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Analysis of avian pest of cereal crops and perception of farmers on avian conservation in PATIGI and EDU local government areas of Kwara state, Nigeria

Odewumi OS and Audu M

Abstract
This study investigated the avian pests affecting cereal crops and the perception of the cereal growers on avian presence in their farmlands in Patigi and Edu Local government areas of Kwara State, Nigeria. A total of 267 questionnaires were administered. Data obtained were analysed both by descriptive and inferential statistics using chi square and correlation. Most of the respondents were male (57.3%) within the age group 51-60yrs. Also, 73% had secondary education with 53.2% from household size >8. Most, 29.6% had 16-20years farming experience with an average farm size of 3.76±1.08 hectares. Twenty-nine avian species were identified as pests of cereal crops. Village weaver (*Ploceus cucullatus*) was the major pests of rice, maize, wheat and guinea corn while Red-headed quelea (*Quelea erythrops*) was the major pest of millet. Rice and maize are majorly attacked at the immature/milky stage, while millet, wheat and guinea corn are attacked majorly at the drying grain stage. The attacks happen in both seasons and at any time of the day. The average crop loss during each planting season was 26-50% (severe category). The effects of avian attack are; stunted growth, reduced crop yield and poor grain quality with weighted mean values of 4.75±0.24, 4.64±0.51 and 4.56±0.55 respectively. The cereal farmers adopted seven control measures. The weighted mean value of perception results ranged from 3.48±1.79 to 4.60±0.83. There was no significant relationship (p>0.05) between Gender and perceived effects of avian attack on cereal crops. Also, there was no significant relationship (p>0.05) between planting season and avian attack leading to reduced crop yield. Furthermore, the perception statement showed varying levels of significance to socio-demographic variables. Farm size, farming season, bird species, cereal crops and life stages showed significant (p<0.01) correlation with average crops loss. This research sheds light on the challenges faced by cereal crop farmers in Kwara State due to avian attack. Respondents recognized birds' potential for income loss, farm abandonment, and discouragement. Recommendations include promoting integrated pest management, raising farmer awareness, fostering collaboration, supporting crop diversification, and establishing compensation mechanisms.

Keywords: Avian, pest, cereal crops, patigi and edu LGAs, farmers' perception

Introduction
Food security, social development, economic expansion, and the sustainable use of natural resources are all fundamentally dependent on agriculture (Pawlak & Kołodziejczak, 2020) [33]. Cereal crops have the potential to make a substantial contribution to global food security. Nevertheless, just like every other crop, a number of factors such as climatic change (Macauley, 2015) [22], soil quality (Liliane & Charles, 2020) [21] and management style (Duguma *et al*., 2010) [11] as well as pest attack (Odewumi, 2022; Ismaila *et al*. (2010)) [29, 16] can hinder its production (Macauley, 2015) [22]. Conflicts between wild animals and agriculture have resulted from an increase in human population, especially in emerging regions with abundant biological diversity (Alemayehu & Tekalign, 2020) [2]. This is viewed as serious issue to farmers, conservationists and developers in many parts of rural Africa and Asia, (Maurice, *et al*., 2019; Uloko *et al*., 2017; Alemayehu & Tekalign, 2020; Nair & Jayson, 2021) [24, 37, 2, 27]. Birds negatively affect most agricultural operations, while certain activities attract birds as specific feeding possibilities (Odewumi, 2022) [29]. Birds which consume cereals are known as granivorous birds. According to de Mey, *et al*. (2012) [8], the physical data on crop damages indicates an average loss of 15-20 percent of the world's grain supply as a result of attack by granivorous birds (Branco *et al*., 2016) [5]. Oerke (2006) [30] estimated that pests such as arthropods, nematodes, rodents, birds, slugs and snails cause a loss of about 15% of the world's rice production.

Damage to agricultural crops by birds is a significant cause of economic loss for farmers globally and is one of the human-wildlife conflicts that may be attributed to patterns and processes on the landscape and the movement of birds that cause agricultural damage over large areas (Canavelli *et al*., 2014) [7]. The Red-billed Quelea, represent the most fatal bird pest that are gregarious and migratory nonetheless other types such as water birds (e.g. ducks and geese) can also be of significance (Mey & Demont, 2013) [9]. Birds inflict visible damage to crops in two ways: direct damage when birds consume seeds or grains, and indirect damage when a group of birds is active in a cereal farm, causing grains to fall to the ground thereby drawing other pests such as rodents (Odewumi, 2022; Desoky, 2014) [29, 10].

Only a small number of birds are significant pests of cereal crops on a global scale. However, birds can become major pests when huge flocks migrate periodically and cluster in large quantities. Among the approximately 1390 bird species in West Africa, Manikowski (1984) [23] listed 36 bird species "known to cause damage" to cereal crops. The seven most significant species are the Spur-winged Goose (*Plectropterus gambensis*), Knob-billed Goose (*Sarkidiornis melanotos*), Village Weaver (*Ploceus cucullatus*), Black-headed Weaver (*Ploceus melanocephalus*), Red-headed Quelea (*Quelea erythrops*), Golden Sparrow (*Passer luteus*) and Red-billed Quelea (*Quelea quelea*). In their own study Mey & Demont, (2013) [9]; Segun *et al*. (2018) [36] classified Red-billed Quelea as one of the world's most infamous nuisance bird species, causing damage to numerous cereal crops such as rice, millet, sorghum, throughout Sub-Saharan Africa. For example, de Mey, *et al*. (2012) [8] estimated annual bird damage to be 13.2 percent of possible rice output over the wet seasons of 2003-2007, culminating in a mean annual economic loss of €7.1 million.

Aside from physical output losses resulting in obvious economic costs, other concerns posed by pest birds include extensive labour needs for bird scaring, the accompanying usage of children who occasionally miss school, jeopardising achievement of essential educational objectives (Odewumi, 2022, Maurice, 2019) [29], potential health or environmental hazards from the use of chemical poisons, and farmer discouragement from dry-season rice agriculture (Mey & Demont, 2013) [9]. Similarly, farmers who scare birds in the field, for example, are socially isolated from their families for an extended period of time.

Avian pests have long been recognized as formidable challenges in agricultural ecosystems, particularly in cereal crop production. In Kwara State, the cereal crops constitute a fundamental component of both local consumption and economic activities, the impact of avian pests has raised concerns among farmers, researchers, and policymakers (Balami *et al*., 2011) [4]. Despite infrequent reports of agricultural losses related to avian pests, there is a considerable gap in understanding the dynamics that govern the interactions between avian pests, cereal crops, and the economic consequences (Hill, 2018) [15]. The study focused on cereal production which is prominent in Patigi and Edu LGAs because of the natural fertile land of the floodplains of the River Niger. The area is considered one of the major zones for cereal production in North Central Nigeria. Also, the area is rich in avian species diversity due to the diverse vegetation and food availability made possible by the floodplains of River Niger. This, however, may result in human-wildlife conflict if there is no synergy between cereal production and avian conservation.

