Program Based Research Grant (PBRG)

Sub-project Completion Report

on

Eco-friendly Rodent Management Through Owl Conservation

Sub-project Duration
February 2018 to January 2022

Coordinating Organization
Entomology Division
Bangladesh Rice Research Institute
Gazipur-1701

Project Implementation Unit
National Agricultural Technology Program-Phase II Project
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

November 2021

Sub-Project ID - 087

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Implementing Organization

Entomology Division
Bangladesh Rice Research Institute
Gazipur-1701

Vertebrate Pest Division
Bangladesh Agricultural Research Institute
Gazipur-1701

Project Implementation Unit
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Abbreviation and Acronyms

Acronyms	Abbreviation
Anon.	Anonymous
AIF-1	Agricultural Innovation Fund-1
ANOVA	Analysis of Variance
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BRRI	Bangladesh Rice Research Institute
Co-PI	Co- Principal Investigator
DAE	Department of Agricultural Extension
EFRM	Eco-friendly Rat Management
FMPHT	Farm Machineries and Post-Harvest Technology
FY	Fiscal Year
GoB	Government of Bangladesh
HQ	Head Quarter
IDB	Islamic Development Bank
IFAD	International Fund for Agricultural Development
LoA	Letter of Agreement
LSD	Least Significance Difference
NATP-2	National Agricultural Technology Program- Phase II project
PBRG	Program Based Research Grant
PCR	Project Completion Report
PI	Principal Investigator
Co-PI	Co-Principal Investigator
PIU	Project Implementation Unit
PMPA	Pest Management Program Area
RCBD	Randomized Complete Block Design
RS	Regional Station
SAAO	Sub-Assistant Agricultural Officer
T. Aman	Transplanted Aman
VPD	Vertebrate Pest Division
WB	World Bank
WT	Watch Tower

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Executive Summary

National Agricultural Technology Program: Phasse-II (NATP 2) aimed to increase agricultural productivity through enhancing agricultural technology generation under Agricultural Innovation Fund (AIF-1). For this, a sub-project entitled "Eco-friendly Rodent Management through Owl Conservation" was approved by PIU-BARC. Sustainable management of rat by conserving owl in nature was the overall goal of this sub-project. The sub-project activities were implemented in Cumilla, Gazipur and Rajshahi districts with the following specific objectives- i) to study the bio-ecology of available owl species and their mass rearing techniques, ii) to develop and validate the effective rat management technique(s) using owl in rice and wheat ecosystem, and iii) to upscale the developed techniques and buildup public awareness on owl conservation for sustainable rat management. Entomology Division of BRRI and Vertebrate Pest Division of BARI implemented the research activities for sustainable rat management during the Covid-19 pandemic situation from February 2018 to January 2022. BRRI component conducted the research activities in rice based ecosystem at BRRI HQ, Gazipur and BRRI RS, Cumilla; whereas BARI conducted the research activities in BARI HQ, Gazipur; BRRI RS, Rajshahi and to some extent in Barishal and Jashore districts. BRRI and BARI executed the sub-project activities to achieve the aforesaid objectives with the challenge for using barn owl to control wild / field rats ecofriendly as both of them are wild and nocturnal i.e., both are active at night time.

Rodents are the major agricultural pest in Bangladesh for crop production, damaging crop both in field and in storage. Every year more than 500 crore taka has been lost by only in rice and wheat crop. Not only damaging our crop but also disseminates more than sixty different diseases in human and animals. Owl is an important nocturnal bird that consumes more than one rat per night and play an important role for biocontrol of rodent pest. Therefore, conservation of owl in nature is an important task for rodent management. To know the local people perception about owl species in Bangladesh, a survey work was done. In addition, food preference of owl and their efficacy on rat management and awareness building activities were also studied.

A survey work was done on owl conservation in Rajshahi, Jashore and Gazipur through questionnaire. Most of the farmers (77.22 %) replied that they had seen only one species whereas 23.33% farmers reported on two species, 3.33% farmers reported on three species. Half of the farmers (50%) mentioned available owl species as Vutum pecha whereas 43.33% farmers mentioned it as Hutum pecha and only 32.22% farmers mentioned it as Laxmi pecha i.e. Barn owl. Most of the farmers (71.11%) respond that they liked owl as bird but 28.89% farmers did not like owl. Majority of the farmers (87.77%) thought that owl had no harmful effect on human and on environment. Most of the farmers (81.11%) thought that owl had no scary effect on human being as well as the environment. Only 18.89% farmer mentioned that it is a dangerous bird. About 85% farmers replied that owl has a beneficial effect on the nature. Only 14.44% farmers thought it has not affected on nature. Majority of the farmers (85.55%) treated owl as a rat feeder whereas 11.11% farmers considered it as environmental protector.

Owls were counted by line transect, point counting and look and see methods by using camera and were identified with the help of taxonomic book/reference. Owl species documentations were recorded by the help of some facebook group such as Birds Bangladesh, Birds and Wildlife of Bangladesh etc. During the study period 13 species of owl were recorded and documented Barn owl, Spotted owlet, Brown Hawk owl, Brown fish owl, Collard scops owl, Asian barred owl, Long-eared owl etc were the most abundant species in different zone. Owl species also located in different area but density was comparatively lower than barn owl species. Three species of owl, collected by BRRI from different locations were reared in small owl aviary to identify at species level with the reference materials. These (Barn owl, Long-eared owl and Asian barred owl) were characterized at their adult stages.

One hundred and nine (109) watching towers (WT) were placed at different heights in rice ecosystem (fields) at BRRI and BARI, Gazipur; and at BRRI RS, Cumilla and Rajshahi to facilitate barn owl for their preying at night using as perching device. Results showed that three and half-meter (3.5 m) height is suitable for effective preying. Owl WTs are effective from dusk to down. The newly developed burrows became inactive (dead) surrounding the 50m dia of WT, and increased in number (inactive burrows) by 15-20% fort-nightly. Owl regurgitates the previous prey item as "pellet" before preying new one. Therefore, cone shaped nylon net was used beneath the WT to collect the regurgitated pellets. Regurgitate pellets, collected from the WTs were air dried, sorted and analyzed carefully with referred rat skeleton. Regurgitated pellets of Barn owl and Spotted owlets were also analyzed by BARI to understand their dietary composition. BARI collected regurgitated pellets from BARI, Gazipur and Rajshahi locations and determined average weight, length, breadth and thickness of 5.82g, 47.95 mm, 30.43 mm and 20.29 mm, and 2.33g, 26.14 mm, 15.66 mm and 11.94 mm for barn owl and spotted owlet, respectively. The diet of barn owl mainly comprised small mammals such as rat, (47.85%), Shrew (27.27%) and insect Coleoptera (4.88%), crab (1.73%). Spotted owlet pellets contained small mammals only mice (32.29%), followed by insect (38.72%) of them Coleoptera (23.92%), Orthoptera (9.29), Hemiptera (3.28%), Odonata (2.23%), snail (2.14%) and crab (6.75%) and unidentified (15.74%). The remaining pellets comprised of wing, legs, heads, shell etc of insect and crab. So, most of the pellets consist of rat bones, skins; and exo-skeleton of insects. Thereby, observed pellets confirmed the rat predation. Small mammals were dominated in the diet of barn owl indicating that they have potential in regulating rat and mouse populations in crop fields as one of the components in integrated rodent pest management options.

