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An inventory of birds and extent of damage to rice farms at the Kpong Irrigation Dam in the Lower Volta Basin, Ghana

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ABSTRACT

This study aimed to assess the incidence of birds raiding rice fields in the Kpong Irrigation Dam area of Ghana. Structured questionnaires were used to interview rice farmers in order to identify the bird species involved, quantify the economic losses incurred, and determine the mitigation measures employed by farmers. The main bird species identified as actively raiding rice fields were *Ploceus cucullatus*, *Ploceus nigerrimus*, *Spermestes cucullatus*, *Spermestes bicolor*, *Quelea erythrops*, and *Dendrocygna viduata*. The economic loss associated with bird raiding was estimated to range from 1,000.00 GHC (124.61 USD) to 1,500.00 GHC (186.92 USD), considering an exchange rate of 8.06 GHC to 1.00 USD at the time of the study. Additionally, farmers incurred 20.00 GHC in daily overhead labour costs to prevent bird raiding. Bird raiding on rice fields not only caused substantial economic losses but also had unintended social consequences. These included increased students' absence from school and farmers' inability to attend and participate in family, community, and other social gatherings. The study highlights the need for practical and efficient methods to mitigate the effects of bird raiding. Given the significant economic and social impacts, it is crucial to develop strategies that effectively reduce bird raiding in rice fields.

Keywords: Crop-raiding; birds; rice production; Lake Volta; food security
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Introduction

Human-wildlife conflict (HWC) has been explained as "any interaction between humans and wildlife that results in negative impacts on human social, economic or cultural life, on the conservation of wildlife populations or on the environment" (WWF, 2005). Crop raiding is a cause of many conflicts between farmers and wildlife throughout the world. In Africa, large proportion of the human population rely directly on agricultural lands for their survival. However, the presence of many species of wildlife which use these land areas as their habitats share same resources in many cases, resulting in conflict between people and wildlife (Butler, 2000).

Human-wildlife conflict (HWC) aggravates when access to the requirements of wildlife impact negatively on humans or when human beings' activities negatively affect the habitat of wildlife. These conflicts arise as a consequence of wildlife raids on crop farms, intimidate, kill or harm people and livestock (Sillero-Zubiri & Switzer, 2001); on the other

hand, when human beings encroach wildlife territories, attempt to control or eradicate wildlife populations and resources as well as attempting to hunt, capture or destroy any wildlife (Mekonen, 2020). The nature and extent of HWC incidents are diverse and widespread, though they are not distributed evenly because they are dependent on the kind of common frontier between humans and wildlife and also the type of species and times of the year (Glikman *et al*., 2021).The destruction caused may have capricious consequences on the livelihood of households depending on their level of livelihood security at the time of the incident (Mulonga *et al*., 2003; Sillero-Zubiri & Switzer, 2001).

It must be noted that both people and wildlife can feel the pain from HWC: whereas farmers suffer expensively from the loss of crops and livestock, wildlife populations may decline or become locally extinct as a result of extensive human-wildlife conflict (Mumby & Plotnik, 2018). For example, in more serious cases, people are killed by wildlife and people kill wildlife through poisoning, trapping, shooting and destruction of habitats resulting in wildlife population eradication (WWF, 2015). The relationship between people and wildlife becomes more complicated when people and wildlife coexist within the same landscape. It is observed that this coexistence could be only harmonious up to a certain threshold of human density and as soon as this threshold is exceeded, wildlife disappears from the landscape (Naughton-Treves & Treves, 2005). HWC is not a new or recent phenomenon in the field of wildlife conservation. Several efforts such as farming far away from protected areas, fencing farms, voluntary relocations of settlement etc. are being put in place to institute a symbiotic relationship between humans and wildlife (Osipova *et al*., 2018).

Agriculture has been the backbone of Ghana's economy ever since independence. Currently, agriculture and agricultural-related activities contributes about 22.1% to the country's GDP and employs around 52% of the population (GSS, 2022). Rice production has been envisaged as a panacea to food security in recent times in Ghana. However, little or no emphasis is laid on the importance of biodiversity conservation and contribution played by the wildlife to rice production and for that matter food security. In Ghana, with a rapidly increasing human population, the number of cases of HWC is expected to increase but to our knowledge, the conflicts involving birds remain poorly documented in the country.