This study aims to address this critical knowledge gap in the context of agricultural sustainability and food security by investigating the prevalence, diversity, and behaviors of avian pests affecting cereal crops in Kwara State farmlands. The findings of this study will offer crucial insights into the avian pest species present, the extent of crop damage they cause, the control measures adopted by farmers as well as their perception and attitude towards birds' presence.

Research Methodology

Description of the Study Area

Kwara State is situated in the North central and has 16 LGAs including Patigi and Edu LGAs with a population of about 2-3 million (National population commission, 2016) (Figure 1). Patigi Local Government Area consist of three districts including Pategi, Lade and Kpada, which was created from Edu Local Government Area of Kwara State, Nigeria. This area is geographically located within 8^0 50^1 N and 5^0 25^1 E of the equator. The location shares common boundaries with Niger State, Kogi State as well as Edu and Irepodun Local Government Areas (Figure 1) (Olabode, 2011) [31]. It has a total land area of about 2924.62sq.km, which is about 5% of the total land area of Kwara State (www.kwarastate.com). According to Kwara State Agricultural Development Project, (KWADP, 2007) [19], approximately 25% of the land area of the Local Government is used for farming activities.

Edu Local Government Area, is one of the sixteen Local Government Areas of Kwara State with its headquarters in Lafiagi. The geographical location falls within latitudes 8^0 30-9^0 00N and longitudes 5^0 00-6^0 20E. It has three (3) districts namely; Lafiagi, Tsaragi and Shonga (Figure 1). It covers an area of 2,542km^2 with a population of 201,469 people as of the 2006 census (National population Commission, 2006). Cereal production especially rice is prominent in this part of the state because of the natural fertile land of the floodplains of the River Niger that stretches from Jebu/ Bacita through Shonga in Edu Local Government. The vegetation in the northern parts of Kwara State, of which Edu Local Government Areas is one, is Savannah grassland (Kwara State Ministry of Agriculture 2004; Omotesho *et al*., 2017) [8, 32].

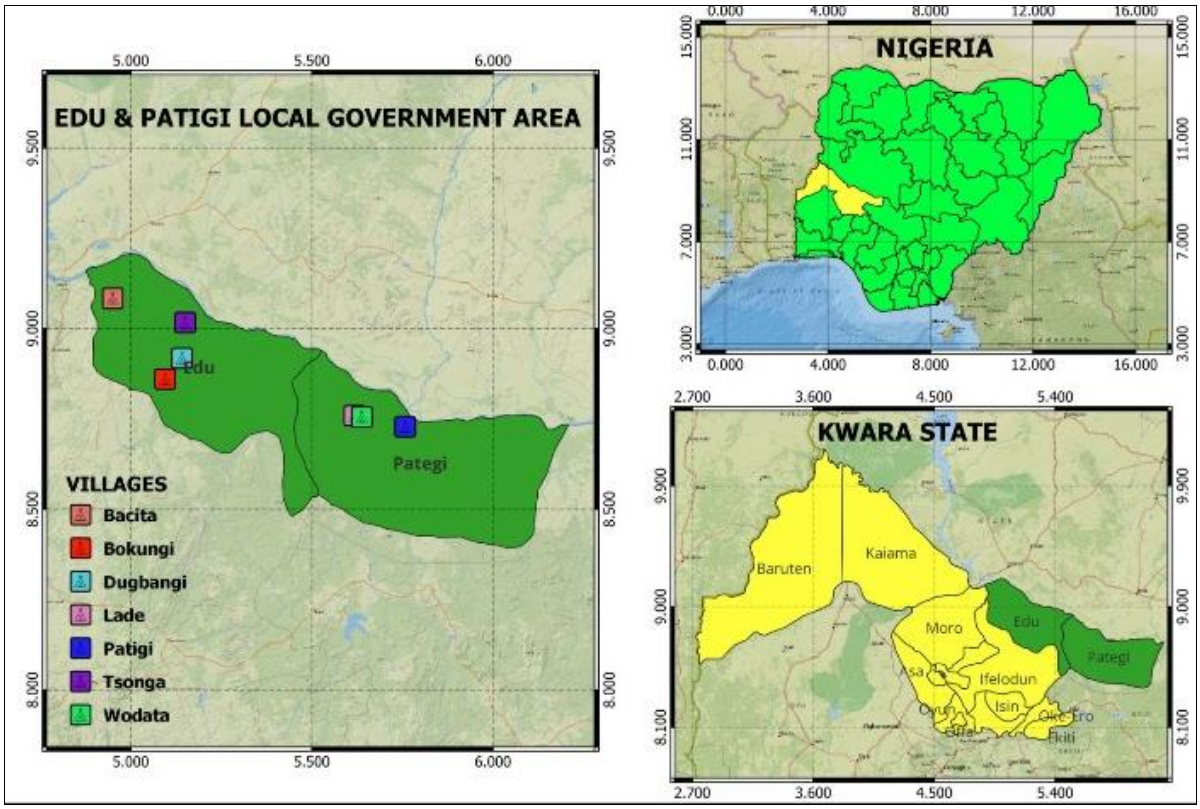

Fig 1: Map showing Patigi and Edu LGAs in National Settings

Method of Data Collection

Population and Sample Size Determination

The sample population for this study consists of the cereal/rice farmers both in Edu and Patigi LGAs which are purposely selected because of their relevance to this study as the main stakeholder. To ease the assessment process purposive sampling technique was adopted. The procedure for sample size determination followed three stages (Omotesho, *et al*., 2017) [32] which are: (1) Random selection of 30% of the major cereal producing villages/communities from the information collected at Kwara State Agriculture Development Programme office; (2) Use of registered cereal/rice farmers in the selected villages/communities; (3) Random selection of 30% of the registered cereal farmers in the selected villages/communities.

The four (4) communities/villages selected in Edu LGA are Tsonga, Bacita, Dugbangi and Bokungi while the three (3) communities/villages selected in Patigi LGA are Wodata, Patigi and Lade. Also, a total of 267 respondents representing 30% of the registered cereal/rice farmers in the two LGAs were randomly selected from a total of 891 registered cereal/rice farmers in the selected communities in the two LGAs. This is in accordance with the suggestion by Mooi, *et al*. (2018) [26] that a sample size of 160 and 300 is valid for multivariate statistical analysis techniques.

Reliability of Research Instrument

A test-retest reliability was carried out to test the consistence as well as to determine the coefficient reliability of survey instrument through a pilot survey administered to 20 farmers from a community/village not included in the final study. The Cronbach Alpha reliability test was adopted. The pilot test result showed Cronbach Alpha reliability values ranging from 0.732 - 0.865, which validates the reliability of the research instrument for the study.

