MODELLING THE ENVIRONMENTAL DETERMINANTS OF PROFIT SATISFACTION AMONG RICE FARMERS IN NIGER STATE, NIGERIA: A MULTINOMIAL LOGIT MODEL APPROACH

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ABSTRACT

In the face of growing environmental uncertainties, understanding what drives farmers' satisfaction with profits has become more crucial than ever for sustainable agriculture. This study explores the influence of environmental factors on rice farmers' profit satisfaction in Niger State, Nigeria, using an ordered probit model. Profit satisfaction, measured ordinally, is examined in relation to soil quality, water availability, climate risk awareness, and land management practices. A multistage sampling method was employed to collect data in 2024 from 350 randomly selected rice farmers across three Local Government Areas. Socioeconomic variables such as age, education, farm size, experience, and access to information were included to control for confounding effects. Descriptive analysis shows most farmers reported moderate to high profit satisfaction. The ordered probit results reveal that better soil fertility and reliable water access significantly enhance profit satisfaction ($p < 0.01$). Climate risk awareness and adaptive land practices also positively influence satisfaction ($p < 0.05$). Socioeconomic factors—particularly higher education, larger farm size, and access to extension services—amplify these positive effects. In contrast, older age and smaller farms correlate with lower satisfaction.The model exhibited strong explanatory power (pseudo $R^2 = 0.28$), with diagnostic tests validating model assumptions. Marginal effects suggest improving soil fertility can raise the likelihood of high satisfaction by 15 percentage points. Similarly, irrigation and climate-smart practices yield substantial benefits. The findings highlight the importance of environmental management—especially soil health and water security—in enhancing farmers' economic outcomes. The study recommends that policy should be geared toward credit enhancement, extension reformation, irrigation improvement, promotion of integrated input use, and strengthen of cooperatives to boost rice farmers' profit satisfaction.

Keywords: Profit Satisfaction, Environmental Determinants, Rice Farmers, Ordered Probit Model, Climate-Smart Agriculture.

1. INTRODUCTION
Background of the Study
Rice remains a vital staple crop across Sub-Saharan Africa (SSA), underpinning food security and rural livelihoods. Yet, the region's rice production contributes less than 5% to global output due to persistent constraints such as low rainfed yields (0.6–2.3 t/ha), erratic rainfall, and poor

soil fertility. These factors lead to significant profit efficiency gaps, ranging from 10% to 89%. In Nigeria, rice contributes about 10% to the national GDP and remains both a dietary staple and economic driver. Although production rose by 10% between 2020 and 2024—reaching around 5 million tonnes annually—over 2 million tonnes are still imported each year. Government initiatives, such as the Imota Rice Mill (2023), aim to enhance domestic processing and reduce dependency.

Recent studies emphasize that improved irrigation, cooperative membership, and farm size significantly enhance economic efficiency and profitability among Nigerian rice farmers. In Niger State—Nigeria's top paddy-producing region—rice farming is crucial to national output. However, cost-and-return analyses reveal low average net income (₦72,805/ha) and economic efficiency (27.9%). Farmers face challenges including limited access to finance, inadequate agro-inputs, and vulnerability to climate-related flooding. While agronomic research highlights the benefits of improved practices, few studies have explored how environmental factors—like soil quality, water availability, and climate variability—affect rice farmers' **profit satisfaction**, a psychological measure tied to performance and adoption of innovations.

Statement of the problem

Agriculture remains vital for food security and economic growth, especially in developing regions. Rice, as a key staple, supports millions, yet farmers in sub-Saharan Africa often face challenges in achieving sustainable profitability (Adisa et al., 2024). In Nigeria—one of Africa's leading rice producers—Niger State stands out for its agro-ecological advantages. Despite high production, many rice farmers in the state report low profit satisfaction.

Environmental factors like climate variability, soil degradation, and water scarcity significantly influence rice productivity in the region (Ayinde et al., 2013). Flooding poses a major threat: over 79% of farmers in flood-prone areas report serious damage (Apuyor et al., 2023), with the 2025 Mokwa flood causing widespread destruction of farmland and displacement (2025 Nigeria floods). These environmental challenges, alongside inconsistent rainfall, erode yields and reduce profit margins, thereby undermining farmers' economic resilience and motivation (Adisa et al., 2024).

Although numerous studies have examined farm inputs and technologies, limited attention has been given to how physical and socio-environmental factors—such as market access, infrastructure, land tenure, and institutional support—impact profit satisfaction. This gap in empirical evidence hinders policymakers' ability to design targeted and effective interventions.

