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Research Article

Indigenous Knowledge and Perceptions of Rice Blast Disease Prevalence and Management among Smallholder Farmers in Gombe State, Nigeria

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ABSTRACT

Rice blast disease, caused by *Pyricularia oryzae*, remains a major constraint to rice production, particularly among smallholder farmers that depend on traditional management practices. This study assessed indigenous knowledge and perceptions of rice blast incidence and management among smallholder farmers in Gombe State, Nigeria, through field surveys and structured questionnaires. Farmers widely recognized rice blast as a serious yield constraint, identifying its characteristic leaf lesions and seasonal occurrence. Disease incidence and severity at the study areas were high during the rainy season, reaching 66.0 % and 35.0 % in Gelengu, 60.0 % and 29.0 % in Malleri, and 58.0% and 30.0 % in Dadin Kowa, respectively. Chemical application was the predominant control method, used by 76 % of farmers in Dadin Kowa, 74 % in Malleri, and 64 % in Gelengu, while adoption of resistant varieties was comparatively low (8–14 %). Most farmers relied on fellow farmers for advice (60 % in Dadin Kowa, 42 % in Malleri, and 36 % in Gelengu), with limited engagement with extension agents and formal training. Perceptions of disease severity were influenced by experience, local knowledge exchange, and access to information. The study highlights the need to integrate indigenous knowledge with modern, eco-friendly management practices and strengthen participatory extension systems to achieve sustainable rice blast control and improved productivity in Gombe State.

Keywords: Disease management; Farmers; Gombe State; Knowledge; *P. oryzae*; Rice blast

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INTRODUCTION

Rice Blast, caused by the fungus *P. oryzae*, is one of the most widespread diseases of rice (*Oryza sativa* L.) and occurs in all rice-growing regions in the world (Sester *et al*., 2019). The damage caused by leaf blast is due to the decrease in the active photosynthetic area during the growing stage, which results in a decrease in tillering, in the number of panicles, and the number of grains per panicle and after can kill the plants fully in severe situations as a result of the infection. In terms of yield loss, panicle or neck blast is the most destructive form of the disease because it prevents grain filling (Sester *et al*., 2019).

Rice blast, caused by the foliar fungal pathogen *P. oryzae*, is a severe worldwide problem threatening global food security. Currently, there are no lasting solutions to eradicate this disease beside the use of chemicals, and indiscriminate use of chemical control agents may lead to the development of resistance by the pathogen and possible environmental and health hazards (Xu *et al*., 2019).

Blast disease can be controlled in various ways including cultivation techniques, planting resistant varieties, and the use of fungicides. The use of resistant varieties is the most effective, economic, and easy, however, the use of this technology is faced with *P. oryzae* that have high genetic diversity, adapt and easy to form new races that can break the resistance of newly introduced varieties (Miah *et al*., 2017). Causative agents of all these diseases are rapidly developing resistance to currently available synthetic fungicides in the market (Miah *et al*., 2017). These synthetic fungicides are non-biodegradable and can accumulate in the soil, water, and plant that are toxic and have undesirable effects on other organisms that are present in the environment and which may affect the food chain. The development of resistance toward the currently available synthetic fungicides has a greater concern for agricultural activity (Durgeshlal *et al*., 2019).

Mostly, management of rice blast is mainly focused on the use of synthetic chemicals and resistant rice varieties. In Nigeria, rice blast management has been limited to foliar spray with fungicides such as Ridomil Gold, Moncozeb and Ortiva Top among others. However, such chemicals are expensive, not easily available to small-scale farmers, and have detrimental effects on the environment, farmer and consumer health, beneficial predators, and parasitoids (Hubert *et al*., 2015). This study aimed to assess the fungicidal efficacy of biosynthesized nanoparticle in the control of rice blast disease.

MATERIALS AND METHODS

Study locations

The study was conducted at Dadin Kowa (Yamaltu Deba region), Gelengu (Balanga region), and Malleri (Kwami region) of Gombe State Northeastern Nigeria. The area is characterized by savannah grassland with scattered trees and shrubs, with much of the land under agriculture.