Questionnaire Administration

A total of 267 questionnaires were administered to cereal/rice farmers in the seven (7) selected communities/villages in the two LGAs. The respondents are distributed as follows: Edu LGA: Tsonga (37), Bacita (48), Dugbangi (34) and Bokungi (36); Patigi LGA: Wodata (36), Patigi (41) and Lade (35). The questionnaire had five sections as follows: Section A: demographic characteristics of the respondents; Section B: farming activities of respondents; Section C: Bird species cereal crops damage Activities and severity; Section D: Bird Control Measures adopted by the farmers and Section E: Perception on Avian presence in farmlands (Appendix I). A collection of avian pests of cereal crops (29 bird species) as identified by Adekola, *et al*. (2019) [1]; Odewumi, (2022) [29] was prepared as album and shown to the farmers to ensure that they get correct identity of bird pests.

Measurement of Variables

The independent variables measured in this study includes; socio-demographic characteristics and farming activities of the respondents coded for statistical analysis. The dependent variables were measured in term of the severity of the avian attack as well as the perception on avian presence in farmland. A four and five-points Likert scale was used for the dependent variables.

Statistical Analysis

The data obtained were coded and stored in excel and then transferred to SPSS version 22 for statistical analysis. The data were analysed both by descriptive (such as frequency, percentages, mean, standard deviation, ranking and charts) and inferential statistics. The relationship between socio-demographic characteristics and effects of avian attack was tested using Chi square. Also, the relationship between severity of attack and the perception statements were tested

using Chi square. Average crop loss was correlated with farm size, farming season, community, type of cereal planted and life stage of cereal crop attacked.

Results

Socio-Economic Characteristics of Respondents

The results of the socio-economic characteristics of the respondents presented in Table 3 shows that majority (57.3%) of the respondents are males with 42.7% females. The highest number of respondents were in the age class 51-60yrs (43.4%) while the lowest number of respondents were in age class 18-30yrs (9.4%). Furthermore, 39.7% of the respondents have secondary education, 33.3% have tertiary education, 28.5% have no formal education while 7.5% have primary school education. The results further showed that majority of the respondents were from household size of >8 (53.2%), followed by household size of 5-8 (25.1%) with the lowest from household size of 1-4 (21.7%).

Farming Activities

The results of the respondents farming activities presented in Table 4 shows that the mean years of farming experience of the respondents was 3.47±1.21 with the largest percentage of respondents' farming experience falling within 16-20years. The average farm size of the respondents was 3.76±1.08 with the majority having farm sizes between 16-20 hectares (37.1%). The majority (79.4) of the farmland are inherited with the least percentage (6.4%) of farmland being leased for farming activities. The study further revealed that the majority of the respondents (50.6%) prefer both seasons of planting as opposed to 42.3% preferring wet season and the remaining 7.1% preferring the dry season. This is an indication that farming is the major occupation in the area and that it is done on commercial scale in land owned by the farmers.

Table 1: Socioeconomic characteristics of correspondents

Variables	Proportion of Respondents in each village							Total	Percentage
	TS	BA	WA	DU	PA	BK	LA		%
Gender									
Male	20	30	14	22	29	10	28	153	57.3
Female	17	18	22	12	12	26	7	114	42.7
Age(years)									
18-30	4	7	4	0	3	6	1	25	9.4
31-50	14	20	7	5	11	12	8	77	28.8
51-60	16	18	7	19	24	15	20	116	43.4
Above 60	3	3	21	10	3	3	6	49	18.4
Education									
Primary	1	2	1	27	8	6	2	20	7.5
Secondary	7	4	19	6	14	7	4	82	30.7
Tertiary	15	25	9	1	11	17	6	89	33.3
None	14	17	7	34	8	6	23	76	28.5
Household size									
1-4	12	11	6		11	12	6	58	21.7
5-8	18	4	6	1	21	11	6	67	25.1
More than 8	7	33	24	33	9	13	23	142	53.2

KEY: TS= Tsonga; BA=Bacita; WA=Wodata; DU= Dugbangi; PA= Patigi; BK=Bokungi; LA=Lade

Table 2: Farming Activities of respondents

Variables	Numbers of Respondents in each Village							Total	Percentage (%)	Mean + SD
	TS	BA	WA	DU	PA	BK	LA			
Years of experience										
1-5	0	5	4	0	5	10	1	25	9.4	3.57±3.59
6-10	4	7	2	0	6	5	1	25	9.4	3.57±2.64
11-15	15	8	4	5	23	17	5	77	28.8	11.00±7.37
16-20	13	23	21	8	4	3	7	79	29.6	11.14±7.99
Above 20	5	5	5	21	3	1	21	61	22.8	8.71±8.52
Overall mean										3.47±1.21
Size of farmland (hectares)										
1-5	1	0	3	0	2	5	1	12	4.5	1.71±1.79
6-10	1	3	6	0	5	6	0	21	7.9	3.00±2.71
11-15	9	17	5	2	19	9	0	61	22.8	8.71±7.18
16-20	15	23	21	12	12	7	9	99	37.1	14.14±5.96
>20	11	5	1	20	3	9	25	74	27.7	10.57±8.94
Overall mean										3.76±1.08
Ownership of farmland										
Purchased	11	8	1	0	7	11	0	38	14.2	5.43±4.99
Inherited	25	32	32	34	31	24	34	212	79.4	30.29±4.11
Lease	1	8	3	0	3	1	1	17	6.4	2.43±2.69
Season of Planting										
Rainy only	5	12	8	21	17	19	31	113	42.3	16.14±8.76
Dry only	4	5	1	13	7	2	0	19	7.1	4.57±4.43
Both	28	31	27	34	17	15	4	135	50.6	22.29±10.67

Keys: TS=Tsonga; BA=Bacita; WA=Wodata; DU=Dugbangi; PA=Patigi; BK= Bokungi; LA= Lade.

Avian Pests of Cereal Crops in the Study Area

A total of twenty-nine (29) bird species were identified as pests of cereal crops in the study areas according to the farmers (Table 3). Only one species (Grey parrot) is endangered while others are Least Concern. However, a total of 26 bird species (89.66%) attack rice, followed by millet with a total of 19 avian pests (65.52%) while maize had the lowest number of avian pests (12) (41.38%). The birds attack the cereal crops at different stages of their lives (from planting stage to Matured/Drying stage). Rice and Maize are majorly attacked at the grain formation (immature grain) stage while Millet, Wheat and Guinea corn are majorly attacked at the Matured/Drying stage.