The cultivation of the first rice (*Oryza sativa*) artificially happened approximately 10,000 years ago in Asia and has since spread throughout the world to be one of the very important crops globally. This crop is now being grown in more than 114 countries around the world and covers over 1% of the Earth's ice-free land surface. Rice provides about 15% of the protein and 21% of the calories consumed by humans. Globally, rice lands occupy an area of 156 million ha and only 19 of the world's countries occupy larger areas (Maclean *et al*., 2002; FAOSTAT, 2008).

More than 100 countries grow rice from a total harvested area of about 158 million hectares producing more than 700 million tons annually (470 million tons of milled rice). Almost 640 million tons of rice is cultivated in Asia which amounts to 93.5% of global production, whiles sub-Saharan Africa produces about 19 million tons (2.8%) and Latin America some 25 million tons (3.7%). Rice is a special crop that grows in a wide range of environments and is productive in

many diverse conditions where other crops would fail (Maclean *et al*., 2002).

In the tropics, multiple cropping cycles of rice are common, two or even three rice crops a year and in some cases, it is produced with other crops either as rotational plantings or mixed cropping (Street & Bollich, 2003). In certain extreme situations, some animals that grow well in wetlands are raised together with rice such as crayfish, fish and duck (Huner, 1994; Halwart & Gupta, 2004; Muzaffar *et al*., 2010). However, it has been documented that 15% of global rice production is lost to animal pests such as arthropods, rodents, birds, slugs and snails (Oerkes, 2005). Nevertheless, birds have been ranked as the second most important biotic constraint after weeds as a conclusion on farmers' surveys in 20 countries in Africa (GRiSP, 2010).

Although rice fields would never provide diverse habitats as natural wetlands do, it habour birds and other species, and therefore, can play important role in bird conservation (Fasola & Ruiz, 1997; Elphic, 2000; Jayasimhan & Padmanabhan, 2019). The main goal of this research is to promote rice farming without hampering the economic viability, food security and wildlife that depend on the same ecosystem for survival. Therefore, the objectives of the present study were to investigate the type of species involved, the extent of losses to humans caused by wildlife species, and the attitude of local farmers to wildlife conservation in rice fields.

Materials and Methods

Study area

The Kpong Irrigation Scheme (KIS) is one of Ghana's four main irrigation schemes. It is located in the Greater Accra and Eastern Regions near the towns of Asutsuare and Akuse, respectively in the Shai-Osudoku and Lower Manya Krobo Districts. It extends along the right bank of the Volta River from the Kpong Hydro-Electric Power Station in Akuse to its confluence which is about 20 km downstream at Asutsuare and Kasunya (Figure 1).

The total coverage area of the Kpong Irrigation Scheme was about 3000 ha located at the right bank of the Volta River. The scheme is publicly managed by the Ghana Irrigation Development Authority (GIDA). The entire rice field is stratified into five blocks with block size of 164 ha which currently hosts an average of 432 farmers (This indicate that the entire KIS area which is approximately 820 ha hosts about 2160 farmers). Every block is sub-divided into 1 ha farms. Each farmer was entitled to an average 0.34 ha or 0.84 acres land.