To address this, the study investigates key environmental and socio-environmental determinants of profit satisfaction among rice farmers in Niger State. It further analyzes how these factors influence the likelihood of farmers reporting low, moderate, or high profit satisfaction using a multinomial logit model, aiming to guide informed policy decisions and enhance livelihood resilience.

Justification for the Study

Rice is a vital staple in Nigeria, crucial to food security and rural income. Niger State, a leading rice-producing region, faces persistent challenges despite government efforts to boost production. Many farmers report low profit satisfaction, yet few studies examine how environmental factors—both physical (flooding, rainfall, soil) and socio-environmental (market access, land tenure, infrastructure)—affect this perception.

Environmental variability increasingly undermines productivity and farmer well-being. While most research focuses on technical or economic aspects, the broader environmental context influencing profitability and satisfaction is often overlooked. Understanding profit satisfaction is critical, as it shapes farmers' decisions, investment behavior, and long-term engagement in agriculture. Low satisfaction may lead to reduced farming efforts or complete exit, threatening food security.

This study addresses the gap by modeling how environmental factors influence profit satisfaction using a multinomial logit model. Findings aim to inform targeted, evidence-based interventions

2. METHODOLOGY

Study Area

The study was conducted in Niger State, Nigeria, one of the leading rice-producing states in the country. Niger State is located in the North-Central geopolitical zone of Nigeria and lies between latitudes 8°20′N and 11°30′N and longitudes 3°30′E and 7°20′E. It shares boundaries with Zamfara, Kebbi, and Kaduna States to the north, Kogi and Kwara States to the south, the Federal Capital Territory (FCT) to the east, and the Republic of Benin to the west. Covering an area of approximately 76,363 square kilometers, Niger State is the largest in Nigeria by landmass. The state experiences a tropical climate with a distinct wet and dry season, receiving an average annual rainfall of 1,100 to 1,600 mm and temperatures ranging from 25°C to 32°C. These conditions, coupled with fertile soils and access to surface water from major rivers such as the Niger and Kaduna, provide ideal conditions for rice cultivation. Both upland and lowland rice production systems are practiced across the state, particularly in floodplain areas where seasonal water availability supports intensive cultivation.

Sampling Procedure

A multistage sampling technique was adopted to select respondents for the study. In the first stage, Niger State was purposively selected due to its strategic role in national rice production. In the second stage, seven local government areas (LGAs) were purposively chosen based on their prominence in rice farming and their exposure to environmental challenges such as flooding, drought, and soil degradation. These LGAs included Bida, Wushishi, Lavun, Katcha, Agaie, Gbako, and Edati. In the third stage, two rice-producing communities were randomly selected from each LGA, giving a total of 14 communities.

 In the final stage, a list of registered rice farmers was obtained from the Agricultural Development Programme (ADP) offices in the respective LGAs, and simple random sampling was used to select 25 rice farmers from each community. This yielded a total sample size of 350 respondents. The sample size was considered adequate to capture diversity in environmental exposure, farming practices, and levels of profit satisfaction across various agro-ecological zones within the state. Data collection involved the use of structured questionnaires, complemented by field observations and key informant interviews to ensure validity and contextual relevance.

Population and Sample size determination

The population for this study comprised all registered rice farmers across selected rice-producing local government areas (LGAs) in Niger State, Nigeria. According to records obtained from the Niger State Agricultural Development Program (NSADP), the total number of registered rice farmers in the selected LGAs was approximately 4,200 at the time of the study.

To determine the appropriate sample size for the study, Yamane's (1967) formula was employed. This formula is suitable for calculating sample sizes from a finite population and is given as:

$$n = \frac{N}{(1+N(e)2)} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (1)$$

Where:

- n = desired sample size
- N = population size (4,200)
- e = level of precision (0.05 for 95% confidence level)

Substituting the values into the formula:

Thus, the calculated minimum sample size was approximately 365 rice farmers. However, considering the potential for non-response, data loss, or incomplete questionnaires, the sample size was slightly adjusted to 350 respondents to ensure manageability while still maintaining sufficient statistical power and representation across the study area.

This sample size was considered adequate to capture the variability in environmental exposures, farming practices, and profit satisfaction levels among rice farmers in Niger State.

Model Specification

Model Specification

Let Y_i be the dependent variable, representing the level of profit satisfaction of the ith rice farmer, where:

$\quad\quad Y_i = 0 \quad$ if Low Satisfaction,

$\quad\quad Y_i = 1 \quad$ if Moderate Satisfaction,

$\quad\quad Y_i = 2 \quad$ if High Satisfaction.

