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Socioeconomic Conditions, Climate Change Vulnerabilities and Weed Challenges among Rice Farmers in Benue and Nasarawa States

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Authors' contributions

This work was carried out in collaboration among all authors. Authors AAJ and MSA designed the study. Authors PUA and RO designed the data collection tool and ran the analyses of the study. Authors AAJ and MSA further took data, and wrote the report and the first draft of the manuscript. Authors AAJ, PUA and MSA managed the literature searches. All authors read and approved the final manuscript.

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Abstract

A 2024 survey assessed the socioeconomic characteristics of rice farmers in Benue and Nasarawa States, their vulnerability to climate change, particularly weed infestations and their adoption of climate-resilient practices. The study covered eight LGAs: Agatu, Guma, Gwer West, and Ohimini in Benue State; and Awe, Doma, Keana, and Lafia in Nasarawa State, spanning 32 rice-farming

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communities. Using the KOBOCOLLECT tool, 320 farmers were interviewed, and data were analyzed with descriptive statistics and ranked by magnitude. Most respondents were 31–40 years old, married, and had secondary education. Farming was their primary occupation, with 11–15 years of experience. Annual incomes ranged from ₦501,000 to ₦700,000, household sizes averaged four to six members, and most had resided in their communities for 1–15 years. The dominant rice variety cultivated was Faro 44, preferred for its high yield, adaptability, and availability. Variety selection was also influenced by market demand, maturity period, pest resistance, soil suitability, and cultural preferences. Climate-related challenges were significant. High temperature ranked as the most severe constraint, followed by flooding, erosion, erratic rainfall, and land degradation. Limited access to climate information, weak adaptive capacity, and heavy weed infestations, particularly barnyard grass, nutgrass, morning glory, and Siam weed, further reduced productivity. To cope, farmers adopted improved varieties, agroforestry, rainwater harvesting, irrigation, integrated pest management, crop diversification, and cooperative membership. The study recommends enhanced farmer education, stronger extension services, improved market access, better rural infrastructure, and intensified research on climate-resilient rice and weed management.

Keywords: Climate change vulnerabilities; rice farmers; weed infestation; climate-resilient practices.

1. Introduction

Rice is the most widely consumed staple food globally, particularly in Asia, Sub-Saharan Africa, and South America. Nigeria is Africa's second-largest rice producer, with ~8 million tons annually (Osabuohien et al., 2018). Rice contributes 10.5% of Nigerians' caloric intake and 6% of household food expenditure (Toluwase et al., 2019).

Climate change severely threatens rice production, altering weather patterns, increasing temperatures, and causing erratic rainfall and droughts (Reed et al., 2022; Ayanlade et al., 2023). Over 70% of Nigeria's rice is produced by rain-fed smallholder farmers with minimal adaptive capacity (Zakaria & Matsui, 2020; Ojo and Baiyegunhi, 2020). Benue and Nasarawa States, in the Southern Guinea Savannah Zone, exemplify this vulnerability. A 2°C temperature increase could reduce rice yields by 10–30% (Akinbile et al., 2020).

In Sub-Saharan Africa, agriculture employs over 60% of the population and contributes about 30% of Gross Domestic Product (GDP), (Ayanlade et al., 2022). Climate variability now accounts for up to 50% of crop yield variability (IPCC, 2021). Without robust interventions, smallholder rice farming in these states risks collapse, threatening food security and local economies.

1.1 Significance of Study

This study provides primary, location-specific insights into the socioeconomic conditions, climate vulnerabilities, weed impacts, and adoption of climate-resilient practices among rice farmers in Benue and Nasarawa States.

1.2 Scope

The study covered 8 LGAs (4 per state), 32 communities, and 320 rice farmers, focusing exclusively on climate-resilient practices in these states.

1.3 Specific Objectives

1. Describe socioeconomic characteristics of rice farmers.
2. Identify commonly cultivated rice varieties and reasons for their choice.
3. Assess current climate vulnerabilities.
4. Identify weed problems associated with climate change.

2. Methodologies

2.1 Study Area

The study areas are Benue and Nasarawa States. Benue State lies within the Lower River Benue trough in the middle belt region of Nigeria. Its geographic coordinates are 7° 47' 10° 0' East, and 6° 25' 8° 8' North. It is one of the North Central states in Nigeria, estimated to have a population of about 4,253,641, using the 2006 census, with estimated population density of 99 persons per km^2. The state's name derives from the Benue River, which is the second largest in Nigeria after the River Niger.

Nasarawa State is located in the North Central region of Nigeria. The state lies between latitude 7° 45′ and 9° 25’ N, and between longitude 7° and 9° 37′ E, (https://nasarawastate.gov.ng/about-nasarawa-state/). It is named for the historic Nasarawa Emirate.