In addition, four different types of eco-friendly rat management (EFRM) devices were evaluated and fine-tuned by BRRI to catch and kill the field rats in rice based eco-system. The rat capture devices, used in rice field bunds or close to the bund of burrow systems were very effective and showed 16% trap success.

Rice, wheat, barley, potato, sweet potato and groundnut crop damaged by rat were also assessed at 0-25, 26-50 and 51-75 meters apart around the watch tower areas. Nest box occupancy was also recorded for nesting and roosting by owl. Percent rat damage in different growth stage of rice, wheat and barley differed significantly in active burrow count methods and cut-uncut methods around the owl watching tower areas. Significantly lowest number of active burrow (0.6) was recorded in 0-25-meter distance around the watching tower followed by 25-50 m (active burrow, 1.5) distance and the highest number of active burrows was observed in 50-75 m (active burrow, 7.5) distance from watching tower both in Rajshahi and Gazipur. Per cent rat damaged and number of active burrows were higher as increase the distance from the watch tower areas. About 55% nest boxes were occupied by owl in Rajshahi and that was 50% in Gazpur. However, in Gazipur maximum nest box were occupied by spotted owlet (*Athena brama*) and in Rajshahi most of the nest box occupied by barn owl (*Tyto alba*). Training program was organized and booklet has been published to build up awareness about owl conservation among the local peoples.

In addition, WTs would also be used as perching devices during day time for insect feeding/ predatory birds, black drongo (*Dicrurus adsimilis*). Among the five different types of nest boxes, barn owl preferred triangular shape nest box for their nesting and breeding purpose. So barn owls are ecofriendly biocontrol agents that can be attracted to the crop fields by installing artificial nest boxes, X-shaped perches or poles with triangular shape nest boxes. It is needless to say, the sub-project had significant role in food safety of Bangladesh and it complied with SDG goal 2.

Key words: Owl, watch tower, survey, regurgitate pellet, rodent damage, perching devices and nest boxes.

PBRG Sub-Project Completion Report (PCR)

A. Sub-project Description

1. **Title of the PBRG sub-project: Eco-friendly Rodent Management Through Owl Conservation**
2. **Implementing organization (s):**
   a. Bangladesh Rice Research Institute (BRRI), Gazipur-1701, and
   b. Bangladesh Agricultural Research Institute (BARI), Gazipur-1701

3. **Name and full address with phone, cell and E-mail of Coordinator, Associate Coordinator, PI/Co-PI (s):**

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4. **Sub-project budget (Tk.):**
   4.1 Total: (in Tk. as approved): 20789575.00 Taka
   4.2 Latest Revised (if any): 1,35,18,451 (for BRRI) + 72,71,124 (for BARI)
5. **Duration of the sub-project:**
   5.1 Start date (based on LoA signed): February 14, 2018
   5.2 End date: January 2022
6. **Background of the sub-project:**

Rodents are the major agricultural pest in Bangladesh for crop production, both before and after harvest. Estimated loss in Bangladesh is about Tk. 1360 million per year (field and store). Average loss of rice is 53 kg/farm family/year, which amounts to 0.63 million tons per year (6.2% of the harvest). Damage is more in the field than that of the store. Rats are tremendous hoarders, cutting and carrying panicles of rice into their extensive burrow systems, thereby damaging much more than they eat (Islam and Hossain 2003, Islam *et. al*., 1993). A single rat can eat 12 kg of food per year and spoils much more by droppings. Rats cause damage to rice at all growth stages. Recent years, rat cause tremendous damage to rice crops around 25 folds than the previous records. They cut and pull seedlings, cut tillers of older plants and panicles. Rat also consumes the feeds of poultry and cause considerable damage every year.

Rats damaged food grains, including paddy, rice and wheat, worth around Tk. 723.72 crore in the 2014-15 fiscal year (FY). Around 237,744 tonnes of paddy have been damaged by rat, which is estimated to be worth Tk 4.39 billion. Around 62,764 tonnes of rice with a market price of Tk 2 billion, and 29,660 tonnes of wheat with an estimated market price of Tk 830 million were damaged by the rats in the current fiscal year. The damaged crops amount to 1 percent of the total crops produced in a year. (**Begum Matia Chowdhury MP,** Honourable Agriculture Minister, addressed in the Parliament on June 22, 2015)

Owls (pecha) are nocturnal birds of prey. The barn owl (*Tyto alba,* family Tytonidae, order Strigiformes) is the most widely distributed species of owl. It is found almost everywhere in Bangladesh and considered as the bio-control agents of rats. Rice and wheat field rats have a large territory. A rat may move up to 200 meters in one night. In contrast, barn owls serve important function in the natural ecosystem over a large area for rat control. Natural rat control using barn owls can reduce the use of rodenticides and their indiscriminate use that can be retained as negative effects on the environment. Young barn owls have a particularly high metabolism, and can eat one-and-a-half to two times of their body weight every day. It is reported that a single barn owl family of two adults and six young can consume more than 1,000 rats over a typical three month nesting period. The barn owl program in rice field area has successfully reduced crop loss from as much as 12% to less than 2% within a year of its implementation (Hafidzi *et. al*., 1999). The absence of such predator in an ecosystem has resulted in destructive increases in prey populations.

Utilization of natural predators like barn owl is an environment friendly solution to pest control (Singleton 1994; Johnson *et. al.*, 1996). In May 2012, it was revealed that farmers in Israel and Jordan had, over a period of ten years, replaced rodenticides by barn owls in a joint conservation

venture called "Project Barn Owl" (Santorelli, 2012). The Malaysian Department of Agriculture has successfully implemented a program to control rats using barn owls in paddy fields throughout Peninsula Malaysia (Hafidzi *et. al.*, 1999). Therefore, barn owl has been found to be a very effective biological agent for controlling rats. Its use not only increases farmers' income by reducing crop losses, but also saves the cost of rodenticides as well as the fields from chemical pollution.

7. **Sub-project general objective (s)**: Sustainable rat management through owl conservation.

8. **Sub-project specific objectives** (BRRI and BARI component)

   8.1 To study the bio-ecology of available owl species and their mass rearing techniques.

   8.2 To develop and validate the effective rat management technique(s) using owl in rice and wheat ecosystem.

   8.3 To upscale the developed techniques and buildup public awareness on owl conservation for sustainable rat management.

9. **Implementing location (s):** Gazipur (BRRI and BARI), Rajshahi & Cumilla

10. **Methodology in brief (with appropriate pictures)**

Entomology Division of BRRI and Vertebrate Pest Division (VPD) of BARI executed the research activities. BRRI component executed the research activities in rice based ecosystem and BARI component conducted research in wheat and vegetables based ecosystem in Gazipur, Cumilla and Rajshahi sites. Owl collection, identification and documentation, its bio-ecology and breeding capacity, food preference, home range, behavior, placement of owl watching tower and nest boxes, rat damage assessment in owl prevailing / sub-project sites etc. were the new thrusts in Bangladesh. These issues were addressed carefully. In addition, PIs and Co-PIs were also involved in other activities to their respective organizations. Though, both of the components executed more or less same activities in different locations to achieve the same objectives of the proposed sub-project but it was challenging as both of the owl and rats were wild, nocturnal and active at night period.