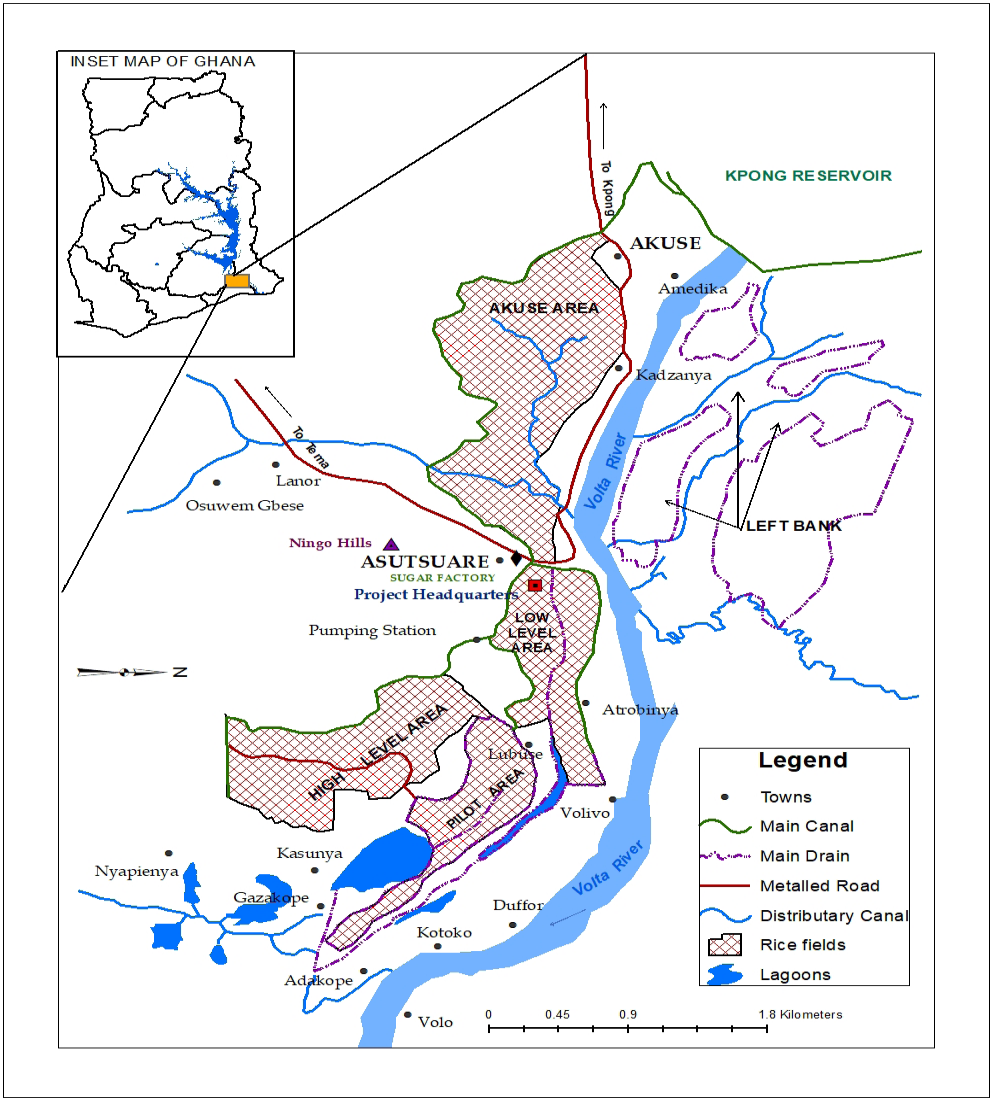

Fig. 1: Map of Kpong-Asutsuare irrigation area showing locations of rice fields

Data Collection and Analysis

The farmers from all five blocks were selected for farmer surveys. We assigned each farm a number, inserted the numbers in the box and then chose the surveyed farmer randomly by picking their corresponding numbers from the box. Data were collected between September and December, 2021 using a semi-structured

interview guide with farmers distributed among all the blocks in the rice field.

Most interviews were carried out in the Dangbe language but occasionally used English or Akan at the interviewee preference. The interviews covered broad areas including the demographic characteristics of farmers, household and cropping data. The study participants were also asked to indicate information about observed animals involved in raiding crops, frequency of animals visiting farms, the timing of crop raiding occurrence, stage of crops proffered by animals, the extent of crop damage experienced by farmers, methods adopted against crop-raiding activities, etc. To minimize biases from farmers' perceptions, which are always embedded in people's personal history and sometimes even in researchers' thinking, the following measures were taken:

1. With the help of a resident research assistant and the head of the block, we disclosed to the farmers what the research was about and its intentions;
2. We clarified that the research was meant for scientific and academic purposes, and that it had no legal or political implications;
3. A small committee was formed to help us avoid questions that would be considered taboos in this community and factors considered private;
4. To avoid any content bias, we crosschecked information given by an individual with a group discussion.

The data collected were analyzed using the Statistical Package for Social Studies (SPSS. V.20.0) software. In this case, data were subjected to descriptive statistics. The Pearson Chi-square was used to determine difference in the level of effectiveness of the various methods used by farmers to mitigate the overall impact of bird raiding activities.