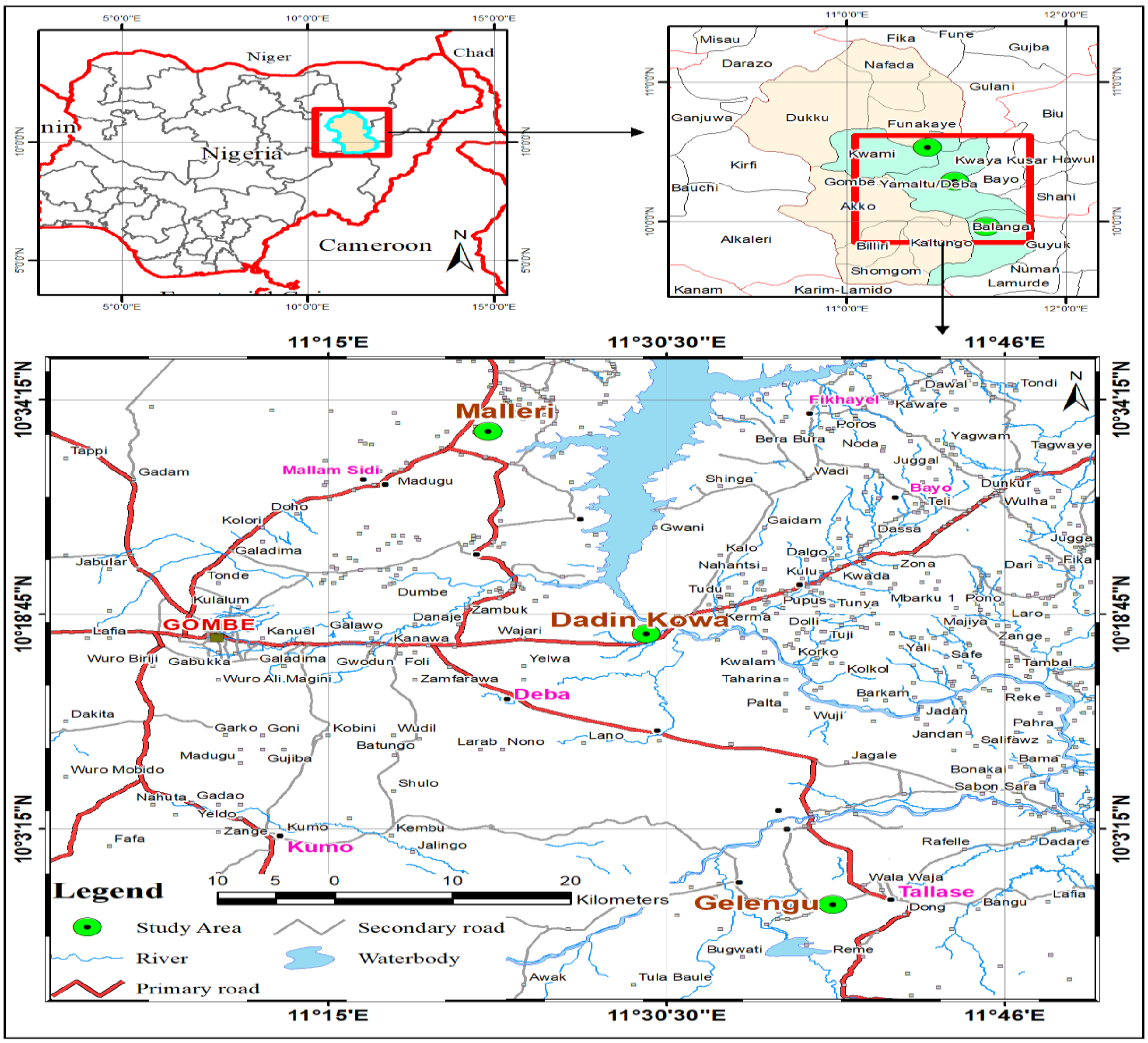

Figure 1. Map of the study locations

Data Collection on Farmers' Knowledge and Perception

A structured questionnaire was administered to rice farmers in the selected survey areas to assess their knowledge and perception of rice blast disease, including its incidence, management practices, and associated challenges.