However, owls were conserved in nature by developing and disseminating eco-friendly technologies among the target farmers.

BRRI Component: Pest management program area (PMPA) has taken initiative to work on this issue approved by BRRI. Entomology Division of BRRI hadn't rat breeding and owl rearing facility, but gathered some experience to manage rice field rats using a small numbers of owls by placing nest boxes and perching towers in BRRI farm, Gazipur.

Two lab technicians were recruited as per sub-project rules in BRRI part for implementing the sub-project activities smoothly in the selected sites namely BRRI HQ, Gazipur and BRRI R/S (Regional Station), Cumilla and BRRI R/S, Rajshahi (rice-wheat ecosystem).

BARI Component: Vertebrate Pest Division of BARI had long experience of rodent management. But it had very limited facilities for bird rearing. So, existing facilities of BARI were modernized to rear owl for controlling rat. Two lab technicians were recruited as per sub-project rules in BARI part to appoint in VPD, BARI, Gazipur and BRRI R/S, Rajshahi. PI and Co-PIs of BARI were responsible for sub-project staff training, mass rearing of rat, owl breeding, owl home range, behavior study and rat damage assessment as well as managing rats in wheat and vegetables ecosystem (using barn owl).

The Co-PI's from BRRI and BARI with sub-project staffs arranged meeting and gave beneficiaries' necessary suggestions and directions in selecting rice and wheat fields close to the BRRI R/S (for proper investigation) namely Gazipur, Cumilla and Rajshahi. They visited the sub-project sites physically for household survey, beneficiaries' selection, target groups formation, establishment of owl nest boxes and watching/perching/hunting towers for rat management in rice and wheat ecosystem. One inception workshop was organized involving beneficiary farmers, SAAOs, local managements, scientists, and specially the end users of the selected technologies.

BRRI Component

i. Study the bio-ecology of available owl species and their mass rearing techniques

a) **Survey, collection, identification and documentation of available owl species in Bangladesh**:

Survey: A survey work was conducted during July 2018-December, 2019 in Gazipur, Rajshahi and Jashore districts. The study used an interview-administered questionnaire. The questionnaire included both open-ended and fixed response questions. The questionnaire was designed to evaluate the knowledge and perceptions of local people about Owl. Education and demographic information, including gender and age, were obtained from each respondent. Interviews were conducted in residents' homes, gardens, places of business, or in village streets. Interviewers recorded all responses directly onto standardized survey forms. All interviews were conducted by a research assistant who had successfully completed at least twelve years of higher secondary education recruited from the local community, through oral interviews carried out during the day in the local language. The total response time was approximately 15 - 25 min. The research assistant administering the survey made initial contact in each village with the local village leaders to seek permission. Data were grouped and summed by response category. The responses were recorded on a data sheet and later transcribed into English and entered into a Microsoft Excel 2010 database. Where multiple responses were possible on an open-response question, data are presented as the percentage (%) of respondents giving each response, and may sum to over 100%.

Collection: BRRI collected three owls from sub-project sites or other available sources. For this, Owl trapping device was developed in BRRI with the help of FMPHT Division where live rat was offered to owl for capturing. When owl came and entered into the cage to catch rat then owl trapped as lived in the device (Fig. 01). One sample was collected from Roumari, Kurigram and two was collected from sub-project sites' and brought to the owl aviary to identify at species level with the reference sources or with an aviary taxonomist / ornithologist for proper documentation.

Owl trap (Front view)

Owl trap (Top view)

Fig. 1: Owl trapping device

Owl Species Composition and Census: The study was also to prepare a list of owl species that usually found in those areas of Gazipur, Rajshahi, Barishal and other places for their proper documentation. It was carried out during June 2018 to July 2020; once in a month. Owls were counted by line transect, point counting and "look and see methods" by using cameras and were identified with the help of taxonomic book. Other owl species documentations were recorded by the help of some facebook group such as Birds Bangladesh, Birds and Wildlife of Bangladesh etc. Line transect is a tape or string laid along the ground in a straight line between two poles as a guide to a sampling method used to measure the distribution of organisms. The essential feature of line transects is that one walks along a straight path and records the individuals seen and their perpendicular distance from the transect line. The simplest method of counting birds is called a "point count", in which a trained observer records all the birds seen and heard from a point count station for a set period of time. A series of point counts completed over a fixed route can then be compared to the results of the same point counts in other seasons or years. Observations were made by standing and sitting from a hiding place and recorded along with their abundance. Surveys were conducted in the morning hours (6.30 a.m. to 9.30 a.m.) and evening hours (3.30 p.m. to 7.30 p.m.) by a single observer. Samplings were made in seasonal basis for the period of three years (2018 to 2020) using same transect and time. Bird surveys were not performed during heavy rains, fog and during strong winds, since these conditions reduce bird activity and detectability (Sutherland, 2004). No specimens were collected but most of species was taken photographed for reference.

The data collected during the whole study period was analyzed in IBM SPSS 26 statistical software. Analysis of variance (ANOVA) was used to test the hypotheses, and Tukey's HSD post hoc analysis was carried to identify specific variables that differ significantly. Species diversity and richness were calculated by using the following formulae.

Shannon-Wiener Index (H') $H' = -\sum\left[\left(\frac{ni}{N}\right) \text{x} \ln\left(\frac{ni}{N}\right)\right]$

Where,

ni= number of individuals of each species (the *ith* species) and

N = total number of individuals for the site, and

ln = the natural log of the number.

Simpson's Index, $\lambda = \frac{\sum ni(ni-1)}{N(N-1)}$

Where,

n_i= number of individuals or amount of each species (i.e., the number of individuals of the *ith* species) and

N = total number of individuals for the site.

Simpson's

Diversity Index, D = 1- λ

The value of D ranges between 0 and 1. With this index, 1 represents infinite diversity and 0, no diversity

b) Study on the food preference of owl species and the forms of their pellets

Owls feed on what they can digest. The food habit of owl was conducted at BRRI and BARI Head quarter central farm, Gazipur and Shampur, Rajshahi during the period from January 2019 to October 2020. The geographical location of Gazipur sadar, Gazipur; and Shampur, Rajshahi is in between Latitude: 24.37175 N 24°22'18.28952'' to Longitude: 88.66124 E 88°39'40.45795". The regurgitated pellets of barn owl and spotted owlet were collected from two sites. Thus flesh, bone, hair, feathers of vertebrates, and chitinous exoskeletons of arthropods are feed on and regurgitated in the form of oval-shaped pellets.