Table 3: Life stages of cereal crops attacked by avian species by the respondents

Bird Species	IUCN Status	Cereal Crops Attacked	Life Stage Attacked
Village weaver	LC	Rice, Maize, millet, wheat, guinea corn	Immature grain and Matured/Drying
Double-spurred francolin	LC	Maize, guinea corn, millet	Planting stage
Northern red bishop	LC	Rice, millet, guinea corn	Mature/Drying
Bronze manikin	LC	Rice, guinea corn, millet	Mature/Drying
Black-and-white manikin	LC	Rice, millet, guinea corn	Mature/Drying
Orange-cheeked waxbill	LC	Rice, millet, guinea corn	Mature/Drying
Pin-tailed whydah	LC	Rice, millet	Mature/Drying
Grey-backed camaroptera	LC	Rice, millet	Mature/Drying
Northern grey-headed sparrow	LC	Rice, millet, guinea corn	Mature/Drying
Black-necked weaver	LC	Rice, Maize, millet, guinea corn	Immature grain and Mature/Drying
Yellow-mantled widowbird	LC	Rice, Maize, millet	Mature/Drying
Yellow-mantled weaver	LC	Rice, Maize, millet	Immature grain and Mature/Drying
Red-eyed dove	LC	Rice, Maize, guinea corn	Mature/Drying
Laughing dove	LC	Rice, Maize, guinea corn	Mature/Drying
Blue-spotted wood dove	LC	Rice, Maize	Mature/Drying
Red-headed quelea	LC	Rice, maize, millet, wheat, guinea corn	Mature/Drying
Black-winged bishop	LC	Rice, millet	Mature/Drying
Vieillot's black weaver	LC	Rice, Maize, wheat, guinea corn	Immature grain and Mature/Drying
Yellow-breasted Apalis	LC	Rice, millet	Mature/Drying
Winding cisticola	LC	Rice, millet, wheat, guinea corn	Mature/Drying
Whistling cisticola	LC	Rice, millet, wheat, guinea corn	Mature/Drying
Tawny-flanked prinia	LC	Rice	Mature/Drying
Yellow-throated longclaw	LC	Rice	Mature/Drying
Olive-green camaroptera	LC	Rice	Mature/Drying
Common bulbul	LC	Rice	Mature/Drying
Short-winged cisticola	LC	Rice, millet, wheat, guinea corn	Mature/Drying
Red-faced cisticola	LC	Rice, millet, wheat, guinea corn	Mature/Drying
Senegal parrot	LC	Maize	Immature
African Grey parrot	EN	Maize	Immature

Table 4: The three major avian pest of each cereal crops as stated by the respondents

Cereal crop	Major Bird Species	Frequency	Percentage %	Ranking
Rice	Village weaver	245	91.76	1st
	Red-headed Quela	237	88.76	2nd
	Bronze manikin	210	78.65	3rd
Maize	Village weaver	251	94.01	1st
	Senegal parrot	230	86.14	2nd
	African Gray parrot	205	76.78	3rd
Millet	Red-headed quelea	235	88.01	1st
	Double-spurred francolin	189	70.79	2nd
	Winding cisticola	165	61.8	3rd
Wheat	Village weaver	85	31.84	1st
	Red-headed quelea	50	18.73	2nd
	Winding cisticola	43	16.1	3rd
Guinea corn	Village weaver	98	36.7	1st
	Red-headed quelea	76	28.46	2nd
	Black-and-white manikin	65	24.34	3rd

Severity and Pattern of Avian attack activities in the study area

The seasonality of attack result (Table 5) showed that the attacks happen during both dry and wet season according to 54.7% of the respondents, 36.3% said it happens during the wet season only while 9.0% said that the attack happens during the dry season only. Also, 81.27% of the respondents stated that crop raiding by birds happens throughout the day. In addition, the result on the severity of avian attack based on average crop loss during each planting season revealed that 32.6% of the respondents believed that crop loss fell under the "severe category" (26-50%), followed by 31.8% which was under the "Moderately severe" category (11-25%) and 25.8% under the "Very severe" category (>50%) with the least

(9.7%) average crop loss falling under the "not severe" category (1-10%). This implies that the farmers will incur a considerable economic loss irrespective of the farming season or cereal crop grown.

Table 5: Severity and Pattern of Avian attack activities in the study area

Variables	Villages							Total	Percentage
	TS	BA	WA	DU	PA	BK	LA		%
Season of Attack									
Wet	6	10	8	6	19	16	32	97	36.3
Dry	5	6	1	1	1	10	3	24	9.0
Both	26	32	27	27	21	10	35	146	54.7
Period of the day when attack is more common									
Morning only	2	5	2	2	5	3	3	22	8.24
Evening only	4	4	2	4	6	2	6	28	10.49
Both	31	39	31	28	30	31	61	217	81.27
Average crop loss									
1-10%	2	6	4	1	5	6	2	26	9.7
11-25%	10	29	7	1	16	21	1	85	31.8
26-50%	20	10	4	1	17	8	27	87	32.6
More than 50%	5	3	21	31	3	1	5	69	25.8

Keys: TS=Tsonga; BA=Bacita; WA=Wodata; DU=Dugbangi; PA=Patigi; BK= Bokungi; LA= Lade.
1-10% =Not severe; 11-25% = Moderately severe; 26-50% =Severe; > 50% =Very severe
Source: Field Survey, 2023

Effect of Avian Attack on Cereal Crops Yield and Quality

The results of the effect of avian species on cereal crop yield and quality is shown in Table 6. The results showed a strong agreement of the respondents to the avian attack leading to stunted growth of cereal crops with a weighted mean value of 4.75±0.24. It ranges from 4.17±1.25 in Bokungi village to 5.00±0.00 in Lade village. Also, the results showed a strong agreement of the respondents to the avian attack leading to reduced crop yield with a weighted mean value of 4.64±0.51. Across the villages it ranges from 4.86±0.35 in Lade village to 4.05±1.22 in Bokungi village. Furthermore, the results also revealed a strong agreement of the respondents to the avian attack leading to poor grain quality with a weighted mean of 4.56±0.55. Across the villages it ranges from 4.19±1.17 in Bokungi village to 4.91±0.38 in Dugbangi village. The implication is that the avian attack will not only lead to crop loss but the quality of the harvested grain may also be poor resulting in greater economic loss.

Table 6: Perceived Effects of Avian pests on Cereal crops

Variables	SA	AG	UD	DS	SD	Weighted sum	Mean +S.D	Decision
Stunted growth	222	30	5	6	4	1261	4.75±0.24	SA
Reduced crop yield	193	62	4	6	2	1239	4.64±0.51	SA
Poor grain quality	183	63	12	6	3	1218	4.56±0.55	SA

Decision Keys: 4.20 - 5.00= SA (Strongly Agree); 3.40 – 4.19=A (Agree); 2.60 – 3.39= N (Neutral); 1.80 – 2.59= D (Disagree); 1.00 – 1.79= SD (Strongly Disagree).

Bird Control Measures Adopted by the farmers

The results shown in Figure 2 revealed that the cereal farmers adopted seven measures/methods in controlling avian pests in their farmland. This methods include; human scarer, traditional medicine (juju), human-like cloths, old cassette nylon, noise making bottle, chemicals and net. The results further shows that a higher number (254) of the respondents make use of Human scarer as a measure of avian control, 243 use noise making bottles, 230 use Nets, 227 use Humanlike clothes, 196 use traditional medicine, 154 use chemicals while 144 respondents use Old cassette nylon as a means of controlling avian pests on the farm.