Field Survey and Sampling of Rice Blast Disease

Field surveys were conducted in August and October, 2024 at three major rice-producing villages in Gombe State: Malleri (Kwami region), Dadin Kowa (Yamaltu Deba region), and Gelengu (Balanga region). These locations were chosen due to their strategic location along the downstream of Dadin Kowa and Balanga dams, making them the leading rice-producing regions in the state.

At each location, three rice farms were randomly selected using a systematic sampling method. A total of nine farms were therefore assessed. Diseased rice plants were collected during the survey, properly labeled, and transported to the laboratory for culturing and further analysis.

Diseased rice plant samples collected from Dadin Kowa, Malleri, and Gelengu villages in Kwami, Yamaltu-Deba, and Balanga regions of Gombe State were transported to the Plant Sciences Laboratory, Gombe State University, Tudun Wada, for bench work.

Disease Incidence and Severity Assessment

Disease incidence and severity were assessed in farmers' fields at four crop growth stages: seedling, tillering, booting, and maturity. Since rice is most vulnerable to blast infection at the booting stage (Devasahayam, 2009), consideration was given to disease assessment during this stage. Disease Incidence (%) was calculated according to Nwilene *et al.* (2008):

$$\text{D}isease\ Incidence\ (\%) = \frac{Number\ of\ infected\ plant\ unit}{Total\ number\ of\ unit\ assessed}\ x\ 100$$

Table 1: Scale lesion type and affected leaf area

Scale	Description
0	No lesion observed
1	Small brown specks of pin-point size or larger brown speck without sporulating center
2	Small roundish to slightly elongated, necrotic gray sports about 1-2 mm in diameter, with distinct brown margin
3	Lesion type is the same as in scale 2, but significant number of lesions on the upper leaves
4	Typical susceptible blast lesions, 3 mm or longer, infecting less than 4 % of the leaf area.
5	Typical blast lesions infection 4 – 10 % of the leaf area.
6	Typical blast lesions infection 11 – 25 % of the leaf area.
7	Typical blast lesions infection 26 – 50 % of the leaf area.
8	Typical blast lesions infection 51 – 75 % of the leaf area and many leaves are dead
9	More than 75 % leaf area affected

(Source: IRRI, 2002)

Disease Severity (%) was evaluated using the Standard Evaluation System (SES) for Rice (IRRI, 2002), which employs a 0–9 scale based on lesion type and the proportion of affected leaf area.

$$Disease\ severity\ (\%)\ nxv/4N\ X\ 100$$

Where, (n)= Number of plants in each category, (v) = Numerical values of symptoms category. (N)= Total number of plants, (4) = Maximum numerical value of symptom category.

Additional agronomic parameters such as number of tillers per hill and leave per tiller were also recorded. All plants within a 6.8 m² plot were evaluated during field assessments. Rice Blast Disease Rating Scale (IRRI, 2002)

RESULTS

Field Survey and Scoring of Rice Blast Incidence and Severity in Selected Study Sites

The survey observed that there were remarkable incidence and severity during raining season compared to dry season. In dry season (table 2), higher percentages of blast incidence and severity were recorded from Dadin Kowa (Tunga) 20.0 %, 12.0 % Malleri (Jigawa 1) 18.0 %, 10.0 % and Galengu (Banaga ward 1) 17.0 %, 9.0 %. The raining season recorded higher incidence and severity at Gelengu (Balanga Gari) 66.0 %, 35.0 %, Malleri (Jigawa 2) 60.0 %, 29.0 %, Dadin Kowa (Hinna) 58.0 %, 30.0 %.