2.2 Data Collection

2.2.1 Primary Data used for the Study

The study questionnaires were administered using a computer-based tool (KOBOCOLLECT). The tool was used as an Application in Android tablets. The choice of survey tool was to lower costs (use of less materials, printed paper, labor), and improved data quality, ease and speed of use. The primary data of the study areas was obtained through administration of semi-structured questionnaires to the selected farmers. The questionnaires were divided into 9 thematic areas based on the specific objectives of the study (Sections A to E). The 4 thematic areas of the questionnaire included;

Section A: Socioeconomic characteristics of the rice farmers in Benue and Nasarawa States.

Section B: Identification of commonly cultivated rice varieties in Benue and Nasarawa States. and reasons for their choice.

Section C: Current climate vulnerabilities of rice farming in Benue and Nasarawa States

Section D: Identification of climate-resilient farming Practices in the study states and their sources of information on climate change or resilient practices.

Section E: Farmers’ identity of common pernicious weeds of rice in Benue and Nasarawa States.

3. Results

3.1 Socioeconomic Characteristics of Rice Farmers in Benue and Nasarawa States

3.1.1 Demographic and Farm Characteristics

The socioeconomic characteristics of rice farmers in Benue state are shown in Figs. 1 and 2. In Benue State (N=160), males comprised 65.0 %, females 35.0 %. Mean age was 40 years; the modal age group was 31 – 40 years (40.0 %). Most respondents were married (81.9%). Educational attainment was predominantly secondary (32.5 %), non-formal (31.3 %), and primary (31.3 %); only 5.0 % had tertiary education. Rice farming was the primary occupation for 81.3%. Farming experience averaged 11 – 15 years, with 31.3 % having 5 – 10 years’ experience. Annual income clustered at N251,000 – N500,000 (34.4 %). Household size was typically 4 – 6 persons (46.3 %). Half of respondents (50.0 %) had resided in their communities for over 21 years.

Figs. 1 c and 1 d show the socioeconomic characteristics of rice farmers in Nasarawa State. In Nasarawa State (N=160), males accounted for 76.9 %, females 23.1 %. Mean age was 41 years, with the 31–50 years bracket predominant (50.4 %). Married respondents constituted 90.6 %. Educational levels: secondary (33.8%), primary (32.5%), no formal education (25.6%),

Chart 1. Sample of sampling procedure for the study

State	LGA Selected	Communities Selected	Farms/Clusters Selected	Farmers Selected
Benue	Agatu	4	10 (10x4=40)	1 (1x40=40)
	Guma	4	10 (10x4=40)	1 (1x40=40)
	Gwer West	4	10 (10x4=40)	1 (1x40=40)
	Ohimini	4	10 (10x4=40)	1 (1x40=40)
Nasarawa	Awe	4	10 (10x4=40)	1 (1x40=40)
	Doma	4	10 (10x4=40)	1 (1x40=40)
	Keana	4	10 (10x4=40)	1 (1x40=40)
	Lafia	4	10 (10x4=40)	1 (1x40=40)
Total	8	32	80 (80x4=320)	320

tertiary (8.1%). Rice farming was the main occupation for 96.9%. Average farming experience was 20 years; 24.4% had 16–20 years' experience. Income similarly peaked at N251,000 – N500,000 (34.4%). Household size of 4–6 persons was most common (41.9%). Most respondents (61.8%) had lived in their communities for over 31 years.

3.1.2 Rice Variety Identification and Choice Rationale

Table 3 shows the distribution of rice varieties cultivated by farmers in Benue and Nasararwa States. Variety identification was high: Benue (91.7%), Nasarawa (88.1%). Faro 44 was overwhelmingly dominant—cultivated by 91.7% in Benue and 97.2% in Nasarawa; Faro 66 accounted for the remainder.

Table 1. Identification of varieties of rice cultivated by farmers in Benue and Nasarawa States

State	Response	No of Respondents	%
Benue	No	3	1.9
	Yes	157	98.1
	Total	160	100
Nasarawa	No	19	11.9
	Yes	141	88.1
	Total	160	100

Table 2. Type of Rice varieties cultivated by farmers in Benue and Nasarawa States

State	Rice Type	Number	%
Benue	FARO 44	144	91.7
	FARO 66	13	8.3
	Total	157	100
Nasarawa			
	FARO 44	137	.97.2
	FARO 66	4	2.8
	Total	141	100

Farmers' primary criterion for variety choice was yield/productivity is outlined in Fig. 4. (Benue: 89.7%; Nasarawa: 86.8%). Secondary factors in Benue were seed availability (57.4%) and climate adaptation (44.5%); in Nasarawa, seed availability (76.8%), market demand (76.2%), maturity duration (69.5%), and climate adaptation (63.2%). Pest/disease resistance, input costs, soil type, and culinary preferences were minimally influential.

3.1.3 Stress Tolerance of Faro 44

Results on tolerance to draught at Benue and Nasarawa States are shown in Table 4. Faro 44 was rated superior in drought tolerance (Benue: 92.9%; Nasarawa: 97.2%), flooding tolerance (Benue: 92.1%), pest/disease tolerance (Nasarawa: 91.5%), and weed tolerance (Benue: 93.5%; Nasarawa: 84.4%). All Benue farmers reported weed disturbances; 95.6% did so in Nasarawa.