To know the forms of their pellets; different age categories of rice field rats i.e. juveniles, sub adults and adults were collected from the field and were kept in confine situation and reared for 7-10 days to check the presence of any chronic rodenticide inside its body (Fig. 02). The safe and selected rats were weighted and released into the feeding box to a single captured owl in an aviary separately. The daily prey uptake as well as the number, shape and color of regurgitated pellets by different age category of owls were recorded (Fig. 03: Owl pellet). Food preference of owl species did not conduct due to lack of owl aviary in BRRI.

Fig. 2. Collected field rat reared in confined condition to protect owl from rodenticides.

Pellet analysis

Pellets were collected from BARI research field, Gazipur and Rajshahi. Total 40 pellets of barn owl, *Tyto alba* and 25 pellets of spotted owlet, *Athene brama* were collected form Gazipur and 20 pellets of barn owl and 15 pellets of spotted owlet were collected from the roosting site of Rajshahi district. Regurgitated pellets found at all the sites were collected in polythene bags and brought to the

laboratory. In the laboratory, pellets were kept at 60^0C in a hot air oven for 24hr to kill the associated insects and any other infectious agent. These pellets were then used for analysis. All the pellets were first weighed on electronic balance and then their morphometric measurements, i.e., length (mm), breadth (mm) and thickness (mm) were recorded. Collected pellets were air dried and processed for analysis. To record the diet composition of the Spotted Owlet and Barn owl, each pellet was first soaked in 8% sodium hydroxide solution for about two hours as described by Neela Narayanan *et al.* (1998) and Mittal (1997). This solution assisted in easy separation of the osseous remains (skulls and other bones) and chitinous contents (undigested insect remains) from other contents like hair, debris etc. The contents were then sieved to separate all the prey remains from the dust and soil particles. To completely separate the prey remains from these unwanted components, a number of washings were given. Then the prey remains were put on filter paper and dried in an oven for 24hr at 60^0C. After complete drying, the skulls, bones, feathers, beaks and insect remains were separated out for identification of prey items (Shehab, 2005; Malhotra and Singla, 2018).

The length and breadth of the pellets were measured by using a Vernier scale and the pellets were weighed using an electronic balance. At the time of analysis, each pellet was put in warm water for softening. The pellet material was disentangled carefully with tweezers. Using a magnifying glass or a binocular microscope the prey items (viz. hairs, feathers, skulls, beaks, and claws) were identified. Fragments of exoskeletons of insects were also separated. The biomass was calculated by multiplying the number of prey items found in pellets by the mean body mass and expressed as a percentage of total biomass consumed (Nadeem *et al.*, 2012). Descriptive statistics (mean and SE) were used to illustrate different diet and size of pellets. To assess and compare the diversity in the diet of two owl species by using Margalef species richness (d), Shannon's-Weiner Diversity index (H), Peilou's evenness (E) indices and Simson dominance index (C) (Magurran, 1988; Ferdous *et al*., 2015; Ulfah *et al*., 2019).

Margalef species richness (d)

$$d = \frac{(S-1)}{\mathrm{Log}(N)}$$

Where,

S = Total species, N = Total individuals

Higher the index greater the richness

Diversity Index: Diversity index (H') states the circumstances of the organism's population mathematically to analyze the number of individuals in each growth step or genus in a habitat community. The most commonly used diversity index is the Shannon-Weiner index (Odum, 1971)

$$H = -\sum(Pi \times InPi)$$

Where, H = Shannon-Weiner index, $Pi = \frac{ni}{N}$

ni = Number of individuals of a species, N =Total individuals of all species

The diversity index criteria are as follows:

$H \leq 1$ = Low diversity

$1 < H \leq 3$ = Moderate diversity

$H \geq 3$ = high diversity

***Evenness Index**:* The evenness index (E) describes the number of individuals between species in a fish community. The more evenly distributed individuals between species, the more balanced the ecosystem will be. The formula used is (Odum, 1971):

$$J = \frac{H}{Hmax}$$

Where, E = Evenness index, H = Diversity index, H_{max} = ln S, S = Number of species found The evenness index value ranges from 0-1. Furthermore, the evenness index based on Kreb, 1989 is categorized as follows:

$0 < E \leq 0.5$ = Depressed community
$0.5 < E \leq 0.75$ = Unstable community
$0.75 < E \leq 1.0$ = Stable community

The smaller the evenness index, the population uniformity smaller as well. It shows the distribution of the number of individuals of each species is not similar. so there is a tendency for one species to dominate. The greater the uniformity value describes the number of biota in each species the same or not much different.

Simpson dominance Index: An uniformity index and small diversity indicates a high dominance of a species against other species. The dominance index formula as follows (Odum, 1971):

$$C = \sum_{i=1}^{s} \left(\frac{ni}{N}\right)^2$$

Where,

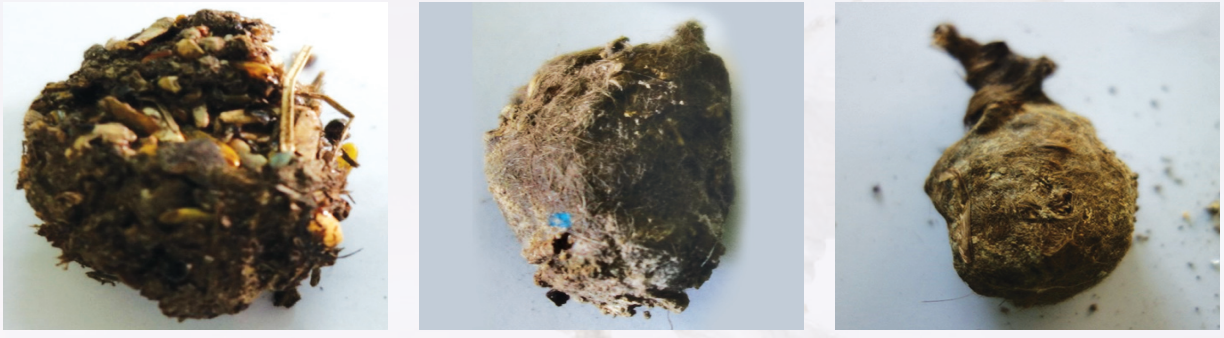
C= Dominance Index,
ni = number of individuals in the 'each' species,
N = total number of individuals,
S = total number of species,

Index values range from 0 - 1 by the following categories:

$0 < C < 0.5$ = Low Dominance.
$0.5 < C \leq 0.75$ = Moderate Dominance.
$0.75 < C \leq 1.0$ = High Dominance.

Rearing rat in VPD lab rat enclosure, Gazipur

Rat burrows and damage in the field



Barn owl regurgitated pellets

Spotted owlet regurgitated pellets

Fig. 3: Rat in encloser, rat infestation in field and regurgitate pellets from Barn owl and Spotted owlet

c) **Establishment of owl aviary and rat breeding ground at BRRI, Gazipur**.
Activities:
   a. Breeding ground for mass rearing of rat to feed owl.
   b. Development of suitable aviary for owl rearing and breeding

These two activities were not executed by BRRI, because of failure of OTM tender. The reasons are stated below-

First time: Tender uploaded to e-GP on July/2020 but cancelled due to wrong posting of budget source (as revenue).