Table 2: Survey of Rice Blast Incidence and Severity in Dadin Kowa, Galengu and Malleri Across Growing Seasons

Study Sites	Farm Location	Rice Variety	Growth Stage	Type of Blast	Dry Season			Rainy Season		
					Incidence	Severity	Damage Index	Incidence	Severity	Damage Index
Dadin Kowa	Hina 1	Jamila	Tillering	Neck/Node	15.0%	5.0%	6.25	20.0%	14.0%	8.48
	Hina 2	FARO 47	Heading	Leaf Blast	15.0%	9.0%	11.25	58.0%	30.0%	52.72
	Tunga 1	FARO 46	Milk stage	Leaf Blast	10.0%	4.0%	3.33	27.0%	17.0%	13.90
	Tunga 2	Jamila	Stem elongation	Leaf Blast	20.0%	12.0%	20.0	23.0%	19.0%	13.24
	Yelwa 1	Jeep	Stem elongation	Leaf Blast	10.0%	4.0%	3.33	15.0%	14.0%	6.36
	Yelwa 2	Jamila	Booting	Leaf Blast	7.0%	2.0%	1.16	18.0%	13.0%	7.09
Gelengu	Near PHC1	Jamila	Heading	Leaf Blast	12.0%	8%	4.66	27.0%	11.0%	9.00
	Near PHC2	FARO 47	Matured grain	Leaf Blast	8.0%	3%	2.00	55.0%	22.0%	36.66
	Balanga Ward	FARO 47	Milk stage	Leaf Blast	17.0%	9%	12.75	56.0%	30.0%	50.90
	Balanga Ward	Jeep	Matured grain	Leaf Blast	14.0%	6%	7.00	42.0%	20.0%	33.00
	Balanga Gari	FARO 47	Tillering	Leaf Blast	8.0%	2%	1.33	46.0%	15.0%	20.09
	Balanga Gari	Jamila	Booting	Leaf blast	9.0%	4%	3.00	66.0%	33.0%	66.00
Malleri	Fegi 1	FARO 47	Matured grain	Leaf blast	5.0%	1%	0.41	29.0%	22.0%	17.57
	Fegi 2	FARO 47	Milk stage	Neck blast	6.0%	3%	1.50	20.0%	16.0%	9.69
	Jigawa 1	Jamila	Matured grain	Leaf blast	18.0%	10%	15.00	38.0%	23.0%	26.48
	Jigawa 2	Jeep	Heading	Leaf blast	7.0%	2%	1.16	60.0%	33.0%	41.81
	Malle 1	Jamila	Booting	Leaf blast	8.0%	2%	1.33	18.0%	14.0%	7.63
	Malle 2	FARO 46	Seedling	Leaf blast	10.0%	4%	3.33	15.0%	10.0%	4.54

Socio-demographic characteristics of the respondent farmers

A total of one hundred and fifty (150) rice farmers were interviewed across three selected study areas namely Dadin Kowa, Gelengu, and Malleri. The results display the distribution of respondents across age groups as shown in Figure 1. Among the age of respondents, highest percentages (36 %) belonged to the age group 51 to 60 years, 32 % were reported to fall within the 41 to 50 years recorded in Gelengu. 31 % of respondents were from Malleri. While in Dadin kowa, 24 % of the farmers are 61 and above.

Educational Qualification of Respondent

The result revealed that farmers' educational levels varied across the three groups (Figure 2). The highest proportion of farmers without formal education occurred in Dadin Kowa (44 %), while Gelengu recorded the highest with primary education (50 %). Secondary education was most common in Malleri (22 %), and higher secondary education and above were also more prevalent in Gelengu (30 %). Overall, Gelengu farmers were generally more educated, whereas Dadin Kowa had the least educated group.

Source of advice on the methods of rice blast management

The analysis of farmers response to sources of advice on the best methods to be used in managing rice blast incidence revealed that majority of farmers depend on their fellow farmers for advice on how to manage rice blast incidence on farm land. The percentage of sources of information is as follows. Dadin Kowa 60 % from fellow farmer, 12 % Local leader, and 10 % from either extension worker or training and workshops. In Gelengu, 36 % depend on fellow farmers, 24 % from training and workshops and 18 % goes for extension workers. For Malleri study site, 42 % goes to fellow famers for advice, 26 % depend on local leaders and lastly 12 % on extension workers respectively.