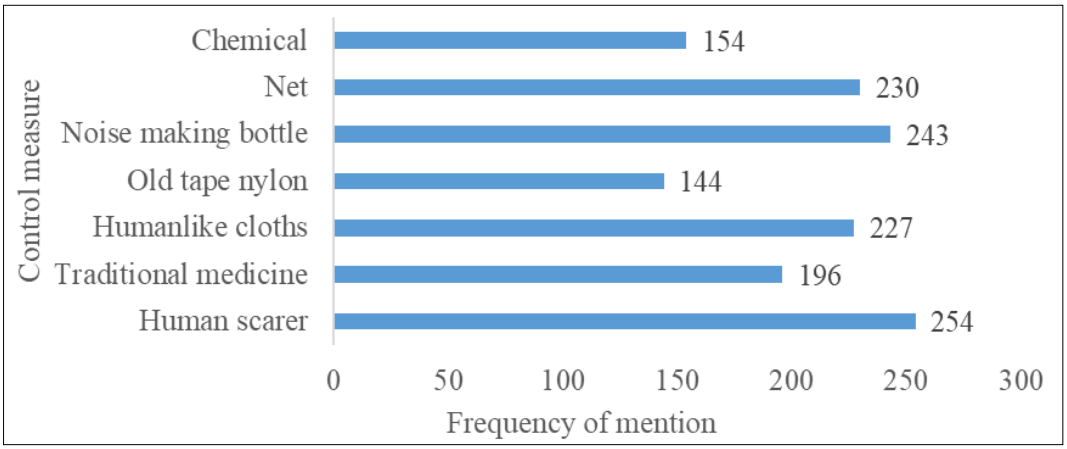

Fig 2: Methods of avian pest control in cereal farmlands

Perception on presence of avian species on farmland

The results of respondents' perception on the presence of avian species on farmland are presented in Table 7. The results show that the respondents agreed that not all birds in cereal farmlands are pest with a weighted mean value of 3.99±1.79. The results also revealed that the respondents strongly agree that birds control insect pests in cereal farms with a weighted mean of 4.43±0.69. Furthermore, the respondents strongly agreed that birds' damage to cereal crops lead to income loss having a weighted mean of 4.50±0.81. The study also revealed that the respondents across the study area strongly agreed that bird damage leads to farm abandonment having a weighted mean of 4.59±0.78. The study further revealed that the respondents strongly agreed to bird damage leading to discouragement having a mean value of 4.60±0.83. The results also revealed that the respondents also strongly agreed to compensation to be paid by government having a mean value of 4.32±0.83.

Table 7: Perception on the presence of avian species on farmland

Variables	SA	AG	UD	DS	SD	WS	WM+StdDv	Decision
Not all birds in cereal farmland are pest								
Total	177	18	5	27	38	1064	3.99±1.79	A
Birds control insect pest in cereal farms								
Total	134	121	6	4	2	1182	4.43±0.69	S.A
Birds damage leads to income loss								
Total	173	68	14	11	1	1202	4.50±0.81	S.A
Bird damage can lead to farm abandonment								
Total	188	63	5	9	2	1225	4.59±0.78	S.A
Birds damage leads to income loss								
Total	173	68	14	11	1	1202	4.50±0.81	S.A
Bird damage can lead to farm abandonment								
Total	188	63	5	9	2	1225	4.59±0.78	S.A
Bird damage leads to discouragement								
Total	195	56	5	4	7	1229	4.60±0.83	SA
Compensation should be paid by government								
Total	121	130	4	5	7	1154	4.32±0.83	SA

Decision Key: 4.20-5.00=SA (Strongly agree); 3.40-4.19= A (Agree); 2.60-3.39=UD (Undecided); 1.80-2.59=D (Disagree); 1.00-1.79=SD (Strongly Disagree)

Relationship between Effects of Avian Attack and Demographic Variables

The result of hypothesis testing on the relationship between socio-demographic variables and the effects of avian attack on cereal crops presented in Table 8 reveals that there is no significant relationship (p>0.05) between the respondents' gender and stunted growth effect while there was a significant relationship (p<0.05) between the respondents' age, education, household size, Years of farming, Farm size, Ownership of farm, cereal crop grown, Planting season and stunted growth effect. The results also revealed that there is a significant relationship (p<0.05) between the respondents' community, age, Education, household size, Years of farming, Farm size, cereal crop grown, Ownership of farm and reduced crop yield effect while there is no significant relationship (p>0.05) between the respondents' gender, and planting season and reduced crop yield effect. Furthermore, the results showed that there is a significant relationship (p<0.05) between the respondents' age, education, Household size, Years of farming, Farm size, Ownership of farm, cereal crop grown, Planting season and poor grain quality effect while there is no significance relationship (p>0.05) between the respondents' gender and poor grain quality effect.

Table 8: Analysis of the Relationship between effects of avian attack and demographic variables

Effects	Variables	Chi2	P -value	Decision
Stunted growth	Community	74.896	0.000**	S
	Planting season	18.962	0.015**	S
	Cereal crop grown	32.563	0.021**	S
Reduced crop yield	Community	59.084	0.000**	S
	Planting season	3.147	0.925	NS
	Cereal crop grown	35.315	0.013**	S
Poor grain quality	Community	98.142	0.000**	S
	Planting season	19.414	0.013**	S
	Cereal crop grown	31.435	0.012**	S

** = Significant at p<0.01

Relationship between Farmers' Perception on Avian Conservation and Socio-demographic variables

The result of the hypothesis test presented in Table 9 shows that there is a significant relationship (p<0.05) between all the respondents' socio-demographic variables tested and perceptions that not all birds in cereal farmland are pests. The results also showed that there is a significant relationship (p<0.05) between the respondents' socio-demographic variables and perception that birds control insect pest in cereal farms except the respondents' gender and ownership of farm. Additionally, the result showed that there is a significant relationship (p<0.05) between the respondents' community, age, education, religion, household size, years of farming, farm size, ownership of farm, planting season and perception

that bird damage leads to income loss but there is no significant relationship (p>0.05) between gender and the perception that bird damage leads to income loss. Furthermore, there is a significant relationship (p<0.05) between the respondents' community, gender, education, religion, household size, farm size and ownership of farm and the perception that bird damage leads to farm abandonment but not significant (p>0.05) with age and planting season.
The result also showed that there is a significant relationship (p<0.05) between the respondents' community, household size, years of farming, farm size, ownership of farm and the perception that bird damage leads to discouragement but there is no significant relationship (p>0.05) between the respondents' age, gender, education, religion, planting season and the perception that bird damage leads to discouragement. Finally, the result showed that there is a significant relationship (p<0.05) between the respondents' community, age, education, household size, years of farming, farm size and ownership of farm and the perception that compensation should be paid by government but there is no significant relationship (p>0.05) between the respondents' gender, religion, planting season and the perception that compensation should be paid by government.

