer application. Across the surveyed communities, irrigation significantly enhanced farm productivity (95%), crop profitability, household welfare, and income stability. The chi-square (χ^2) test results further confirmed a strong association between irrigation activities and improved farmers' livelihoods, underscoring the critical role of irrigation in supporting rural development in Jama'are LGA.

Despite the highlighted positive outcomes, challenges such as limited access to credit, low association membership, declining soil fertility, and inconsistent fertilizer use were encountered in the LGA and continue to constrain optimal productivity. Essentially, to make irrigated agriculture more sustainable in Jama'are LGA, governments and NGOs need to address these issues through improving institutional support, strengthening farmers' cooperatives, enhancing access to agricultural finance, and implementing integrated soil and water management strategies.

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