BIRD SPECIES DIVERSITY IN RICE FIELDS IN NORTHERN NIGERIA

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ABSTRACT
Rice serves as food for more than half of the human population globally. Despite the rapid expansion of farmlands for rice cultivation to meet the needs of the growing human population, avian utilization of rice fields remains largely unexplored, particularly in northern Nigeria. We aimed to explore the bird species abundance and richness of rice fields in the popular agricultural town of Kura, located in the southern Kano, Nigeria. We conducted bird surveys at some selected rice fields using the line transect method in the early morning hours between 7 am and 10 am. Data was collected during the wet and dry seasons (2018-2019). About 13,058 individual birds belonging to 66 species and 33 families were documented. There was no significant seasonal variation in bird species abundance and richness. The species were classified as residents (83%), Palearctic migrants (14%), and Intra-African Migrants (3%). The six most diverse families were Ardeidae, Ploceidae, Rallidae, Falconidae, Estrildidae, and Accipitridae. The majority of the bird species recorded utilized the rice fields for foraging and roosting. Future agricultural intensification could negatively influence avian species; we therefore recommend the adoption of climate-smart agricultural practices by rice farmers in Northern Nigeria.

Keywords: Rice field, avian diversity, northern Nigeria.

INTRODUCTION
Rice is an important crop globally as it provides food for more than half of the human population (Platt *et al.*, 2021). Rice fields serve as nesting and foraging habitats for many bird species (Platt *et al.*, 2021; Htay *et al.*, 2022). Their suitability for bird species is a result of the variety of foods and microhabitats generated from water management and soil tillage activities (Stafford *et al.*, 2010).
However, with the expansion of human-modified landscapes to serve the increasing human population, the fate of biodiversity largely depends on the quality of agricultural practices utilized (Platt *et al.*, 2021). Despite the rapid expansion of farmlands for rice cultivation to meet the needs of the growing human population in northern Nigeria, avian utilization of rice fields remains largely unexplored. As bioindicators (Hanmer *et al.*, 2022), proper documentation of avian diversity provides a means of monitoring the condition within a given habitat (Singh *et al.*, 2022). Our objectives were to determine bird species abundance and richness of rice fields in the agricultural town of Kura, and also to investigate the seasonal variation in the abundance and richness.

MATERIALS AND METHODS

Study Area
This study was carried out in rice fields south of Kano, Nigeria (11^{0}25'N - 12^0 47'N, 8^{0}22'E - 8^{0}39'E) as shown in Figure 1, located within the Sudan savanna agro-ecological zone of northern Nigeria;

has distinct wet and dry seasons (Babuga *et al.*, 2023). Kura serves as the most extensively irrigated Local Government Area in Kano State. As an agricultural town, Kura is known for rice production (Usman and Dodo, 2014) and other food and vegetable crops, both during the wet season and by irrigation during the dry season. Some of the crops produced in this area include wheat, maize, millet, guinea-corn, beans, tomatoes, onions, sugarcane, cucumber, cabbage, water melon, garden egg, etc. The sampling site is under cultivation throughout the year.
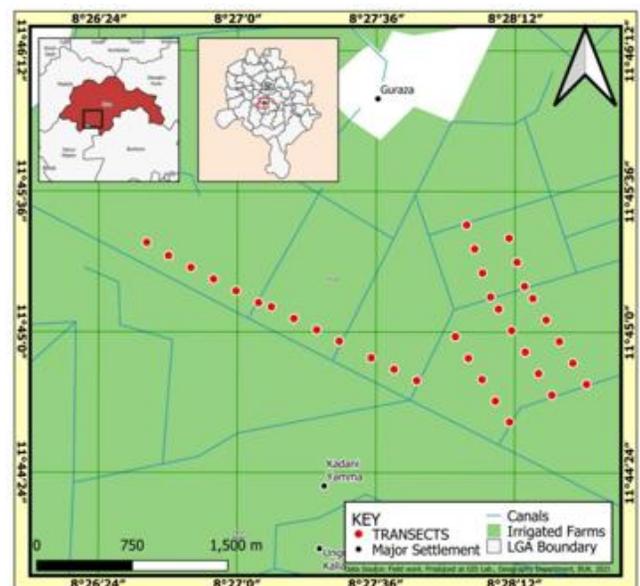
Figure 1: Map Showing the Location of Transects at Kura, Kano, Nigeria