Table 9: Analysis of the Relationship between farmers' perception and demographic variables

Demographic variables		PECP1	PECP2	PECP3	PECP4	PECP5	PECP6
Community	Chi2	182.759	70.339	69.538	91.562	77.766	78.610
	P-value	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**
Age	Chi2	40.451	34.123	44.407	14.854	19.479	40.908
	P-value	0.000**	0.001**	0.000**	0.250	0.078	0.000**
Gender	Chi2	17.498	5.331	3.841	12.468	8.322	4.257
	P-value	0.002**	0.255	0.428	0.014**	0.080	0.372
Education	Chi2	60.412	38.458	24.254	28.004	19.748	28.657
	P-value	0.000**	0.000**	0.019**	0.006**	0.072	0.004**
Household size	Chi2	42.987	24.234	34.746	21.487	25.662	24.919
	P-value	0.000**	0.002**	0.000**	0.006**	0.001**	0.002**
Years of farming	Chi2	67.829	49.609	36.003	20.609	31.589	44.133
	P-value	0.000**	0.000**	0.003**	0.194	0.011**	0.000**
Farm size	Chi2	38.792	61.255	64.253	54.806	30.778	37.247
	P-value	0.001**	0.000**	0.000**	0.000**	0.014**	0.002**
Ownership of farm	Chi2	19.892	14.565	21.442	21.456	33.699	24.174
	P-value	0.011**	0.068	0.006**	0.006**	0.000**	0.002**

** = Significant at p<0.01

Correlation between Average crop loss and Farming Variables

The result on correlation test presented in Table 10 shows that there is a positive and significant (p<0.01) correlation between average crops loss and respondents' farm size, bird species and farming season. However, there was a negative and no significant (p>0.01) correlation between average crops loss and cereal crops damaged and life stage of cereal crops damaged.

Table 10: Correlation between Average crop loss and Farming Variables

Variables	Correlation value (r)	Sig.	Decision
Size of farm	0.316	0.000**	S
Farming season	0.310	0.000**	S
Bird species	0.53	0.000*	S
Cereal crops	-025	0.341	NS
Life stage of cereal crop	-051	0.205	NS

** = Significant at p<0.01; * = Significant at p<0.05

Discussion

Demographic Characteristics of Respondents

Socio-economic characteristics provide valuable insights for understanding the context of cereal crops growers in Edu and Patigi LGAs. The majority of respondents being male (57.3%) is an indication that males are more into farming than females in the study area. This is in agreement with the report by Atibioke, *et al*. (2012) [3]; Salisu, *et al*. (2021) [35] that men are more engaged in farming activities than women in Nigeria. The demographic trend of substantial proportion of respondents falling within the age group 51-60 years (43.4%), having more than 10 years of farming experience, farming in both wet and dry seasons and almost all the respondents being indigenes of Kwara State (99.6%) suggests that the study population is closely tied to the local agricultural landscape which could be linked to the level of traditional farming practices common in rural areas, which might have implications for pest management strategies. This is in tandem with the statement by Obiero *et al*. (2020) [28] that indigenous perspective is crucial for understanding the dynamics of pest-related challenges specific to a region, as local knowledge and practices may differ from those of non-indigenous farmers. The majority being married (55.8%) and having households with more than eight members (53.2%) will enhance their farming activities and pest control efforts. This is in agreement with the views of Atibioke, *et al*. (2012) [3] and Carnegie *et al*. (2020) [6] that marriage serves as a means of generating family support/labour in crop production processes including pest control. Also, majority (71.5%) of the farmers have formal education which will be good for understanding and dissemination of avian conservation awareness and adoption of avian friendly/ecofriendly control

measures. This is in line with the opinion of Kuzuhara *et al*., (2020) [18] that having higher number of respondents with formal education may suggest access to resources, including knowledge and financial means, which can be advantageous for pest management in agricultural contexts.

Avian pest species of cereal crops

The identification of twenty-nine bird species as pests of cereal crops underscores the diversity and complexity of the avian pest problem that if not addressed properly will have greater consequences on cereal production and avian conservation in the study area. The presence of Village weaver (*Ploceus cucullatus)*, Black-necked weaver (*Ploceus nigricollis)*, Vieillot's black weaver (*Ploceus nigerrimus)*, Red-headed quelea (*Quelea erythrops)*, Laughing dove (*Streptopelia senegalensis)*, parrot, Mannikin species, sparrows francolin and Northern red bishop is in tandem with the findings of Odewumi, (2022) [29]; Adekola *et al*., (2019) [1]; Mey & Demont, (2013) [9]; Segun *et al*. (2018) [36]. However, rice and maize farmers has to contend with diverse species of birds on their farmlands as more than half (58.62%) of the birds recorded attack rice while about 37.93% of the birds attack maize. Weaver birds are the major pest of the cereal farmers being the major pest of rice, maize, wheat and guinea corn while Red-headed quelea was the major pest of millet. This agreed with studies carried out on avian pests by Adekola *et al*., (2019) [1] and Odewumi, (2022) [29]. Funmilayo and Akande, (2007) [14] reported that rice is one of the five crops most frequently damaged by birds in the Western States of Nigeria. Elliott & Bright (2007) [12] also stated that in Ogun, Osun and Ekiti states, the consensus was that Village Weavers (*Ploceus cucullatus)*, Red-headed Quelea (*Quelea erythrops*), and Bronze Mannikins (*Lonchura castaneothorax*) were the most important constraint to rice production. Similarly, Mey & Demont, (2013) [9]; Segun *et al*. (2018) [36] classified Red-billed Quelea as one of the world's most infamous nuisance bird species, causing damage to numerous cereal crops such as rice, millet, sorghum, throughout Sub-Saharan Africa.

Cereal crop damage activities

An overwhelming majority of respondents, (95.1%), reported high prevalence both during the dry and wet seasons which underscores the significant impact of avian pests on cereal farming in the region and suggests that these challenges are widespread among farmers. This could be as a result of non-availability of natural food for the birds due to vegetation clearing for large-scale farming, logging, grazing etc. This finding contrasts with the observations made by Maurice *et al*. (2019) [24], who noted that the dry season was characterized by more crop raids than the wet season in the Southwest Region of Cameroon, and also differs from the findings of Odewumi (2022) [29], that the majority of damage occurred during the wet season in cereal farm around Old Oyo National Park.

It is noteworthy that the activities of birds is more serious in the area as most of the respondents (90.3%) lost a considerable portion 11% - more than 50% of the crops planted to the attack. This level of loss can have a significant economic impact on farmers and underscores the urgency of effective pest management strategies. This is in tandem with the report by Kale *et al*. (2014) [17] who opined that the yield loss birds caused vary from 10 to 80% as they flock in large numbers. Conversely, 9.7% of respondents reported "not severe" crop loss, falling within the range of 1-10%. While this represents a smaller proportion, it may suggests that there are successful pest management practices in place for some farmers that result in minimal losses. Exploring and disseminating these effective strategies could be beneficial for the broader farming community.