3.1.3.1 Pernicious Weeds

Table 5 and Fig. 2 represents farmers' responses to newer weed disturbances in rice farms in Benue and Nasarawa States. In Benue, dominant weeds were *Echinochloa* spp. (59.0%), *Commelina*/*Ipomoea* spp. (43.6%), and *Cyperus* spp. (20.5%). In Nasarawa, *Cyperus* spp. (82.9%), *Digitaria* spp. (47.7%), and *Echinochloa* spp. (30.8%) were most prevalent.

3.1.3.2 Climate Vulnerabilities

Fig. 3 provides data on the current climate vulnerabilities affecting rice farming/farmers in Benue and Nasarawa States. Benue farmers ranked temperature (94.4%) as the primary climate threat, followed by flooding/waterlogging (85.0%) and soil erosion (81.3%). Nasarawa farmers identified erratic rainfall (98.1%) as most critical, followed by increased temperature (78.8%) and soil erosion (76.3%).

3.1.3.3 Climate-resilient Practices

Table 6, represents farmers response on climate-resilient farming practices in Benue and Nasarawa States Awareness of climate-resilient practices was moderate: Benue (83.1%), Nasarawa (76.3%). Benue farmers prioritized capacity building (47.4%), agroforestry (44.4%), and crop diversification (43.6%). Nasarawa farmers ranked crop diversification first (91.0%), followed by agroforestry/drought-resistant varieties (79.5%) and climate-adapted calendars (71.3%). Government support and policy alignment were least cited in both states as shown in Table 2.