Sampling Method
We randomly placed eight transects that made up a total length of 5.4 km at some selected rice fields in Kura town. Birds were observed and counted using the line transect method (Burgess *et al.*, 2000). Surveys were conducted from 7 am to 10 am. A pair of binoculars was used for viewing distant birds, while a field guide (Borrow and Demey, 2014) was used for species identification. Sampling was repeated three times in each season (wet and dry) from Feb 2018 to Jan 2019.

Data Analyses
Species family name, scientific name, and residence status were given based on the field guide, The Birds of Western Africa (Borrow and Demey, 2014), while feeding guild characterization was according to Handbook for the Birds of the World Alive (del Hoyo *et al.*, 2017). We employed the Generalized Linear Mixed models

(GLMMS) using the Poisson distribution to assess the seasonal variation in species abundance and richness (Awoyemi *et al.*, 2024). Transect and sampling times were considered as random effects in our models. A heat map was used to display the seasonal occurrence of the 10 most common species (Tinoco *et al.*, 2021). All analyses were carried out in R statistical software (R Core Team, 2024).

RESULTS
About 13,058 individual birds belonging to 66 species and 33 families were recorded during the study period. This comprised 55 resident species, nine Palearctic migrants, and two Intra-African Migrants. Among these include 33% predators, 26% insectivorous, and 20% Granivorous. Others included omnivorous (18%), and frugivorous (3%). The six dominant families were Ardeidae

(herons), Ploceidae (weavers), Rallidae (crakes & moorhens), Falconidae (falcons), Estrildidae (finches), and Accipitridae (raptors) as indicated in Table 1. There was no significant seasonal variation in species abundance (Estimate ± SE = -0.07 ± 0.47, Z = -0.15, p = 0.878) and richness (Estimate ± SE = -0.13 ± 0.13, Z = -0.97, p = 0.332) (Figure 2).

The 10 most abundant species included Red-billed Quelea (*Quelea quelea*), Northern Red Bishop (*Euplectes franciscanus*), Cattle Egret (*Bubulcus ibis*), White-billed Buffalo Weaver (*Bubalornis albirostris*), Zitting Cisticola (*Cisticola juncidis*), Squacco Heron (*Ardeola ralloides*), Yellow Wagtail (*Motacilla flava*), Chesnut-bellied Starling (*Lamprotornis pulcer*), Yellow-crowned Bishop (*Euplectes afer*), and Spur-winged Lapwing (*Vanellus spinosus*). The seasonal occurrences of these species are shown in Figure 3.

Table 1: Checklist of Birds Recorded in Rice Fields at Kura, Kano, Nigeria from Feb 2018 to Jan 2019.