Bird attack on cereal crop life stage

The pattern of avian attack on cereals within the study area span across the different life-stages of the crops (planting to maturity/drying) but more common/serious in the milking and drying stages. This meant more efforts, time and finances for bird control. This observation underscores the persistent need for farmers to engage in bird control measures throughout the planting season, resulting in substantial economic losses and diverting valuable time away from other agricultural activities. This is in agreement with the report by Odewumi, (2022) [29], that avian pests pose a significant threat to cereal crops in communities surrounding Old Oyo National Park across various life stages, spanning from planting to maturity/drying. According to Adekola *et al*., (2019) [1] birds mostly affect crops during early stages of germination and milking stages and also late stages of maturity and harvesting stages in Ondo State. The study's comprehensive assessment of crop vulnerability to avian species attacks at different developmental stages offers critical insights for developing precise and effective pest management approaches. Notably, rice and maize are most susceptible during the flowering/grain formation stage, with 221 and 296 frequency of mention, highlighting the need for protective measures during this crucial growth phase. In contrast, millet faces its greatest vulnerability at the Maturity/Drying stage (81), warranting a detailed examination of the factors attracting birds to mature millet crops for nuanced pest management. Wheat exhibits lower susceptibility at the Maturity/Drying stage (4), underscoring the importance of addressing this less frequent vulnerability. Interestingly, Guinea corn shows minimal vulnerability during the planting/germination stage (zero attacks), suggesting lower risk during early growth. These findings stress the importance of tailoring pest control strategies to specific crop growth stages, guided by the provided quantitative data to enhance crop resilience.

Effects of Avian Attack on Cereal Crops

The results showed a strong agreement of the respondents to the effects of avian attack on cereal crops leading to stunted growth (weighted mean value of 4.75±0.24), reduced crop yield (weighted mean value of 4.64±0.51) and poor grain quality (weighted mean of 4.56±0.55). The implication is that the avian attack will not only lead to crop loss but the quality of the harvested grain may also be poor needing additional effort and cost to improve the grain quality. This will eventually result in reduced price and consequently in greater economic loss for the farmers, thereby discourage them in farming. This is in line with the statement by Pejchar *et al*. (2018) [34]; McLaughlin & Kinzelbach, (2015) [25] that birds can consume substantial portions of a crop, leading to yield losses that can have severe consequences for farmers and communities relying on these crops for sustenance and income. Franklin *et al*., (2023) [13] also noted that beyond mere yield reduction, avian pests can also degrade the quality of cereal crops by contaminating them with feces, feathers,

and pathogens. Franklin *et al*. (2021) [13]; Desoky, (2014) [10] stated that contaminated crops often require additional cleaning, sorting, or processing, incurring extra costs for farmers. These quality issues can further lead to lower market prices for the affected produce, compounding the economic impact.

Bird Control Measures

Generally, the cereal crop farmers in the study area adopted seven different bird control methods in their farmlands. These methods are local, cost less, non-lethal except for the use of Chemicals. Among the different control measures employed, the study revealed that human scarers and noise making bottles were the most effective methods. Other methods include the use of human like clothes, traditional medicine, net, chemicals and old tape nylon. The prevalence of humanlike clothes, suggests a reliance on visual avian deterrence by creating the illusion of human presence. Traditional medicine used highlights the potential influence of cultural or local beliefs on avian control practices. The application of chemicals raises questions about the environmental impact and efficacy of chemical-based methods. In contrast, the use of old tape nylon appears to be a less common or possibly cost-effective approach. In a parallel investigation carried out by Odewumi (2022) [29]; Maurice *et al*. (2019) [24], it was observed that many of these strategies are indigenous, demanding substantial labor, time, and resources. Furthermore, some of these methods exhibit limited durability and effectiveness, necessitating frequent reapplication. This situation also tends to result in prolonged periods during which their children are unable to attend school as a result of scaring away birds from the farm. This agrees with the observation of Maurice *et al*. (2019) [24].

Perception on Presence of Avian Species on Farmland

The results concerning respondents' perceptions of avian species on farmlands convey valuable insights into the complex interactions between farmers and avian pests in cereal crop cultivation. Notably, respondents generally agree that birds are considered pests in cereal farmlands, as indicated by the weighted mean value of 3.48±1.79. This consensus aligns with the understanding that birds can cause substantial crop damage. Conversely, respondents strongly agree that birds serve as natural controllers of insect pests in cereal farms, with a weighted mean of 4.43±0.69. This perception highlights the ecological role of birds in pest regulation. Moreover, respondents strongly concur that bird damage to cereal crops leads to income loss, with a weighted mean of 4.50±0.81. This acknowledgment underscores the economic impact of avian pest damage. Furthermore, respondents across the study area express strong agreement that bird damage can lead to farm abandonment (weighted mean of 4.59±0.78) and discouragement (mean value of 4.60±0.83). These sentiments underscore the profound consequences of avian pest infestations on farmers' livelihoods and motivation, with varying degrees of agreement across villages. Lastly, respondents also strongly agree that compensation should be paid for the damages incurred (mean value of 4.32±0.83), reflecting a recognition of the need for support in mitigating losses. In summary, these results illustrate the multifaceted perspectives of farmers regarding avian pests in cereal farming, encompassing ecological, economic, and social dimensions. These perceptions underscore the importance of integrated pest management strategies that consider both the ecological roles of birds and the economic challenges posed by their presence. This is in tandem with the report by Maurice *et al*. (2019) [24]; Odewumi, (2022) [29].

Conclusion and Recommendation

The identification of twenty-nine bird species as cereal crop pests underscores the diversity and complexity of the avian pest problem. This occur year-round, leading to substantial economic losses for farmers from stunted growth, poor grain quality and reduced crop yield. The avian control methods adopted are either labour intensive or costly. Furthermore, the study highlights the multifaceted perceptions of farmers regarding avian pests, emphasizing the ecological role of birds as natural controllers of insect pests while acknowledging their potential for causing income loss, farm abandonment, and discouragement. Based on the results of the study, it is recommended that farmers should be encouraged to adopt an integrated approach to avian pest management that strike a balance between ecological considerations and the economic challenges posed by avian pests.

References

1. Adekola O, Odewumi OS, Agbelusi EA. Avian Pests of Cereal Crops in Rainforest and Savanna Agro-Ecological Zones, Ondo State, Nigeria. Journal of Research in Forestry, Wildlife & Environment. 2019;11(1):11-23.
2. Alemayehu N, Tekalign W. Prevalence of crop damage and crop-raiding animals in southern Ethiopia: The resolution of the conflict with the farmers. Geo Journal; c2020 Sep.
3. Atibioke OA, Ogunlade AA, Abiodun BA, Ogundele MA, Omodara, Ade AR. Effects of Farmers' Demographic Factors on the Adoption of Grain Storage Technologies Developed by Nigerian Stored Products Research Institute (NSPRI): A case study of selected villages in Ilorin West LGA of Kwara State. Research on Humanities and Social Sciences. 2012;2(6):56-63. Available from: www.iiste.org ISSN 2224-5766 ISSN 2225-0484(Online).
4. Balami DH, Ogboru I, Talba DM. The Cereal Economy in Nigeria and the Sub-regional Dimension. Vol. 1. Benue State: Social Science Study Group (SSSG); c2011.
5. Branco JO, Keske BR, Barbieri E. Abundance and potential impact of granivorous birds on irrigated rice cultivation, Itajaí, Santa Catarina, Brazil. Arquivos do Instituto Biologico. 2016;83:1-7.
6. Carnegie M, Cornish PS, Htwe KK, Htwe NN. Gender, decision-making and farm practice change: An action learning intervention in Myanmar. Journal of Rural Studies. 2020;78:503-515.
7. Canavelli SB, Branch LC, Cavallero P, González C. Multi-level analysis of bird abundance and damage to crop. Agriculture, Ecosystems & Environment. 2014;197:128-136.
8. De Mey DY, Demont M, Diagne M. Estimating bird damage to rice in Africa: evidence from the Senegal River Valley. Journal of Agricultural Economics. 2012;63(1):175-200.
9. De Mey YD, Demont M. Bird Damage to Rice in Africa: Evidence and Control. In: W. MCS, Johnson D, Ahmadi N, TE, Jalloh A, editors. Realizing Africa's rice promise.