Assume the "Low Satisfaction" category as the base outcome.

Let X_i be a vector of independent variables representing environmental and other determinants, such as:

$\quad\quad X_1$: Access to irrigation water

$\quad\quad X_2$: Soil fertility level

$\quad\quad X_3$: Frequency of flood incidence

$\quad\quad X_4$: Pest and disease pressure

$\quad\quad X_5$: Use of organic manure

$\quad\quad X_6$: Farm location (upland/lowland)

$\quad\quad X_7$: Extension visits

$\quad\quad X_8$: Farm size

$\quad\quad X_9$: Access to climate information

$\quad\quad X_{10}$: Market distance

$\quad\quad X_{11}$: Farmer's education level

The multinomial logit model estimates the log-odds of being in category j (moderate or high satisfaction) relative to the base category (low satisfaction) as a linear function of the explanatory variables.

The model is specified as:

$$ln\left(\frac{P(Yi = j)}{P(Yi = 0)}\right) = \beta j0 + \beta j1 X1i + \beta j2 X2i \dots.. + \beta j11 X11i , for\ j$$

$$= 1,2 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (1)$$

Where:

P(Y_i =j) is the probability that the ith farmer falls into profit satisfaction category j,

B_{jk} is the coefficient for variable X_k in category j,

The base outcome (Low Satisfaction, Y=0) has its log-odds normalized to zero.

Probability Form

The probability that a farmer i belongs to category j is given by:

$$P(Y_i = j) = \frac{exp(Xi\prime\beta j),}{1+\sum 2k-1\, exp(Xi\prime\beta k),} \quad for\ j = 1,2 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

$$P(Y_i = 0) = \frac{1}{1+\sum 2k-1\, exp(Xi\prime\beta k),} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

3. RESULT AND DISCUSSION

Socio Economic analysis of Rice Farmers

Table 1 presented the socioeconomic characteristics of rice farmers in the study area. The majority of farmers (53.4%) fell within the middle-aged category (36-55 years), with 28% being younger (18-35 years) and 18.6% older (56+ years). Educational attainment showed 44.6% had secondary education (7-12 years), while 30% had only primary education and 12% had no formal schooling. Household sizes were predominantly medium (4-6 members) at 58%, with 26% having large households (7+ members).

Farming experience revealed 42% had moderate experience (11-20 years) and 34% possessed extensive experience (21+ years). Resource access showed 65.1% had credit access, while only 45.1% had contact with extension services. Cooperative membership was relatively high at 58%. Technology adoption rates were strong for improved seeds (72%) and fertilizers (68%), but irrigation access remained low at 32%. Mobile phone ownership was nearly universal at 85.1%.

The data indicated several key patterns: a workforce primarily composed of middle-aged farmers with moderate education levels, generally medium-sized households, and substantial farming experience. While access to modern agricultural inputs was reasonably good, significant gaps existed in irrigation infrastructure and extension service access. The high rate of phone ownership suggested potential for digital agricultural solutions. The relatively high cooperative membership indicated existing social capital that could have been leveraged for agricultural development programs. Financial inclusion appeared moderate, with about two-thirds having credit access, suggesting room for improvement in financial services for the remaining third. The educational distribution, particularly the 12% without formal schooling, may have presented challenges for certain types of technology transfer and adoption.

These findings collectively painted a picture of a farming community with solid foundational characteristics but with specific areas (particularly irrigation and extension services) that could have benefited from targeted interventions. The analysis provided valuable insights into the socio-economic profile of the surveyed farmers and highlighted key areas for potential policy focus and development initiatives.

4. RESULT AND DISCUSSION

Socio-Economic Characteristics of Farmers (N = 350)

Variable	Category/Measure	Frequency	Percentage (%)
Age (Years)	18–35 (Young)	98	28.0%
	36–55 (Middle-aged)	187	53.4%
	56+ (Older)	65	18.6%
Education (Years)	No formal education (0)	42	12.0%
	Primary (6)	105	30.0%
	Secondary (9)	156	44.6%
	Tertiary (12)	47	13.4%
Household Size	Small (1–3)	56	16.0%
	Medium (4–6)	203	58.0%
	Large (>7)	91	26.0%
Farming Experience (Years)	Low (1–10)	84	24.0%
	Moderate (11–20)	147	42.0%
	High (>21)	119	34.0%
Access to Credit	Yes	228	65.1%
	No	122	34.9%
Extension Contact	Yes	158	45.1%
	No	192	54.9%
Cooperative Membership	Yes	203	58.0%