S/No	Family	Scientific Name	English Name	Status	Guild
1	Accipitridae	*Circus aeruginosus*	Western Marsh Harrier	PM	Predator
2		*Elanus caeruleus*	Black-shouldered Kite	R	Predator
3		*Melierax metabates*	Dark Chanting Goshawk	R	Predator
4		*Milvus aegyptius parasitus*	Yellow-billed Kite	R	Omnivore
5	Alaudidae	*Eremopterix leucotis*	Chesnut-backed Sparrow Lark	R	Omnivore
6		*Galerida cristata*	Crested Lark	R	Omnivore
7	Anatidae	*Dendrocygna viduata*	White-faced Whistling Duck	R	Omnivore
8	Apodidae	*Apus affinis*	Little Swift	R	Insectivore
9		*Cypsiurus parvus*	African Palm Swift	R	Insectivore
10	Ardeidae	*Ardea cinerea*	Grey Heron	R	Predator
11		*Ardea intermedia*	Intermediate Egret	R	Predator
12		*Ardea melanocephala*	Black-headed Heron	R	Predator
13		*Ardea purpurea*	Purple Heron	PM	Predator
14		*Ardeola ralloides*	Squacco Heron	R	Predator
15		*Bubulcus ibis*	Cattle Egret	R	Insectivore
16		*Butorides striata*	Green-backed Heron	R	Predator
17		*Egretta garzetta*	Little Egret	PM	Predator
18		*Ixobrychus minutus*	Little Bittern	R	Predator
19		*Ixobrychus sturmii*	Dwarf Bittern	IM	Predator
20	Bucerotidae	*Tockus nasutus*	African Grey Hornbill	R	Frugivore
21	Charadriidae	*Vanellus spinosus*	Spur-winged Lapwing	R	Insectivore
22		*Vanellus tectus*	Black-headed Lapwing	R	Insectivore
23	Cisticolidae	*Camaroptera brachyura*	Grey-backed Camaroptera	R	Insectivore
24		*Cisticola galactotes*	Winding Cisticola	R	Insectivore
25		*Cisticola juncidis*	Zitting Cisticola	R	Insectivore
26	Columbidae	*Columba guinea*	Speckled Pigeon	R	Granivore
27		*Streptopelia senegalensis*	Laughing Dove	R	Granivore
28	Coraciidae	*Coracias abyssinicus*	Abyssinian Roller	R	Insectivore
29	Corvidae	*Ptilostomus afer*	Piapiac	R	Omnivore

30	Cuculidae	*Centropus senegalensis*	Senegal Coucal	R	Predator
31	Estrildidae	*Euodice cantans*	African Silverbill	R	Granivore
32		*Lagonosticta senegala*	Red-billed Firefinch	R	Granivore
33		*Spermestes cucullata*	Bronze Mannikin	R	Granivore
34		*Uraeginthus bengalus*	Red-cheeked Cordon-bleu	R	Granivore
35	Falconidae	*Falco ardosiaceus*	Grey Kestrel	R	Predator
36		*Falco chicquera*	Red-necked Falcon	R	Predator
37		*Falco naumanni*	Lesser Kestrel	PM	Insectivore
38		*Falco tinnunculus*	Common Kestrel	PM	Predator
39	Glareolidae	*Cursorius temminckii*	Temminck's Courser	R	Predator
40	Hirundinidae	*Hirundo aethiopica*	Ethiopian Swallow	R	Insectivore
41	Jacanidae	*Actophilornis africanus*	African Jacana	R	Predator
42	Laniidae	*Corvinella corvina*	Yellow-billed Shrike	R	Insectivore
43	Malaconotidae	*Laniarius barbarus*	Yellow-crowned Gonolek	R	Insectivore
44	Motacillidae	*Motacilla flava*	Yellow Wagtail	PM	Omnivore
45	Muscicapidae	*Oenanthe*	Northern Wheatear	PM	Insectivore
46	Passeridae	*Passer griseus*	Northern Grey-headed Sparrow	R	Granivore
47	Phalacrocoracidae	*Microcarbo africanus*	Long-tailed Cormorant	R	Predator
48	Phylloscopidae	*Phylloscopus trochilus*	Willow Warbler	PM	Insectivore
49	Ploceidae	*Bubalornis albirostris*	White-billed Buffalo Weaver	R	Granivore
50		*Euplectes afer*	Yellow-crowned Bishop	R	Granivore
51		*Euplectes franciscanus*	Northern Red Bishop	R	Granivore
52		*Ploceus cucullatus*	Village Weaver	R	Granivore
53		*Ploceus luteolus*	Little Weaver	R	Granivore
54		*Quelea*	Red-billed Quelea	R	Granivore
55	Psittaculidae	*Psittacula krameri*	Rose-ringed Parakeet	R	Frugivore
56	Pycnonotidae	*Pycnonotus barbatus*	Common Bulbul	R	Omnivore
57	Rallidae	*Crex egregia*	African Crake	R	Predator
58		*Gallinula angulata*	Lesser Moorhen	IM	Omnivore
59		*Gallinula chloropus*	Common Moorhen	R	Omnivore
60		*Zapornia flavirostra*	Black Crake	R	Predator
61	Recurvirostridae	*Himantopus*	Black-winged Stilt	R	Predator
62	Rostratulidae	*Rostratula benghalensis*	Greater Painted-Snipe	R	Omnivore
63	Scolopacidae	*Tringa glareola*	Wood Sandpiper	PM	Insectivore
64	Sturnidae	*Lamprotornis caudatus*	Long-tailed Glossy Starling	R	Omnivore
65		*Lamprotornis pulcher*	Chesnut-bellied Starling	R	Omnivore
66	Timaliidae	*Turdoides plebejus*	Brown Babbler	R	Insectivore