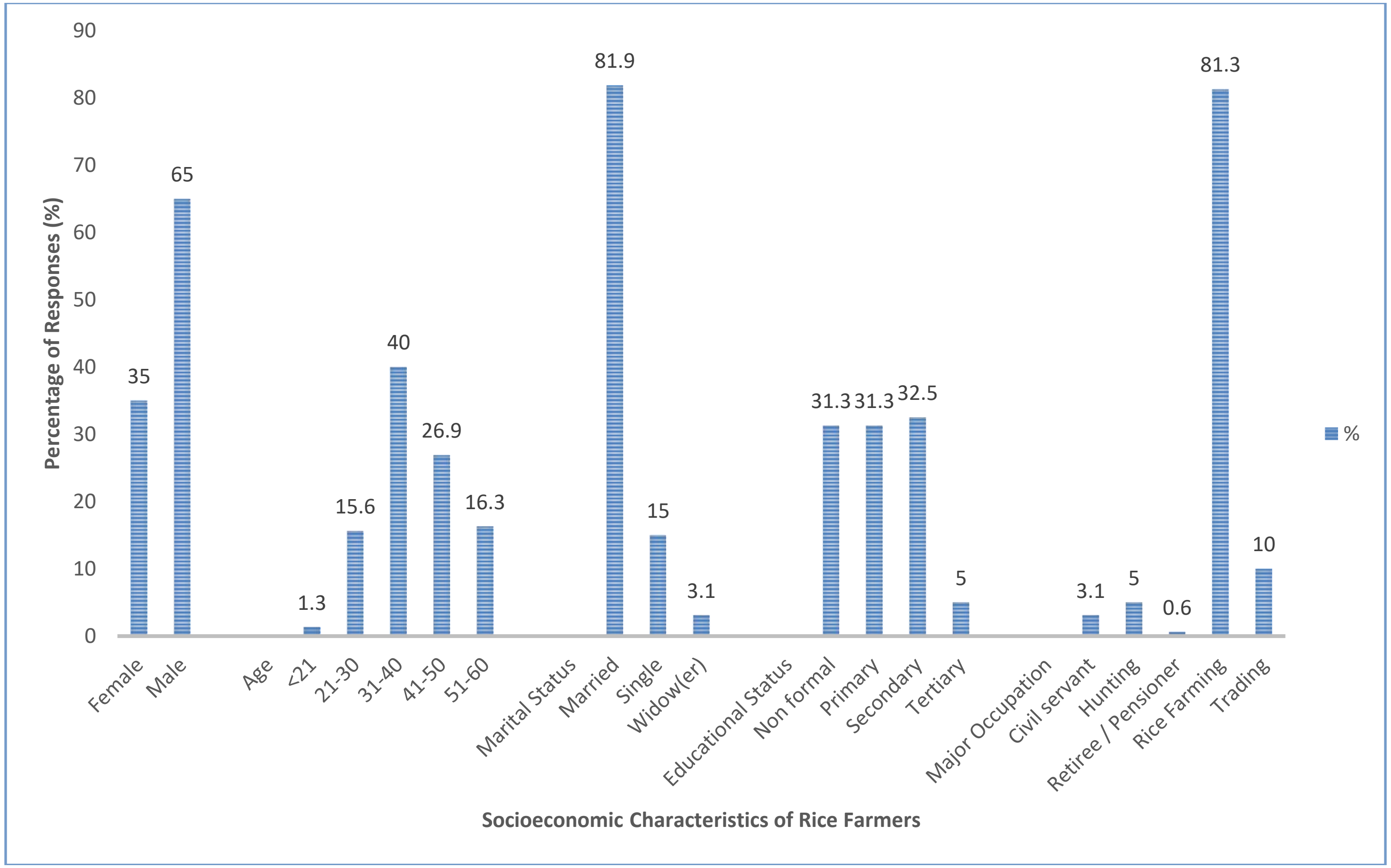

Fig. 1a. Socioeconomic characteristics of rice farmers in Benue State

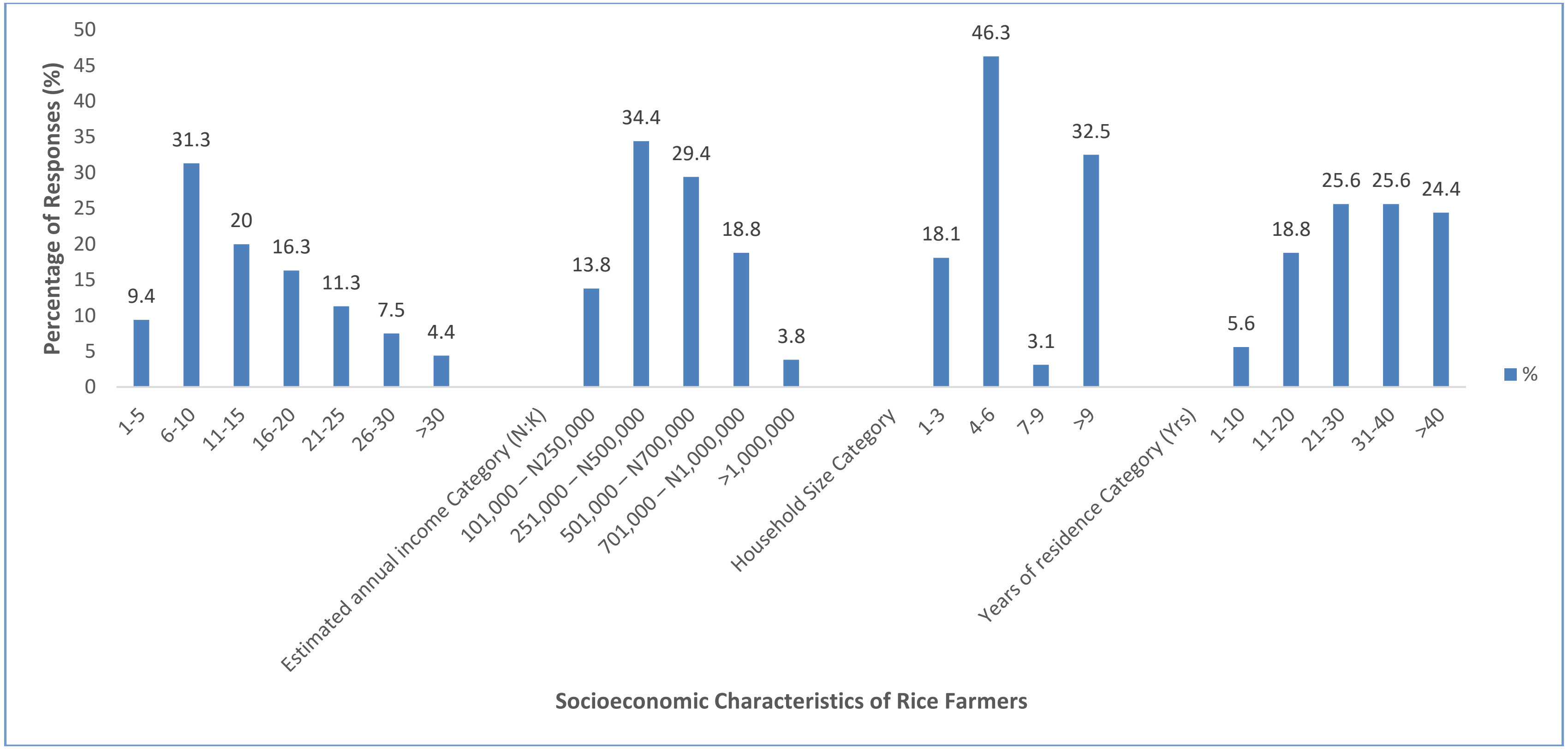

Fig. 1b. Socioeconomic characteristics of rice farmers in Benue State

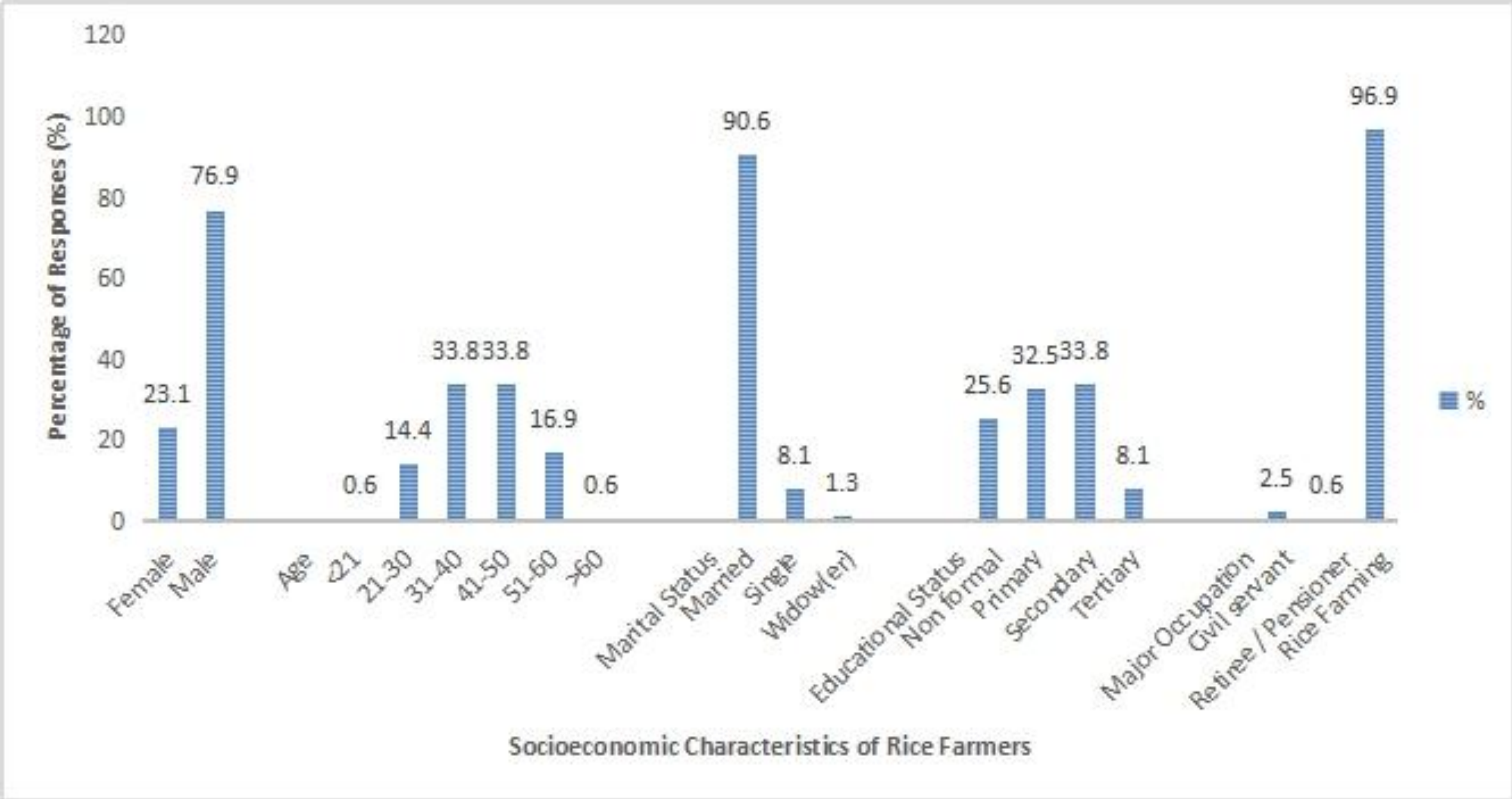

Fig. 1c. Socioeconomic characteristics of rice farmers in Nasarawa State

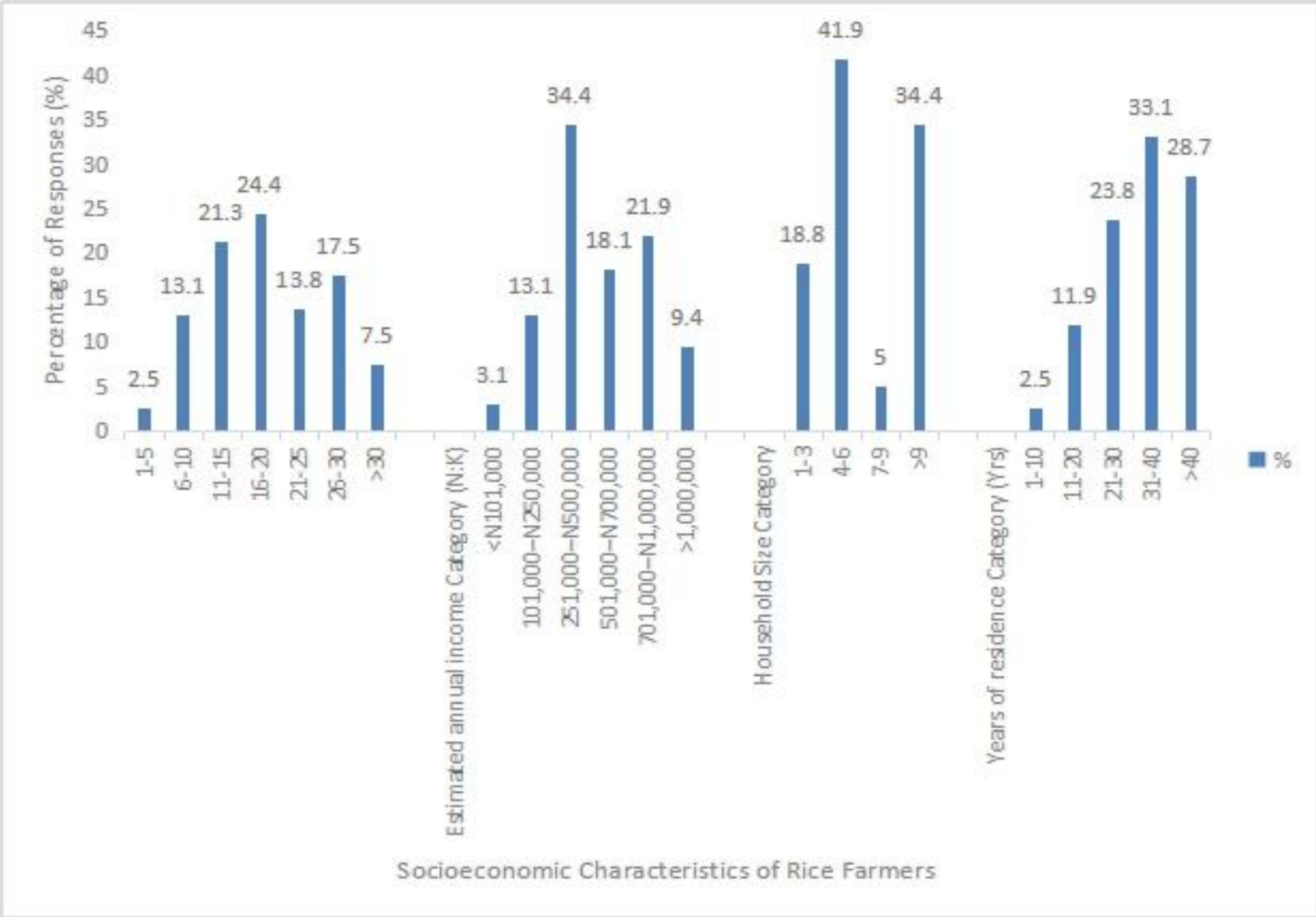

Fig. 1d. Socioeconomic characteristics of rice farmers in Nasarawa State

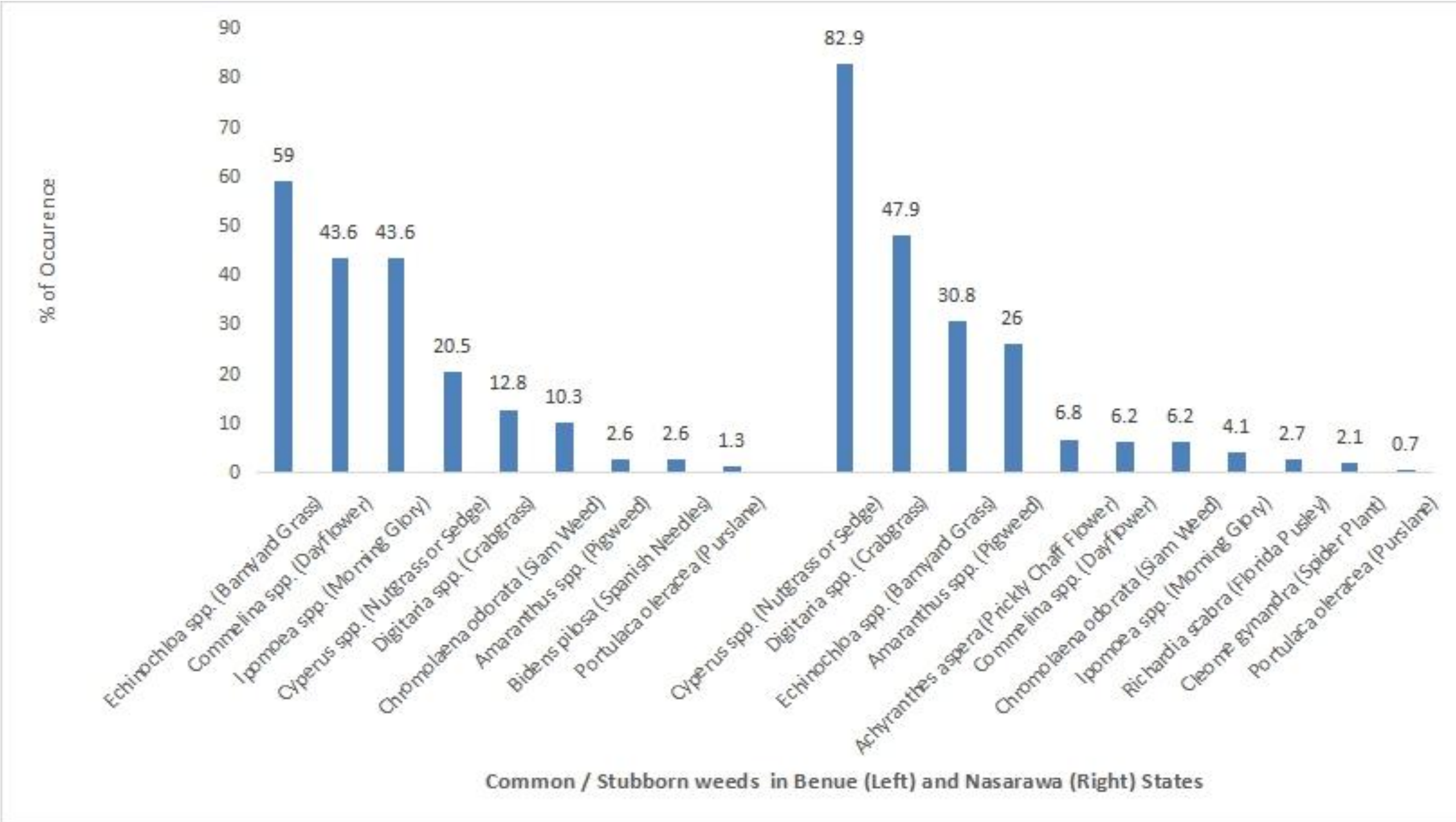

Fig. 2. Common pernicious weeds associated with rice farms in Benue and Nasarawa States

Table 3. Rice varieties with higher tolerance to drought in Benue and Nasarawa States

State	Rice Varieties	Number of respondents	%
Benue	Faro 44	145	92.9
	Faro 66	11	7.1
	Total	156	100
Nasarawa	Faro 44	137	97.2
	Faro 66	4	2.8
	Total	141	100

Table 4. Rice varieties with more resistance to flooding in Benue and Nasarawa States