Second time: Tender uploaded in e-GP but cancelled due to the argue of NATP2 procurement section. The argue was "the procurement entity should be the sub-project PI, not Md. Zahid Hasan, Executive Engineer, BRRI".

Third time: Problems solved with the discussion of three procuring authorities (BRRI, BARC and Consultant of NATP2), but BRRI procurement section didn't upload the e-GP tender due to "the short period of time" of the sub-project (PID: 087).

ii. Development and validation of effective rat management technique in rice, wheat and vegetables ecosystem

Activities:

a) **Placement of owl watching tower and nest boxes:** BRRI component executed the research activities in rice based ecosystem, whereas BARI component conducted research in wheat and vegetables based ecosystem in Gazipur, Comilla and Rajshahi sites. Multistage cluster sampling

method was followed for this experiment to develop and validate the effective rat management technique(s) using owl in rice and wheat ecosystem. BRRI component has executed the research activities in rice based ecosystem, and BARI component conducted this experiment in rice-wheat and vegetables ecosystem. A total of 109 watching tower and 24 nest boxes were established in selected areas. Out of 44 watching tower (WT), 24 towers were placed in some selected plots at BRRI HQ and remaining twenty in BRRI RS, Cumilla for preliminary study. Each nest box was set beyond the owl home range of adjacent selected one and considered as a replication. Nylon net was used beneath the WT to collect the owl regurgitate pellets (Fig. 04: Nylon net). In addition, five different types of owl nest boxes have evaluated to find out the suitable box(s) for owl nesting (Fig. 04).

Owl watching tower with cone shaped nylon net

Owl nest box set in Rajshahi

Triangular shaped owl nest box

Fig. 04: Watching tower with cone shaped nylon net and Triangular nest box

b) Development and validation of ecofriendly rat management technique

Eco-friendly rat capture devices were prepared using different house hold materials like bucket, white bucket, small PVC pipes, pepsi-cans, cycle spokes, wires, infant baby milk can and single capture live trap, found in local market (Fig. 05). Collected devices were prepared in such way to be used as trap for capturing rat in live. Different types of baits were used in the trap to attract rat in the devices. These devices were placed in the rice field along with the bunds for 7 to 10 consecutive nights in the same place. The fresh water was used the bucket in such a height, so that the trapped rat did not jump from the bucket. It can swim only in water. The number of rat trapped was recorded in the next morning and removed from the bucket and finally, buried in soil at a safe place. In addition, bamboo made devices were tried to convert to trap rat in live.

Fig. 5: Ecofriendly rat capturing devices

c) Assessment of rat damage surrounding the watching tower, nest box and in control areas:

Rat damage assessment were conducted at the surrounding area of watching tower and nest boxes. The study on rat damage around the watch tower was conducted at three places of Bangladesh- Namely Gazipur, Cumilla and in Rajshahi district. In Gazipur, BRRI and BARI experimental field and residential areas ($23^0$98 N', $90^0$40' E) were used for the study and In Cumilla and Rajshahi Regional station; Wheat Research Centre, Shampur (24.37 N, 88.66E) and Fruit Research Center, Binodpur, Rajshahi ($24^0$36' N, $88^0$65'E) areas were used for these study. Sixty-five owl watching tower and twenty nest box were installed in those locations. Watching tower are 3m to 4.6m long pole prepared by bamboo with cross (X) shaped top for seating owl on it and perching and searching rat in crop field. Nest box (87 cm x 89.5 cm x 90.5 cm) is a triangular shaped box nesting and breeding for owl safely. Nest box were installed in different tree and building above 4.6m apart from the ground level. One nest box was set for every four hectare of crop field.

Rice, wheat, barley, potato, sweet potato and groundnut crops damaged by rat were assessed around the watch tower areas. Rat damage assessment around the owl watching tower was done by two ways. One- number of active burrows count methods and another- crop damage assessment method. Active burrow count and crop damage was done three 0-25, 26-50 and 51-75 meters apart around the owl watching tower. Data were recorded in three crop stage i.e., booting, grain filling and mature stages of the rice crop.

Rat damage estimation by cut and uncut method

Rice, wheat and barley damage was estimated by this method (Fig. 06). The experiment was laid out following RCB design with 10 replications. Ten plots were randomly selected. In each plot ten samples were taken. The data from these ten samples were used for calculation the damage in each plot as a percentage. Very large, or very small plots were not selected for sampling data. Ten samples along one of the diagonals were selected in each plot. The distance between samples (between 3 to 5 steps) depends on the length of the diagonal. A sample closer than 3 meters (3 large steps) from any edge of the plot was not chosen. Each sample consists of 50 cm square frame in which all tillers, cut and uncut tillers were counted. These figures were put on a record sheet. The sampling frame is placed without looking, so that taking data would be real. After recording data from one plot, next plots were selected randomly and repeated up to ten samples.

Per cent rice, wheat and barley damage was calculated with following formula:

$$\text{Percent rate damage} = \frac{\text{Number of cut tillers}}{\text{Total number of tillers}} \times 100$$

Data were taken every 15 days' interval up to harvesting of the crop.

Groundnut: Rodent damage of groundnut in the form of per cent pods damaged was recorded at 0-25 m, 26-50 m and 50-75 m distance from the watch tower areas. At each watch tower distance area 2 x 2 m quadrats were placed. Five plants were uprooted from each quadrat randomly to count the total number of pods and the pods damaged by rodents (those with signs of rodent gnawing) per plant. Average number of pods damaged per plant and average density of plants/$4m^2$ were determined for each field. Percent pods damaged were calculated using the formula given below:

$$\text{Percent pod damage} = \frac{\text{Damaged pod}}{\text{Total pods}} \times 100$$

Potato and sweet [potato and sweet potato damaged by rat in the form of percent tuber damaged was also recorded at 0-25 m, 26-50 m and 50-75 m distance from the watch tower areas. Sampling of potato and sweet potato damaged was recorded as same as the groundnut. Percent tuber damaged of potato or sweet potato were calculated using the following formula

$$\text{Percent tuber damage} = \frac{\text{Damaged tuber}}{\text{Total tuber}} \times 100$$

Collected data were analyzed by one-way analysis of variance by SPSS software and means were compared by least significant differences (LSD). Graphical data were presented by Sigma plot.

Rat damage in rice at maximum tillering stage

Rat damage in irrigated rice field

Rat damaged at rice field in Gazipur

Rat damaged in sweet potato field in Gazipur

Watch tower set at the wheat field in Rajshahi

Watch tower set at wheat field in Rajshahi

Watch tower set in Gazipur around wheat field

Watch tower set at wheat field in Gazipur

Watch tower set at barley field in Gazipur

Watch tower set at potato field in Gazipur

Watch tower set at vegetables field in Gazipur

Owl Nest box set in Gazipur

Fig. 06: Rat damaged field with watch tower and nest boxes.