Results and Discussion

Demography of the respondents

In all, 252 rice farmers were interviewed, the mean age was 46.1 years (SD = 15.43 years; Range = 15.86) and the number of years they had cultivated rice in the area ranged from 1–21 years. The estimated amount of money invested in rice cultivation per crop season was between 1,000.00 GHC (124.00 USD) to 6,000.00 GHC (744.40 USD) and the income accrued per crop season ranged from 2,000.00 GHC (124.00 USD) to 8,000.00 GHC (992.50 USD). More than half of the respondents, 151 (59.9%) farmed on one plot (1.5 acres); 36 (14.3%) farmed on two plots (3 acres); 16 (6.3%) farmed on three plots (4.5 acres); and eight (3.2%), six (2.4%) and four (1.6%) indicated that they farmed on four (6 acres), five (7.5 acres) and seven (10.5 acres) plots respectively. Most farmers were found to engage in cultivating rice varieties with high market value and preference of consumers such as *Jasmine* rice, 101 (40.1%); *X-Vicker* rice, 108 (42.9%); whilst few (1.6%) preferred *99 days*, *Jet*, and perfume rice varieties respectively. Some farmers, 31 (12.3%), did not have any preference for rice variety but dependent on availability of seedlings at the planting season. On other crops cultivated in addition to the rice, 181 (71.8 %) of the farmers interviewed did not have any, 43 (17.1%) cultivated okro while

the remaining farmers, 28 (11.1%) engaged in cultivation of crops such as maize, cassava, sweet potatoes and watermelon. However, it was revealed through this study that, majority of the farmers around the KIS, 238 (94.4%) depend fully on rice production as their source of income or livelihoods, whilst 14 (5.6%) were partially dependent on the rice farms. On challenges currently affecting rice production in the study area, 81.3% (205) attributed it to crop raiding animals, whilst the remaining farmers, 18.7% (47), attributed it to both high cost of farm inputs and crop raiding activities by wild animals.

Wild animal species involved in rice raiding activities

Birds were found to be the main taxa that contributed to the reduction of rice yields. 207 (82.1%) affirmed this; other taxa are rodents, 5.6% (14) and 12.3% (31), whereas some farmers attributed the loss of rice yield to insects and other invertebrates attacks. Specifically, the farmers mentioned two species of weaver birds (*Ploceus cucullatus* - Village weaver, and *Ploceus nigerimus* - Vieilloit's black weaver) as the major birds that feed on the rice grain at the matured stage. Manikins (*Spermestes cucullatus* - bronze manikin, *Spermestes bicolor* - black-and-white mannikin, and red-headed quelea (*Quelea erythrops*) were intricate in consuming rice grains at a succulent immature stage (when the content has not been solidified or at 'milking' stage) (Table 1). They ranked the impacts as severe. The farmers mentioned small-sized mouse (unidentified) and white-faced whistling duck (*Dendrocygna viduata*) as other vertebrates that destroy the rice at the nursery stage, but the impact was so low or not severe.

TABLE 1
Stage of rice and the severity of rice damage by birds

Stage of plant development	Species involved in crop damage	Level of severity	Reason for rating
Nursery	White-faced whistling duck	Low	Low inputs, renewable,
Mature-Milking fruit/ grain stage	Bronze mannikin	High	High inputs invested and cannot renew
	Black-and-white mannikin	High	
	Red-headed quelea	High	
Mature-Hard dough stage	Village weaver	High	High inputs invested and cannot renew
	Vieilliot's black weaver	High	

Source: Field Survey, 2021

Most farmers interviewed i.e. 84.5% (213), thought the birds came from the nearest forest and wildlife reserve which serves as refuge for birds after feeding or forage; 3.2% (8) mentioned bird originated from vegetation along the Volta Lake, and 12.3% (31) farmers mentioned shade trees and fallow lands around the villages as the source of these raiding birds. On the period of the day that the raiding took place, majority of the farmers 224 (88.9%) indicated they observed bird raiding activities throughout the day periods i.e. morning, afternoon and evening with peak periods occurring either morning and evenings

depending on bird species involved, time of the day and season. However, the ducks and the mice were never seen raiding either morning, afternoon or evenings which most farmers presumed such raiding activities occurred during the dark hours.