Source of farmer's Rice Varieties

The study also uncovered that source of rice varieties cultivated across study sites. The highest percentage goes to local farmer in reach of seeds in Dadin Kowa 48 %, Gelengu 36 %, and Malleri 26 %. Similarly, farmers going to local market constitute the following percentage Gelengu 36 %, Malleri 34 % and Dadin Kowa 32 %. Lastly, it was also revealed that in Malleri (18 %), Gelengu (10 %) and Dadin Kowa (8 %) use to purchase rice seed from Gombe State Agricultural Development Project (GSADP).

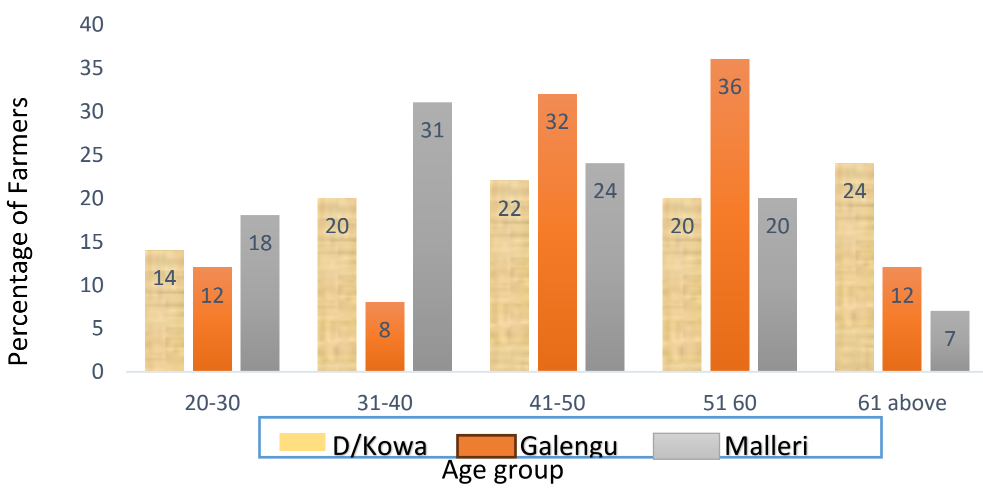

Fig 1. Age Distribution of Respondents (n=150)

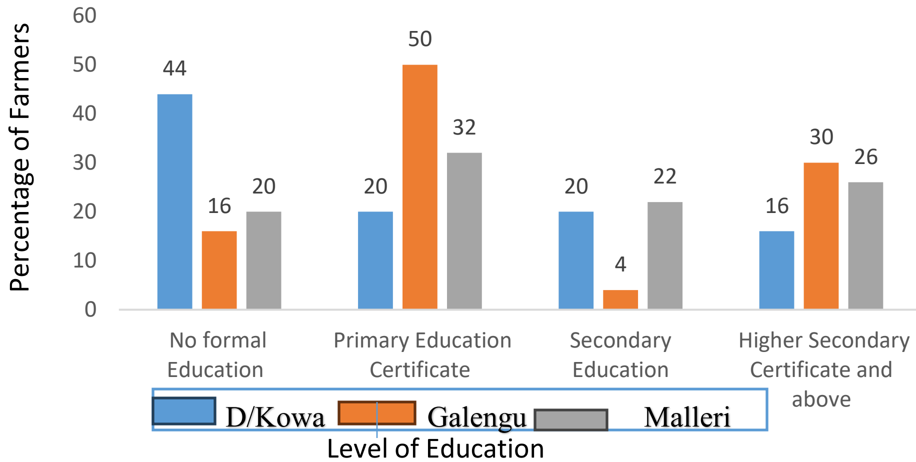

Fig 2. Level of educational Qualification of Respondent

Table 3. Farmer Source of Advice on the Methods of Rice Blast Management

Source of Advice	**Dadin Kowa Percentage (%)**	**Gelengu Percentage (%)**	**Malleri Percentage (%)**
Fellow Farmer	60	36	42
Extension Worker	10	18	12
Training and Workshops	10	24	14
Local leaders	12	10	26
Visiting Researcher	8	12	6