Key: R=Resident, PM=Palearctic migrant, IM=Intra-African Migrant
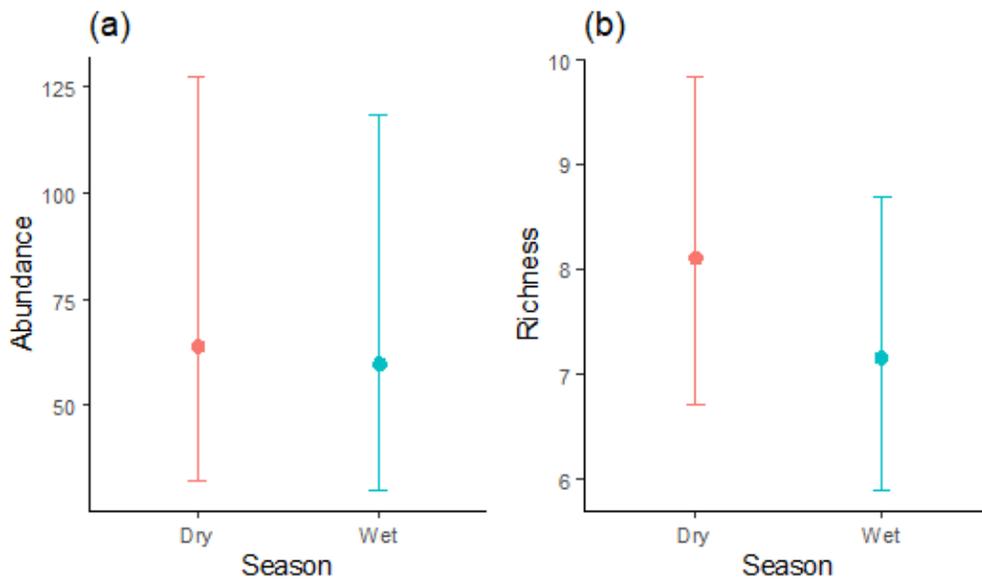
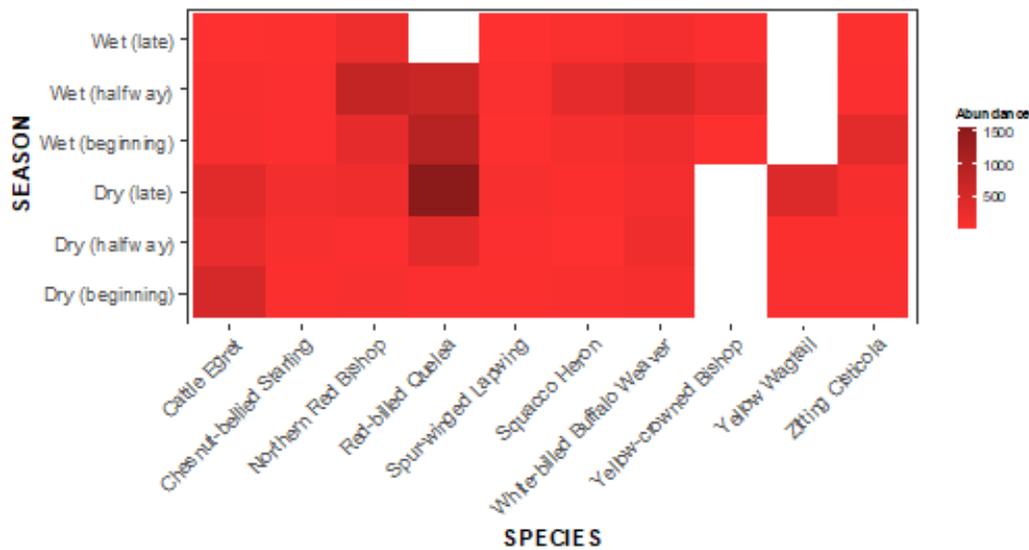**Figure 2:** Seasonal Variation in Bird Species Abundance (a) and Richness (b)