Deterrent methods used by farmers to reduce crop raiding of birds

Figure 2 presents the various methods employed by farmers to deter birds from raiding the grains. The findings revealed that (i)about one-third of the farmers, 74.2% (187), used objects to make noise; (ii) 6.3% (16) used their voices to shout; (iii) 3.2% (8) combined shouting and killing; (iv) 3.2% (8) combined shouting, using objects to make noise, and killing (v); 0.8% (2) covered their farms with nets and combined noise making and mounting of scarecrow; (vi) 12.3% (31) mentioned several miscellaneous methods such as catapults, kites, drones etc.

On the preference for the choice of methods, 75.0% (189) of the farmers preferred shouting by voice and making noise with objects; 10.3% (26) preferred shouting; and only 1.6% (4) of the farmers preferred the use of nets to cover their crops; another 12.3 % (31) of them did not have any preference. None of the farmers interviewed admitted 100% effectiveness of any of the methods or the combination of it to scare raiding animals but the level of effectiveness varied significantly from farmers' preferred method to another (X^2 = 80.228; df = 3, p = 0.000).

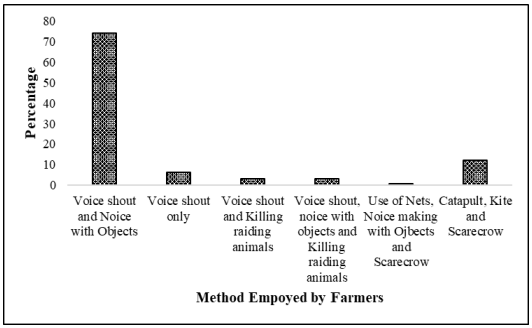

Fig. 2: List of techniques used to prevent birds from raiding rice farms

The estimated cost of controlling raiding birds on rice farms

Per each cropping season, the farmers indicated that the monetary cost of controlling raiding birds ranges from 500.00 GHC (62.00 USD) to 2,000.00 GHC (248.10 USD) per acre, with an average cost estimated around 1,240.00 GHC (153.80 USD) of rice field for those who uses shouting and noise from objects. As shown in Table 2, at least 74 (29.4%) of the farmers spent less than 500.00 GHC on protective strategies, 119 (47.2%) spent between 600.00 GHC to 999.00 GHC, and 35 (13.9%) spent between 1000.00 GHC to 1499.00 GHC. Also, 18 of the farmers representing 7.1% spent between 1500.00 GHC to 1999.00 GHC to protect birds from raiding on their rice farms, whereas only few farmers, 6 (2.4%), spent beyond 2000.00 GHC (248.10 USD). The cost of labour per day for shouting and making noise was 20.00 GHC (2.40 USD) per man-day. The net direct and

indirect cost involved protecting birds from raiding was estimated to be 2,000.00 GHC each planting season. The overall cost however vary based on the size of the farm and extent of birds raiding activities.

TABLE 2
Estimated cost involved in controlling birds raiding activities

Cost in Ghana Cedis (GHC)	USD Equivalent	Frequency	Percentage (%)
<500 GHC	62.03 USD	74	29.4
600–999 GHC	74.4–123.9 USD	119	47.2
1000–1499 GHC	124–185.9 USD	35	13.9
1500–1999 GHC	186.1–248 USD	18	7.1
>2000 GHC	248.1 USD	6	2.4

Note: Exchange rate during the study period was calculated at USD 1.00 to GHC 8.06; Source: Field survey, 2021

Social cost

On the social cost, the farmers mentioned the loss of their children's education as most of them depended on their families for shouting and making noise from the objects. Others included the farmer forfeiting social gatherings to protect their crops and not being with the family all the time because they must always be on the farm to contribute to the shouting and driving the birds away.

Key discussions

The necessity of ensuring food security for an ever-increasing human population while also preventing the loss of precious biological diversity leaves much to be desired. The commitment made by 182 countries at the 2002 World food summit to halve the number of malnourished people has made it more challenging to conserve biological diversity at the same time (FAO, 2009). The quest to secure food manifests itself in the Ghanaian rice farming, which involves a wide range of people of different age groups ranging from 15 years to 86 years, cultivating different varieties of rice. Whereas, most of the respondents depend solely on rice for a living, few of them cultivate other crops like maize, okra, potatoes etc. to supplement the rice cultivation.