Fig. 07: Pictorial view of training activities

11. Results and discussion

Study the bio-ecology of available owl species and their mass rearing techniques

Activity 1: Survey, collection, identification and documentation of available owl species in Bangladesh

Survey work: It was conducted in three districts viz. Rajshahi, Gazipur and Jashore to know the general concept of farmers on owl and to know the bio-ecology of available owl species. First, the sub-project scientist asked farmer about the main crop they were cultivated in their field. Majority (84.44%) of farmers reported that rice was their main crop whereas 15.55% farmer reported on wheat and only 11.11% farmers expressed that they cultivated vegetables and other crops as their main crop (Table 1).

Almost all farmers were medium to poor farmers. There were some landless farmers cultivated vegetables and other crops as main crop in their homestead areas. They were asked about intensity of rat damage in their crop field. About 51% farmers reported that their crop field was moderately damaged by rat whereas 34.44% farmers reported in highly damaged and only 14.44% famers reported that the intensity at rat damage in their crop field was very high (Table 2).

Scientists of Vertebrate Pest Division tried to get some idea about farmer's practices for controlling rodents in their crop field. Most of the farmers (83.33%) were used poison baiting whereas 24.44% farmers were attempted to control rat by setting trap in their crop field. A few of farmers (3.33%) did not use either trap or poison (Table 3). They used only some indigenous techniques for controlling rodents in their crop fields. Farmers were asked either they had seen owl or not? Almost all farmers (97.77%) were familiar with owl whereas only 2.22% farmers had not seen owl in their life (Table 4).

Scientists of Vertebrate Pest Division asked them about the number of owl species had they seen in their locality. Most of the farmers (77.22 %) replied that they had seen only one species whereas 23.33% farmers reported on two species, 3.33% farmers reported on three species and only 1.11% farmers had seen more than three species in their locality (Table 5). Farmers were asked about the name of owl species. They did not know the species name. They mentioned only the local name of available owl species. Half of the farmers (50%) mentioned available owl species as Vutum pecha, Brown Fish Owl whereas 43.33% farmers mentioned it as Hutum pecha, Rock Eagle Owl and only 32.22% farmers mentioned it as Laxmi Pecha i.e. Barn owl (Table 6).

Once upon a time owl was a dangerous bird thus it was considered as evil omen. But now, the time has been changed. Most of the farmers (71.11%) responded that they liked owl as bird but 28.89% farmers did not like owl (Table 7). Majority of the farmers (87.77%) thought that owl had no harmful effect on human and the environment, only 14.44% thought owl is not good for them. About 15% farmers reported that it has evil effect on human being (Table 8).

Farmers were asked about the scary effect of owl. Most of the farmers (81.11%) thought that owl had no scary effect on human being as well as the environment. Only 18.89% farmer mentioned that it is a dangerous bird (Table 9). Scientist of Vertebrate Pest Division asked them either they were known about the food habit of owl or not. Majority of them (93.33%) were known about the food habit of owl. Out of them, cent per cent opined that rat is the main food of owl whereas 22.22% farmers thought insect is main food and only 7.77% farmers told shrew is the main food of owl (Table 10).

Farmers were asked about the beneficial effect of owl. About 85% farmers replied that owl has a beneficial effect on the nature. Only 14.44% farmers thought it has not effect on nature (Table 11). Majority of the farmers (85.55%) treated owl as a rat feeder whereas 11.11% farmers considered it as environmental protector (Table 11).

Sub-project scientists asked farmers, "owl is necessary to conserve"? About 61% farmers opined not necessary to conserve whereas 38.89% farmers thought owl should be conserved in nature. Farmers opinion on owl conservation options were recorded. Majority of the farmers (76.66%) mentioned that public awareness can be an important tool for owl conservation whereas 15.55% farmers opined on creating un-disturbing habitat and only 7.77% farmers reported on tree plantation (Table 12).

Our observations demonstrated that the ethno-biological approach in schools favors respect toward cultural and symbolic differences, which results in better comprehension about the natural world as well as conservation of local bio-cultural heritage. So, we consider that this information is fundamental for the construction of intercultural plans of education and cons ervation of wild predatory birds in these three districts.

Asian owls face many challenging conservation issues including habitat destruction from forest fragmentation, and a forestry technique called clear cutting, as well as ingestion of pesticides. The problem is compounded by an insufficient knowledge of owl populations to allow assessment of the impact of such issues on them.

Table 1. Farmers response on main crop that they cultivated in the study area in 2018-19.

District	Farmers response on			
	Rice	Wheat	Vegetables	Other
Rajshahi (n=30)	23 (76.67%)	10 (33.33%)	7 (23.33%)	
Gazipur (n=30)	30 (100%)	0 (0.00%)	0 (0.00%)	
Jashore (n=30)	23 (76.67%)	4 (13.33%)	3 (10.00%)	
Average (n=30)	25.33 (84.44%)	4.67 (15.55%)	3.33 (11.11%)	

Table 2. Farmers response on damage intensity on rice & wheat by rat in the study area

District	Farmers response on		
	Very high	High	Medium
Rajshahi (n=30)	3 (10,00%)	12 (40.00%)	15 (50.00%)
Gazipur (n=30)	0 (0.00%)	0 (0.00%)	30 (100%)
Jashore (n=30)	10 (33.33%)	19 (63.33%)	1 (3.33%)
Average (n=30)	4.33 (14.44%)	10.33 (34,44%)	15.33 (51.11%)

Table 3. Farmers response on rat management techniques that they generally use for controlling rodents in their crop field.

District	Farmers response on		
	Setting traps	Poisons baiting	Others
Rajshahi (n=30)	16 (53.33%)	24 (80.00%)	0 (0.00%)
Gazipur (n=30)	0 (0.00%)	30 (100.00%)	0 (0.00%)
Jashore (n=30)	6 (20.00%)	21 (70.00%)	3 (10.00%)
Average (n=30)	7.33 (24.44%)	25 (83.33%)	1 (3.33%)

Table 4. Farmers response on the status of Owl as familiar bird in the study areas.

District	Farmers response on	
	Seen	Unseen
Rajshahi (n=30)	28 (93.33%)	2 (6.67%)
Gazipur (n=30)	30 (100.00%)	0 (0.00%)
Jashore (n=30)	30 (100.00%)	0 (0.00%)
Average (n=90)	29.33 (97.77%)	0.66 (2.22%)

Table 5. Farmers response on number of owl species had they known in the study areas.

District	Farmers response on			
	One	Two	Three	Four
Rajshahi (n=30)	15 (50.00%)	15 (90.00%)	0 (0.00%)	0 (0.00%)
Gazipur (n=30)	30 (100%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Jashore (n=30)	20 (66.67%)	6 (20.00%)	3 (10.00%)	1 (3.33%)
Average (n=90)	21.66 (72.22%)	7 (36.66%)	1 (3.33%)	0.33 1.11%)

Table 6. Farmers response on the name of owl species had they seen in the study areas.