State	Rice Varieties	Number of respondents	%
Benue	Faro 44	129	92.1
	Faro 66	11	7.9
	Total	140	100
Nasarawa	Faro 44	129	91.5
	Faro 66	11	7.8
	Faro 67	1	0.7
	Total	141	100

Table 5. Rice varieties reported for tolerance to weed problems in Benue and Nasarawa States

State	Rice Varieties	No of Respondents	%
	Faro 44	143	93.5
	Faro 66	9	5.9
	Faro 67	1	0.7
	Total	153	100.0
Nasarawa			
	Faro 44	135	84.4
	Faro 66	5	3.1
	Faro 67	1	.6
	Total	160	100.0

Table 6. Farmers responses on -weeds disturbance to rice farms in Benue and Nasarawa States

State	Response	No. of Respondents	%
Benue	Yes	160	100
Nasarawa	No	7	4.4
	Yes	153	95.6
	Total	160	100

4. Discussion

The socioeconomic profile of rice farmers in Benue and Nasarawa States reflects demographics typical of Sub-Saharan African agricultural communities. These characteristics—particularly age, education, experience, and income—significantly influence technology adoption and productivity (Sisay et al., 2023; Kanu and Przezbórska-Skobiej, 2025). Similar studies affirm that socioeconomic variables shape farmers' risk attitudes, allocative efficiency, and preferences for varietal traits (Abubakar et al., 2023; Kehinde et al., 2022).

Male dominance in rice farming (Benue: 65%; Nasarawa: 76.9%) aligns with regional patterns. Gebre et al. (2019) reported 44.3% male dominance among maize farmers in Tanzania, while Tokula et al., (2019) documented 67% male farmers in Benue. This disparity is attributed to gender inequality in access to productive resources, patriarchal inheritance systems, and sociocultural norms. The mean farmer age (Benue: 40 years; Nasarawa: 41 years) corroborates Yeboah and Jayne (2020), who estimated the agricultural workforce across six African nations at 38–45 years.

High marriage rates (Benue: 81.9%; Nasarawa: 90.6%) reflect the reliance on family labour, consistent with Tokula et al. (2019), Ngeywo et al. (2015), and Sisay et al., (2023). Predominant household sizes of 4–6 persons suggest labour constraints, given rice's high labour demands, a factor linked to reduced farm sizes and low annual incomes (Adewumi et al., 2024; Ajayi and Sanyang, 2023; Adenuga et al., 2024).

Most farmers possessed secondary education (Benue: 32.5%; Nasarawa: 33.8%), with 25.6% in Nasarawa having no formal education. This aligns with MIJARC/IFAD/FAO (2012) and Reimers and Klasen, (2013), who noted that only 2% of tertiary students in Sub-Saharan Africa enroll in agriculture. Low educational attainment constrains adoption of climate-smart innovations, high-yielding varieties, and modern information systems (Chen et al., 2024; Hassan et al., 2024).