Table 4: Source of Famer's Rice Varieties

Source of Rice Varieties	**Dadin Kowa Percentage (%)**	**Gelengu Percentage (%)**	**Malleri Percentage (%)**
Local Market	32	36	34
Local Farmers	48	36	26
RIFAN	6	8	12
TRIMIN	4	6	4
GSADP	8	10	18
Others	2	4	6

Keys:
RIFAN: Rice Farmer's Association of Nigeria
TRIMIN: Transforming Irrigation Management in Nigeria
GSADP: Gombe State Agricultural Development Project

Methods Used to Control Rice Blast Disease on a Farm Land by Respondent

On the basis of the methods used in managing rice blast disease, this study observed the highest percentage of the methods of disease control chemical application across all study sites. The higher percentage was recorded in Dadin kowa (76 %), followed by Malleri (74 %) and Gelengu (64 %) followed by planting resistant varieties with Gelengu (14 %) having the highest percentage, while Malleri and Dadin Kowa recorded 10 % and 8 % respectively.

Farmers Response to Choice of Fungicides and its Effectiveness

The result of farmer's response to choice of fungicides and its effectiveness across study sites reveled that the fungicide Blast Force got the highest percentage for both the choice and its effectiveness. In Gelengu 40 % and 32 %, Dadin Kowa 38 % and 60 % and finally Malleri 32 % and 44% followed by Ridomil Gold with Gelengu 26 % and 40 %, Malleri 26 % and 34 %, and Dadin Kowa 22 % and 30 %. Lastly Mancozeb recorded the lowest percentage 10 % and 10 % in Gelengu, and 8 % and 4 % for both Dadin kowa and Malleri.

Table 5: Methods Used to Control Rice Blast Disease on a Farm Land by Respondent

Methods of Controlling Rice Blast Disease	Dadin Kowa Percentage (%)	Gelengu Percentage (%)	Malleri Percentage (%)
Planting Resistant Variety	8	14	10
Crop Rotation	4	6	4
Abandon Field	2	2	2
Apply Chemicals	76	64	74
Changing Planting time	2	4	2
Split application of N fertilizer	4	2	4
Burning diseased Strews	2	6	4
Others (not using any methods	2	2	0

Table 6: Farmers Response to Choice of Fungicides and its Effectiveness

Fungicides	Farm Locations of Study Areas					
	Dadin Kowa		Gelengu		Malleri	
	Choice of Fungicides (%)	Effectiveness of Fungicides (%)	Choice of Fungicides (%)	Effectiveness of Fungicides (%)	Choice of Fungicides (%)	Effectiveness of Fungicides (%)
Blast Force	38	60	40	32	32	44
Ridomil Gold	22	30	26	40	26	34
Mancozeb	8	4	10	10	8	4
Others	32	6	24	20	34	18

DISCUSSION

The seasonal variation in rice blast incidence and severity observed in this study was strongly influenced by climatic factors such as relative humidity, rainfall, temperature, and leaf wetness duration, which directly affect the life cycle of *P. oryzae*. High humidity and prolonged leaf wetness during the rainy season created favorable conditions for spore germination and host colonization, leading to higher blast incidence. These findings are in agreement with Talbot (2019), emphasized the role of microclimatic conditions in pathogen epidemiology. Similarly, Nwilene *et al.* (2020) and Sester *et al.* (2014) reported that blast epidemics often peak in wet, humid periods across Nigeria and other rice-producing regions.

The positive correlation between disease incidence and severity recorded in this study is similar to the findings of Khan *et al*. (2017) and Sharma *et al.* (2021), who noted that increased infection frequency translates to greater host tissue damage and yield losses. The persistence of measurable blast incidence during the dry season (20 % in Dadin Kowa) also supports earlier reports by Sere *et al.* (2019) that blast inoculum can survive in crop residues and volunteer rice plants, serving as primary infection sources. These results therefore align with classical plant pathology models while highlighting the importance of cultural practices like residue management and rotation as complementary control measures.