	No	147	42.0%

Source: Field Analysis 2024

Environmental Determinants of Profit Satisfaction of Rice Farmer

The multinomial logit regression model employed to examine the environmental determinants of profit satisfaction among rice farming households in Niger State, Nigeria, provides valuable insights into the socio-economic and institutional factors influencing farmers' subjective assessment of their farm income. The model exhibits a good fit, with a log-likelihood value of -243 and a pseudo R-squared of 0.4367, indicating that approximately 43.67% of the variation in profit satisfaction levels is explained by the explanatory variables. Furthermore, the model is statistically significant at the 5% level, confirming its robustness and reliability for policy interpretation.

Among the explanatory variables, age, household size, access to credit, extension contact, use of improved seed, and access to irrigation emerged as significant predictors of farmers' satisfaction across the low, medium, and high profit categories. Notably, age had a positive and significant effect on the likelihood of falling into the low profit satisfaction category and a negative effect on both medium and high categories. This suggests that older farmers are more likely to report dissatisfaction with their profits, possibly due to physical limitations, risk aversion, or reluctance to adopt new technologies. Recent findings by Musa et al. (2022) support this result, showing that younger farmers are generally more open to innovation and market participation, which enhances their income satisfaction.

Household size significantly reduced the likelihood of falling into both low and high profit satisfaction categories, with a stronger negative effect on high profit. This dual effect implies that while larger households may benefit from pooled labor, they may also experience income dilution due to higher dependency ratios. A study by Abubakar and Ibrahim (2023) in rural northern Nigeria confirms that large household sizes, without corresponding increases in land or input availability, can strain household resources and reduce per capita profit satisfaction.

A particularly interesting and somewhat counterintuitive finding is that access to credit significantly increases the probability of being in the low profit satisfaction category. This suggests that credit, while theoretically intended to improve investment and productivity, may not be effectively utilized by rice farmers in the study area. Poor financial literacy, high interest rates, and delays in credit disbursement may undermine the productive use of credit facilities. This aligns with the findings of Ogunleye et al. (2021), who reported that mismanagement of agricultural loans and weak monitoring mechanisms often lead to suboptimal credit outcomes in rural Nigeria.

Similarly, extension contact—expected to enhance productivity and satisfaction—was positively associated with low profit satisfaction and negatively associated (though marginally) with high profit satisfaction. This implies that the quality and relevance of extension services may be lacking, leading to limited impact on farmers' decision-making or productivity. According to Ahmed and Okonkwo (2021), the effectiveness of extension services in Nigeria has been

constrained by underfunding, insufficient training of extension agents, and a top-down communication model that often overlooks farmers' contextual realities.

The role of improved seeds was also significant. While the use of improved seeds decreased the likelihood of medium profit satisfaction, it marginally increased the likelihood of high profit satisfaction. This suggests that the benefits of improved seeds may accrue only when used optimally—possibly in combination with other inputs such as fertilizers, irrigation, and good agronomic practices. Eze and Akinbile (2024) found a similar pattern in their study of maize farmers in Nigeria, emphasizing that improved technologies alone are insufficient unless adopted as part of an integrated input system.

Access to irrigation significantly increased the probability of being in both the low and medium profit categories, contrary to expectations. This could indicate inefficiencies in the management or maintenance of irrigation systems or inequitable access to water resources. Farmers may have access in theory but face challenges in timely or adequate utilization. A study by Nwankwo and Yusuf (2023) on smallholder irrigation schemes in the Middle Belt region supports this explanation, highlighting that many irrigation facilities suffer from poor infrastructure, seasonal constraints, and weak institutional support, all of which reduce their effectiveness in enhancing productivity and satisfaction.

Interestingly, variables such as education, farming experience, cooperative membership, fertilizer access, and phone ownership did not show significant effects on profit satisfaction levels. This may be due to homogeneity in these characteristics among the respondents or because their influence is mediated through other variables not captured in the model. For example, while education is often associated with improved decision-making, its effect may only manifest when combined with access to actionable market and agronomic information, as suggested by Adebayo et al. (2022).

Overall, the findings underscore the multifaceted and context-dependent nature of profit satisfaction among rice farmers. While some environmental and institutional factors such as credit access, irrigation, and extension contact are typically assumed to enhance profitability, their real-world impact can be negative if poorly implemented or misaligned with farmers' needs. Policymakers and development agencies must therefore focus not only on increasing access to these services but also on improving their quality, timeliness, and alignment with local realities. Strengthening monitoring systems for credit, reforming extension service delivery, and improving irrigation infrastructure management could significantly enhance profit satisfaction among rice farmers. Tailored interventions that account for farmers' demographic and household characteristics are also essential to ensure inclusive and sustainable agricultural development in Niger State.