Average farming experience (Benue: 11–15 years; Nasarawa: 20 years) positively influences productivity. Experienced farmers achieve profitable yields despite climate variability, corroborating established positive correlations between experience and agricultural output.

High variety identification rates (Benue: 91.7%; Nasarawa: 88.1%) and overwhelming preference for Faro 44 (Benue: 91.7%; Nasarawa: 97.2%) reflect farmers' attachment to familiar, proven varieties. This aligns with Sheshi & Usman, (2018), and Adenuga et al. (2024), who observed that land-owning farmers sustain cultivation of known varieties. Selection criteria—yield, seed availability, climate adaptation, market demand, and maturity duration—correspond with Ghimire et al. (2015), Ajayi and Sanyang (2023). Limited adoption of newer varieties (e.g., Faro 66, Faro 67) stems from insufficient awareness, weak commercialization, and narrow evaluation frameworks prioritizing yield over non-yield traits (Okoro et al., 2024; Nagargade et al., 2018; Nyang'au et al., 2020; Paiman et al., 2020; Pickson & He, 2021).

Faro 44 was consistently rated superior in drought tolerance (Benue: 92.9%; Nasarawa: 97.2%), flooding tolerance (Benue: 92.1%), pest/disease tolerance (Nasarawa: 91.5%), and weed tolerance (Benue: 93.5%; Nasarawa: 84.4%). These perceptions are supported by evidence of genetic mechanisms for drought tolerance (DSM2 gene, QTLs) and flood resilience through developmental and physiological strategies (Du et al., 2010; Bernier et al., 2008; Chen et al., 2020; Anugwa et al., 2022; Awan et al., 2019). Farmers' preferences thus reflect rational selection based on observed performance under adverse conditions.

Dominant weeds: *Echinochloa* spp., *Cyperus* spp., and *Digitaria* spp., typify direct-seeded rice systems (Nagargade et al., 2018; Awan et al., 2019). Faro 44's perceived weed tolerance aligns with findings on varietal differences in weed suppression. However, low educational levels and labour constraints impede effective management, allowing weed propagule accumulation (Paiman et al., 2020).

Farmers identified temperature (Benue: 94.4%) and erratic rainfall (Nasarawa: 98.1%) as primary climate threats, alongside flooding, soil erosion, and limited adaptive capacity. These findings reflect global evidence that rice is a climate-sensitive crop, and faces heightened risks from warming and precipitation variability (Chen et al., 2020; Saud et al., 2022; Vicente-Serrano et al., 2010). Limited access to climate-resilient varieties and information exacerbates vulnerability, underscoring the need for targeted adaptation strategies (Yusuf et al., 2019; Pickson & He, 2021).

Awareness of climate-resilient practices was moderate (Benue: 83.1%; Nasarawa: 76.3%). Benue farmers prioritized capacity building (47.4%), agroforestry (44.4%), and crop diversification (43.6%); Nasarawa farmers ranked crop diversification first (91.0%), followed by agroforestry/drought-resistant varieties (79.5%) and climate-adapted calendars (71.3%). These preferences align with documented determinants of CSA adoption: household size, farm income, extension access, and social capital (Nyang'au et al., 2020; Eshetu et al., 2021; Anugwa et al., 2022; Gebre et al., 2019). Scaling up cost-effective farm management adaptations, stress-tolerant varieties, and institutional support is critical for enhancing resilience and reducing rice import dependency (Huang et al., 2015; Kabir et al., 2017).

5. Conclusion

The study concludes that rice farmers in Benue and Nasarawa States are predominantly male, aged 31–50 years, married, and primarily educated to secondary school level. Rice farming constitutes their main occupation, with an average of 15–20 years of experience. Annual income typically ranges from N251,000 to N500,000. Most farmers operate households of 4–6 persons and have resided in their communities for approximately three decades.

Faro 44 is the overwhelmingly preferred rice variety, selected principally for its high yield, seed availability, market demand, and superior tolerance to drought, flooding, and weeds relative to other varieties. Despite this preference, weed infestation—particularly *Echinochloa* spp., *Commelina* spp., and *Cyperus* spp., remain a pervasive production constraint, underscoring the need for improved weed management and enhanced crop resilience.

Key climate vulnerabilities affecting rice production include increased temperature, flooding, waterlogging, soil erosion, erratic rainfall, and land degradation. Compounding these are limited access to climate information, lack of climate-resilient varieties, pest and disease pressure, and inadequate infrastructure.

6. Recommendations

1. Develop and implement targeted adaptation strategies to strengthen rice production resilience in both states.
2. Promote timely weed identification and adoption of effective, context-specific control measures.
3. Enhance the capacity of rice farming systems to withstand and recover from climate-related shocks through improved water management, diversification of crop varieties, and strengthened climate information services.

Disclaimer (Artificial Intelligence)

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

Competing Interests

Authors have declared that no competing interests exist.

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