District	Farmers response on species			
	Burn owl	Hutum pencha	Vutum pencha	Others
Rajshahi (n=30)	16 (53.33%)	23 (76.67%)	6 (20.00%)	0 (0.00%)
Gazipur (n=30)	0 (0.00%)	0 (0.00%)	30 (100.00%)	0 (0.00%)
Jashore (n=30)	13 (43.33)	16 (53.33%)	9 (30.00%)	0 (0.00%)
Average (n=90)	9.66 (32.22%)	13 (43.33%)	15 (50%)	0 (0%)

Table 7. Farmers response on their choice of Owl as a bird in the study areas.

District	Farmers response on	
	Yes	No
Rajshahi (n=30)	27 (90.00)	3 (10.00%)
Gazipur (n=30)	28 (93.33%)	2 (6.67%)
Jashore (n=30)	9 (30.00)	21 (70%)
Average (n=90)	21.33 (71.11%)	8.66 (28.89%)

Table 8. Farmers response on harmful effect of owl in the study areas.

District	Farmers response on species			
	Yes	No	Evil omen	Others
Rajshahi (n=30)	3 (10.00%)	27 (90.00%)	3 (10.00%)	0 (0.00%)
Gazipur (n=30)	0 (0.00%)	30 (100.00%)	0 (0.00%)	0 (0.00%)
Jashore (n=30)	10 (33.33%)	22 (73.33%)	11 (36.67%)	21 (70.00%)
Average (n=90)	4.33 14.44%)	26.33 (87.77%)	4.66 (15.56%)	7 (23.33%)

Table 9. Farmers response on scary effect of owl in the study areas.

District	Farmers response on	
	Dangerous	No
Rajshahi (n=30)	6 (20.00)	24 (80.00%)
Gazipur (n=30)	0 (0.00%)	30 (100.00%)
Jashore (n=30)	11 (36.67%)	19 (63.33%)
Average (n=90)	5.66 (18.89%)	24.33 (81.11%)

Table 10. Farmers response on owl's food habit in the study areas.

District	Farmers response on food habit					
	Known	Unknown	Food			
			Rat	Shrew	Insect	Others
Rajshahi (n=30)	30 (100%)	0 (0.00%)	30 (100%)	1 (3.33%)	9 (30.00%)	0 (0.00%)
Gazipur (n=30)	30 (100%)	0 (0.00%)	30 (100%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Jashore (n=30)	24 (80%)	6 (20%)	30 (100%)	6 (20%)	11 (36.67%)	0 (0.00%)
Average (n=90)	28 (93.33%)	2. (6.66%)	30 (100%)	2.33 (7.77%)	6.66 (22.22%)	0 (0%)

Table 11. Farmers response on usefulness of owl in the study areas.

District	Farmers response on				
	Usefulness		Helpful as		
	Yes	No	Environmental Protector	Rat feeder	Others
Rajshahi (n=30)	28 (93.33)	2 (6.67%)	6 (20.00%)	24 (80.00%)	0 (0.00%)
Gazipur (n=30)	30 (100%)	0 (0.00%)	0 (0.00%)	30 (100.00%)	0 (0.00%)
Jashore (n=30)	19 (63.33%)	11 (36.67)	4 (13.33%)	23 (76.67)	3 (10.00%)
Average (n=90)	25.66 (85.55%)	4.33 (14.44%)	3.33 (11.11%)	25.66 (85.55%)	1 (3.33%)

Table 12. Farmers response on owl conservation in the study areas.

District	Farmers response on					
	Need to conserve		Owl conservation options			
	Yes	No	Tree plantation	Not disturbing	Public awrenes	Others
Rajshahi (n=30)	30 (100%)	0	7 (23.33)	8 (26.67)	15 (50.00)	0 (0.00%)
Gazipur (n=30)	0 (0.00%)	30	0 (0.00%)	0 (0.00%)	30 (100%)	0 (0.00%)
Jashore (n=21)	5 (16.67)	25 (83.33%)	0 (0.00%)	6 (20.00%)	24 (80.00%)	0 (0.00%)
Average (n=90)	11.66 (38.89%)	18.33 (61.11%)	2.33 (7.77%)	4.66 (15.55%)	23 (76.66%)	0 (0%)

Abundance, identification and documentation of owl species

According to Banglapedia 15 species of owl have been recorded in Bangladesh of them one species was Tytonidae and fourteen species were Strigidae family. The total number of bird species, mean number of species/transects, and their density recorded in various zones are shown in Fig.8 and Fig. 9. Two species of owls were detected in three locations (Fig. 8). The most abundant species of owls were Spotted owlets (mean 2.6 birds/point count and total species 13.33\location) followed by barn owl in Gazipur whereas barn owl species was recorded higher in Rajshahi (means 1.6/point count and total species) compared to spotted owlet (Fig. 8 and Fig. 9). In Barishal more or less equal number of owl species (barn owl and spotted owlet) were recorded.

Distribution of two owl species in three regions, Gazipur region had recorded the highest number of Spotted owlet followed by Rajshahi and Barishal region (Fig. 10 and 11). In case of Barn owl distribution Rajshahi had the highest number compared with other two regions and followed by Barishal and Gazipur had the lowest number of barn owl species (Fig. 10 and 11). Among different zones, Spotted owlet was the most abundant in Gazipur and Barn owl for Rajshahi zone.