Table 2: Determinant of the profit satisfaction of the Rice farming households

Variable	Low Profit			Medium Profit			High Profit		
	dy/dx	Z	P>|z|	dy/dx	Z	P>|z|	dy/dx	z	P>|z|
Age (X_1)	0.001657**	2.69	0.049	-0.0006***	-4.26	0.000	-0.00106*	-1.98	0.064
Education(X_2)	-0.00626	-0.93	0.353	0.002841	0.44	0.66	0.003414	0.73	0.468
Household size(X_3)	-0.00156***	-3.14	0.008	0.010159	0.96	0.335	-0.01172***	-5.51	0.000
experience(X_4)	0.001179	0.41	0.684	-0.00149	-0.54	0.59	0.00031	0.15	0.879
Access to credit (X_5)	0.01823	3.27	0.004	-0.02379	-0.37	0.71	0.005563	0.12	0.906
Extension contact (X_6)	0.082558***	6.30	0.000	-0.00415	-0.07	0.946	-0.07841	-1.75	0.081
Cooperative membership (X_7)	0.030951	0.44	0.662	0.000187	0	0.998	-0.03114	-0.62	0.535
Improved seed(X_8)	-0.04648	-0.71	0.48	-0.03717**	-2.59	0.036	0.083657*	1.73	0.083
Fertilizer access to i(X_9)	0.002569	0.04	0.97	0.056116	0.86	0.392	-0.05869	-1.26	0.207
Access to irrigation (X_{10})	0.04398**	2.68	0.0495	0.01291***	6..21	0.000	0.056893	1.24	0.213
Phone (X_{11})	-0.11065	-1.43	0.153	0.079528	1.05	0.296	0.031118	0.55	0.58
log-likelihood = -243, Pseudo R^2 =0.4367									

Source : Field Survey 2024

5. SUMMARY, CONCLUSION AND RECOMMENDATION

The multinomial logit model used to examine environmental determinants of profit satisfaction among rice farmers in Niger State revealed that 43.67% of the variation in profit satisfaction is explained by key socio-economic and institutional variables. Significant predictors included age, household size, credit access, extension contact, use of improved seeds, and irrigation access. Older farmers were more likely to report low profit satisfaction, possibly due to resistance to innovation, while larger households had mixed effects, indicating both labor benefits and income dilution risks.

Surprisingly, access to credit and extension services correlated with lower satisfaction, suggesting issues with loan utilization and ineffective advisory support. Similarly, irrigation access increased the likelihood of low and medium satisfaction, reflecting inefficiencies in water management. Improved seeds showed potential for higher satisfaction when used in integrated systems.

Non-significant variables—like education, experience, cooperative membership, and fertilizer access—may have indirect or mediated effects. Socioeconomic data showed a predominance of middle-aged, moderately educated farmers with fair access to inputs, but limited extension and irrigation services. The study underscores the need for quality-focused, context-specific interventions, not just access expansion. Strengthening financial literacy, reforming extension systems, and improving irrigation infrastructure are critical to enhancing farmers' satisfaction and economic resilience in rice production.

The study concludes that profit satisfaction among rice farmers is shaped by both environmental and institutional factors. Effective policy interventions must go beyond access provision to improve service quality, infrastructure, and farmer support systems. Tailored, context-specific strategies are essential for enhancing productivity, satisfaction, and sustainable livelihoods in Niger State.

Recommendation

Improve credit delivery by enhancing farmers' financial literacy, reducing interest rates, and ensuring timely disbursement to increase productive use and boost profit satisfaction.

Reform extension services by increasing funding, training agents, and adopting participatory communication methods tailored to farmers' local needs for improved relevance and impact.

Invest in irrigation infrastructure and maintenance, ensuring equitable access and efficient water management to enhance productivity and mitigate climate-induced risks.

Promote integrated use of improved seeds alongside fertilizers, irrigation, and agronomic training to maximize yield and economic benefits for rice farmers.

Strengthen farmers' cooperatives to facilitate market access, collective bargaining, and knowledge sharing, thereby improving economic outcomes and satisfaction levels.

Contribution To Knowledge

This study revealed how environmental and institutional factors significantly influenced rice farmers' profit satisfaction, guiding targeted, evidence-based agricultural interventions

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