From a management perspective, the seasonal disease patterns observed in this study suggest that biosynthesized nanoparticles (BNPs) would be most effective when applied during the rainy season, when disease pressure is highest. This is in agreement with the findings of Manikandan *et al*. (2020) and Rani *et al.* (2022), demonstrated strong antifungal activity of BNPs under humid conditions. However, unlike conventional fungicides, BNPs require further validation under field conditions across diverse seasonal environments.

The predominance of middle-to-older aged farmers (41–60 years) found in this study is consistent with the reports of Bello *et al*. (2021) and Sawah *et al.* (2022), who highlighted the aging profile of rice farmers in Nigeria. This trend is also similar to Abdoulaye *et al.* (2020) and Mignouna *et al.* (2019), who observed that rural–urban migration has led to fewer young people engaging in rice production across sub-Saharan Africa. This demographic structure suggests a potential challenge for adoption of new technologies such as BNPs, as older farmers may be less receptive to innovations compared to younger counterparts.

The generally low to moderate educational attainment among farmers in Dadin Kowa, Gelengu, and Malleri aligns with national surveys (NBS, 2020) showing that over 60 % of smallholder farmers in Nigeria have no more than primary education. This is in agreement with Asfaw and Admassie (2020) and Ojo *et al.* (2021), noted that education level significantly affects farmers' ability to acquire and apply agricultural innovations. Similar observations were made by Wossen *et al.* (2017), highlighting literacy as a key determinant of technology adoption.

The reliance on informal advice networks such as fellow farmers and community leaders recorded in this study is similar to the findings of Davis *et al.* (2020) and Rogers (2019), reported that farmer-to-farmer knowledge exchange dominates in smallholder systems with limited extension coverage. While these networks promote local practices, they may also hinder adoption of emerging technologies like BNPs unless early adopters receive targeted training.

The dominance of informal seed exchange systems among respondents in Dadin Kowa, Gelengu, and Malleri mirrors findings across sub-Saharan Africa. This result is in agreement with FAO (2021) and McGuire and Sperling (2016), showed that informal seed systems ensure accessibility but often lack quality control. Similarly, Almekinders *et al.* (2019) and Tripp and Louwaars (2020) emphasized that reliance on local seed networks can restrict dissemination of improved varieties, including blast-resistant rice. Integrating BNP deployment with formal seed programs could therefore strengthen blast management strategies.

The high reliance on chemical fungicides recorded in this study is in agreement with Sere *et al.,* (2019), Nwilene *et al.* (2020), and Sester *et al.* (2014), noted that fungicides remain the most widely used strategy for blast control in Nigeria. Blast Force, which was perceived as the most effective fungicide, was also commonly reported in earlier studies, similar to Ogbede *et al.* (2020) and Tambo *et al.,* (2021). However, the risk of resistance development from repeated systemic fungicide use has been well-documented (Castroagudín *et al.* 2015). This underscores the potential of BNPs, which, unlike fungicides, act via multiple antifungal mechanisms. Thus, BNPs may serve as a sustainable alternative or complement, a finding similar to Manikandan *et al.* (2020) and Rani *et al.* (2022).

CONCLUSION

This study underscores the enduring significance of rice blast disease as a major biotic constraint to smallholder rice production in Gombe State, Nigeria. The findings reveal that while farmers possess a rich reservoir of indigenous knowledge enabling them to recognize and respond to the disease, their management practices remain largely traditional and reactive, shaped by generational experience rather than scientific guidance. The strong association between disease prevalence and seasonal climatic factors particularly humidity, rainfall, and leaf wetness highlights the environmental sensitivity of *P. oryzae* epidemics in the region. Although chemical fungicides continue to dominate control strategies, their sustainability is increasingly threatened by resistance development and ecological concerns. To move beyond the limitations of current practice, an integrated management framework is required one that bridges local experiential wisdom with modern scientific innovations, including eco-friendly solutions such as biosynthesized nanoparticles and resistant cultivars. Empowering farmers through participatory extension systems and improved access to quality inputs will be pivotal in achieving durable disease control. Ultimately, integrating indigenous and scientific knowledge represents not merely a pragmatic response to rice blast, but a model for sustainable agricultural resilience in sub-Saharan Africa.

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