CABI Publishing; c2013. p. 241-249.
10. Desoky AE-A. Damage Caused by Birds and Rodent in Field Crops and their Control. Journal of Global Innovations in Agricultural and Social Sciences. 2014;2(4):169-170.
11. Duguma LA, Darnhofer I, Hager H. The financial return of cereal farming for smallholder farmers in the Central Highlands of Ethiopia; c2010. p. 137-153.
12. Elliott C, Bright E. Review of the bird pest problem and bird scaring in south west Nigeria: Making Nigerian Agricultural Markets Work for the Poor. Monograph Series. 2007;(8):35.
13. Franklin AB, Sarah NB, Susan AS. Pathogens from Wild Birds at the Wildlife–Agriculture Interface. In: Owen JC, Hawley DM, Huyvaert KP, editors. Infectious Disease Ecology of Wild Birds. Oxford Academic; c2021. Available from: https://doi.org/10.1093/oso/9780198746249.003.0011. Accessed 26 Sep 2023.
14. Funmilayo O, Akande M. The ecology economic impacts and control of vertebrate pests of upland rice in the western state of Nigeria. Research Bulletin No. 5. Institute of Agricultural Research and Training, University of Ife, Ibadan; c2007. p. 41.
15. Hill CM. Crop foraging, crop losses, and crop raiding. Annual Review of Anthropology. 2018;47:377-394.
16. Ismaila U, Gana AS, Tswanya NM, Dogara D. Cereals production in Nigeria: Problems, constraints and opportunities for betterment. African Journal of Agricultural Research. 2010;5(12):1341-1350.
17. Kale MA, Dudhe N, Kasambe R, Bhattacharya P. Crop Depredation by Birds in Deccan Plateau, India. International Journal of Biodiversity. 2014;2014:947683. Available from: http://dx.doi.org/10.1155/2014/947683.
18. Kuzuhara H, Takimoto H, Sato Y, Kanagawa A. Insect pest detection and identification method based on deep learning for realizing a pest control system. In: 59th Annual Conference of the Society of Instrument and Control Engineers of Japan (SICE); c2020. p. 709-714.
19. Kwara State Agricultural Development Project (KWADP). Ilorin, Nigeria; c2007.
20. Kwara State Ministry of Agriculture. Development and Investment Policies in Agriculture. April 2003/2004 Edition; c2004.
21. Liliane TN, Charles MS. Factors Affecting Yield of Crops. In: Agronomy-Climate change and Food Security. London: Intechopen; c2020.
22. Macauley DH. Cereal Crops: Rice, Maize, Millet, Sorghum, Wheat. United Nations Economic Commission for Africa; c2015.
23. Manikowski S. Birds injurious to crops in West Africa. Tropical Pest Management. 1984;30:379-387.
24. Maurice ME, Fuashi NA, Mengwi NH, Ebong EL, Awa PD, Daizy NF. The Control Methods used by the Local Farmers to reduce Weaver-Bird Raids in Tiko Farming Area, Southwest Region, Cameroon. Madridge Journal of Agriculture and Environmental Sciences. 2019;1(1):31-39. Available from: DOI: 10.18689/mjaes-1000106.
25. McLaughlin D, Kinzelbach W. Food security and sustainable resource management. Water Resources Research. 2015;51(7):4966-4985.
26. Mooi E, Sarstedt M, Mooi-Reci I. Market Research: The Process, Data and Methods Using Stat. Singapore: Springer; c2018.
27. Nair RP, Jayson EA. Estimation of economic loss and identifying the factors affecting the crop raiding behaviour of Asian elephant (*Elephas maximus*) in Nilambur part of the southern Western Ghats, Kerala, India. Current Science. 2021;121(4):521-528.
28. Obiero KO, Klemet-N'Guessan S, Migeni AZ, Achieng AO. Bridging Indigenous and non-Indigenous knowledge systems and practices for sustainable management of aquatic resources from East to West Africa. Journal of Great Lakes Research; c2022.
29. Odewumi OS. Avian Pests of Cereal Crops: Insight from Farmers around Old Oyo National Park, Nigeria. Nigerian Journal of Wildlife Management; c2022. p. 44-55.
30. Oerke EC. Crop losses to pest. Journal of Agricultural Science. 2006;144(1):31-43.
31. Olabode AD. Determining Rice Productivity Level for Sustainable Agricultural Development in Patigi Local Government Area (LGA) Of Kwara State, Nigeria. Journal of Sustainable Development in Africa. 2011;13(5):124-135.
32. Omotesho KF, Ogunlade I, Akinrinde AF, Omotayo RO. Farmers' Perception of Dry Season Rice Farming in Edu Local Government Area of Kwara State, Nigeria. Tropical Agricultural Research & Extension. 2017;20(1 & 2):21-31.
33. Pawlak K, Kołodziejczak M. The Role of Agriculture in Ensuring Food Security in Developing Countries: Considerations in the Context of the Problem of Sustainable Food Production. Sustainability. 2020;12(13):5488.
34. Pejchar L, Clough Y, Ekroos J, Nicholas KA, Olsson OLA, Ram D, *et al*. Net effects of birds in agroecosystems. Bio Science. 2018;68(11):896-904.
35. Salisu LH, Abubakar AB, Aliyu SM. Effects of Demographic Characteristics for Farmers' to Climate Change in Bunkure, Nigeria. Agrometeorology; c2021. Available from: http://dx.doi.org/10.5772/intechopen.95988.
36. Segun A, Sunday OI, Erastus OO, Francis KA. Solution to Bird Pest on Cultivated Grain Farm: A Vision Controlled Quadcopter System Approach. International Journal of Engineering Research & Technology. 2018 Oct;7(10):213-219.
37. Uloko J, Tyowua B, Adebayo B. Evaluation of Wildlife Pests on Rural Farms in Guma and Gwer-East LGAs of Benue State, Nigeria. Journal of Research in Forestry, Wildlife and Environment. 2017;9(1):97-103.