In most developing countries, the limitations to crop production have been attributed to excess rainfall, drought, and lack of fertilizer (Rao *et al*., 2002). However, the results of this study indicated that the farmers interviewed mentioned wildlife crop damage as the most significant limitation to rice production. The specific taxa were birds and three major genera mentioned were *Spermestes*, *Quelea erythrops* and *Ploceus* consuming the rice at the immature and matured stages of the grain of rice respectively. These birds forage in their numbers and every single raid causes a significant loss to the farmer's yield. Manikowski (1984) provided a list of 36 bird species that cause damage to crops in West Africa (among approximately 1390 bird species) and out of this seven emerged as the most important species causing damage to rice. In comparison, this study recorded six species

of birds belonging to four genera (*Ploceus, Quelea, Spermestes* and *Dendrocygna*) and two orders (Passeriformes and Anseriformes).

Behaviorally, all the bird species mentioned by the farmers move and feed in large flocks as single species or mixed species (Jayasimhan, & Padmanabhan, 2019). Damage to rice by these birds differ with respect to the stage of growth of the rice as follows: (i) at the nursery stage by white-faced whistling duck but the level of severity is ranked low; (ii) at young fruit stage (the milking stage) by manikin and quelea attack and high level of severity; (iii) at mature fruit or hard-dough stage by the weaver birds attack with high level of severity. The level of severity of impact is ranked low by the farmers (at the nursery stage) probably because it occurs at the early stage of the farm and the farmer can replace the nursery with less input. The farmers ranked the damage at the fruiting stage high in terms of severity probably because the farmer has invested a lot of resources to grow the plant at that stage.

The farmers indicated that proximity to a protected area, Volta lake and shade trees along the villages serves as a refuge or habitat for the birds. This is supported by Manikowski (1984) that the presence of trees, bushes or reeds and water in the vicinity of rice fields increase vulnerability. He explained that these resources provide the birds with perches, nesting sites, and water for drinking and a habitat for waterfowl. It must be noted that this study site is about 20km away from the Shai-Hills resource reserve, very close to the Volta Lake and this makes the rice fields susceptible to bird attack. This also conforms to the conclusion by FAO (1991) that crop fields closed to breeding and roosting sites are the most susceptible to bird damage.

The farmers had a lot of methods or techniques at their disposal but the majority preferred to employ a low-tech, non-lethal and scary effect to prevent their farms from bird damage. The use of net to cover the rice appeared to be an innovative method but the cost of the material is high and in addition, it has the tendency to trap and kill a lot of birds. The farmers prefer the low-tech, non-lethal scary effect method because they use their children and other family members to scare the birds (though sometimes they employ people on daily basis). This has a severe toll on the farmers' social life, such as poor education of their children and cutting off from communal functions during the period.

Conclusion and Recommendation

The following birds' species emerged as the main species inflicting substantial losses on rice production: white-faced whistling duck (*Dendrocygna viduata*); village weaver (*Ploceus cucullatus*); Vieilloit's black weaver (*Ploceus nigerrimus*); bronze manikin (*Spermestes cucullatus*); black-and-white manikin (*Spermestes bicolor*) and red-headed quelea (*Quelea erythrops*). These species belong to the Order Passeriformes and possess a common characteristic of the mode of feeding and foraging, to render them good candidates for rice destruction.

Economic losses are incurred from rice consumption through the reduction of productivity and the cost of prevention of birds from feeding on the rice grains, which add extra financial burden on the farmer. In addition, the farmer incurs some social losses of poor children education and is socially cut from family and other communal ceremonies during bird controlling periods. The use of net to cover crops emerged as the most effective method to prevent birds from raiding rice grains; however, due to high cost in acquiring the net, a low-tech, low-cost, non-lethal but

scary effect emerged as the preferred one because it is less harmful to the environment and birds. It thus indicates that as much as the birds destroy the farmers' rice, they still want to keep them alive. This suggests that more research is needed to develop alternative techniques that farmers can easily adopt. In addition, we suggest to economists to propose an index-based insurance scheme for farmers whose crops would be devastated by rice damaging birds after applying a non-lethal technique

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