Figure 3: Seasonal Occurrence of the 10 Most Common Bird Species

DISCUSSION

Almost 35% of terrestrial ecosystems are subjected to agriculture, and intensification in farming practices is one of the main drivers of biodiversity decline (Angkaew *et al.*, 2023). This study provides an insight into the avian species of extensively irrigated rice fields in Northern Nigeria. We recorded 66 species during the one-year study period. These species comprise terrestrial and aquatic birds that utilize the rice fields as resting, foraging, breeding, and nesting grounds. The species richness and feeding guilds recorded are in line with similar research in the tropics (Platt *et al.*, 2021). Although more species of birds were recorded in the dry season, there was no significant seasonal variation in bird species abundance and richness between the seasons.

Farmlands are hotspots for diverse avian species; in this study, we recorded relatively low species richness, taking into consideration the species diversity reported from previous studies in Northern Nigeria (Hulme, 2007). We identified two main factors responsible for the poor species abundance and richness. The rice fields are largely devoid of standing plants, which deprives some birds of nesting and foraging sites. The most important factor is disturbances by humans from farming activities throughout the year. Recent study indicates that farmland diversification promotes greater species abundance and can be achieved with increase in vegetation complexity (Smith *et al.*, 2022). Many factors influence the diversity and richness of birds on farmlands. For instance, the height and density of vegetation in farmland have a great influence on species distribution (Whittingham and Evans, 2004). It was also

reported that farming intensity and tree density affect avian species richness and diversity in farmlands, with less intensive farming activity and medium tree density harbouring higher species richness and diversity. Likewise, farmlands that maintain more of their natural features actually sustain more avian diversity (Hulme, 2007). Bonthoux *et al.* (2017) asserted that the amount of woody elements or hedgerows affects bird communities in agricultural landscapes because they determine the occurrence of certain species based on their diet and breeding behaviour. Other factors that influence bird species within agricultural lands include landscape size and heterogeneity, type of crop, management practices, and season (Katuwal *et al.*, 2022), and agricultural land-use type (Yahya *et al.*, 2022).

It is important to note that climate change poses significant threat to agriculture, ecosystems, human and animal livelihoods, and this has serious implications on food security in West African countries (Zakari *et al.*, 2022). Similarly, the Sudano-Sahelian zone of northwestern Nigeria is experiencing climatic variability leading to recurrent droughts and desertification, which undermine the agricultural sector (Azare *et al.*, 2020). As such, future agricultural intensification could negatively influence avian species; we therefore recommend the adoption of climate-smart agricultural practices by rice farmers in Northern Nigeria.

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