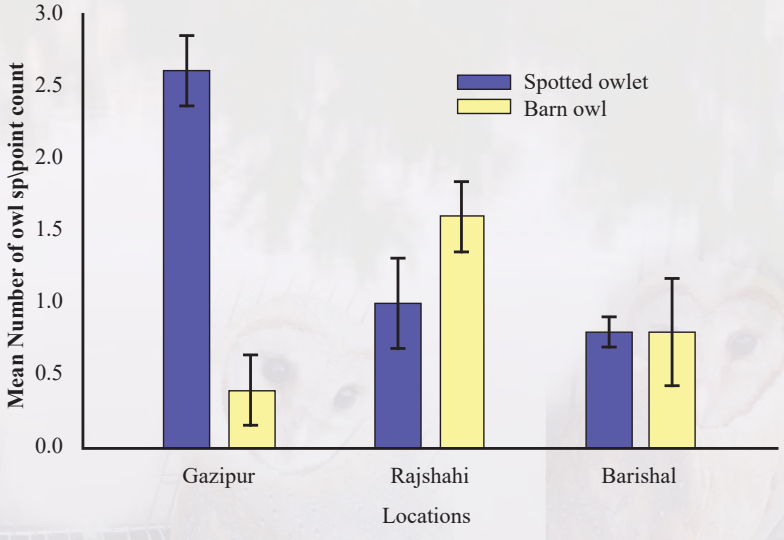


Fig 8: Mean number of owl species/count in three districts of the study areas

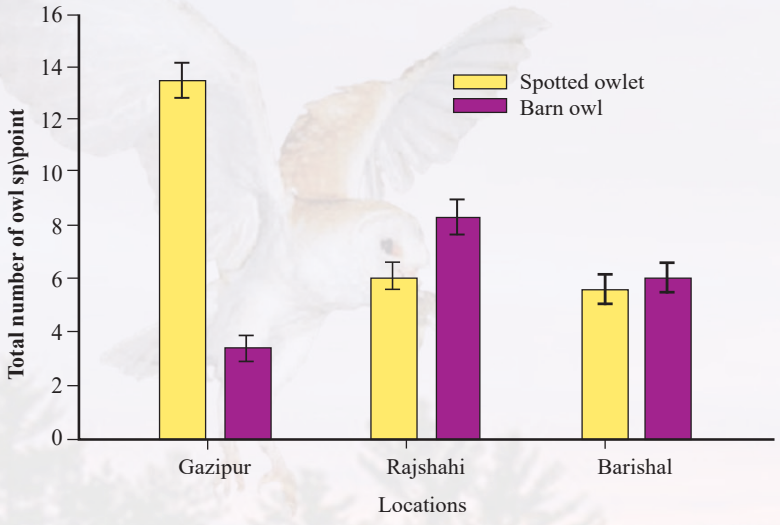


Fig 9: Total number of owl species recorded in three districts of the study areas

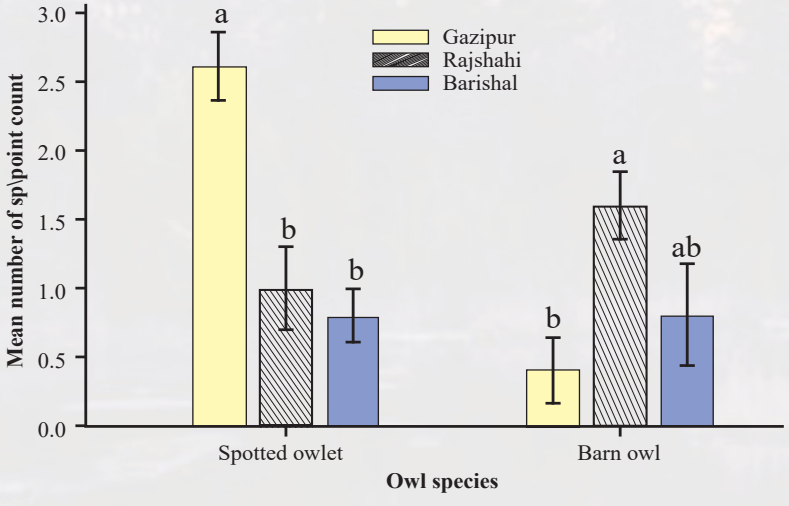


Fig. 10: Abundance of owl species (Mean number/point count) in three districts of the study areas.

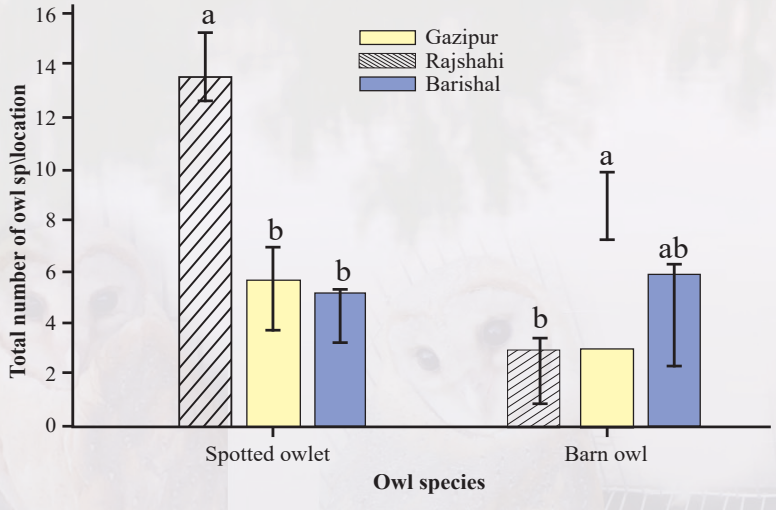


Fig. 11: Abundant of owl species (total species/location) in three location of the study area

Bird species diversity

The species diversity index fluctuated from 0.69 (site- Barishal) to 0.5 (site- BARI Head quarter, Gazipur) (Table 13). The highest diversity was shown at coconut orchard in Barishal followed by mango orchard in Rajshahi, and the lowest diversity had recorded in Gazipur. Apart from the diversity, species evenness has shown variation in the sites with values of 0.53 (site- Coconut orchard, Barishal), 0.523 (site- Mango orchard, Rajshahi), 0.38 (site- Gazipur). The variation in species diversity and species evenness at various sites may be due to the influx of visitors, vehicles and local people in and near the campus and the availability of food to the birds.

Shannon's diversity index indicated that Barishal and Rajshahi habitat had higher species diversity (H = 0.69 and 0.687) than Gazipur habitat (H = 0.548) (Table 13). The overall birds' diversity for Barishal, Rajshahi and Gazipur was (H =0.682). On the other hand, the Simpson's diversity indexes for owl species were 0.533, 0.523 and 0.38 respectively. However, the overall Simpson's diversity index for the three habitats was 0.798. This indicates greater variation in species diversity between the results obtained by using Shannon's and Simpson's diversity indices. This is because Simpson's diversity index takes into consideration relative abundance which is not the case for Shannon's diversity index. The higher diversity in the habitat may be due to high numbers of individuals in some of bird species and diverse vegetation types as microhabitats which favored varieties of bird species. The anthropogenic activities such as parking lots, housing developments and agricultural fields may have changed the diversity in the area which is well reflected by the species composition before human intervention (Sax and Steven, 2003).

Table 13. Species richness and diversity index of owl species in three locations/ study area.

Locations	Shannon-Wiener Diversity Index	Simpson's Diversity Index
Gazipur	0.548	0.38
Rajshahi	0.687	0.523
Barishal	0.69	0.533
Over all	**0.682**	**0.498**

During the study of the sub-project period 14 species of owl have been recorded and documented (Anon., 2007, 2013, 2016). The owl species recorded and documented during the study period have been shown in Table 14.

Barn owl, Spotted owlet, Brown Hawk owl, Brown fish owl, Collard scopes owl etc were the most abundant species in different zone. All other owl species also presented in different but density was comparatively lower than others owl species.

Table 14. Different species of owl documented and recorded in different areas of Bangladesh

Sl. No.	Bengali name	English name	Scientific name	Recorded places in Bangladesh
01	লক্ষী পেঁচা	Barn owl	*Tyto alba*	Rajshahi, Mirpur, Dhaka, Bola, Gazipur, Barishal, Dinajpur,
02	ভুতুম পেঁচা, খয়রা মেছো পেঁচা	Brown fish owl	*Bubo zeylonensis*	Dhaka, Bogura, Nilphamari, Khulna, Meherpur, Faridpur, Shariatpur, Sundarban, Thakurgaon, Lakshmipur, Hobigonj
03	খয়রা শিকরে পেঁচা	Brown hawk owl	*Ninox scutulata*	Cumilla, Narayangonj, Munsigonj, Dhaka, Chattagram, Gazipur, Moulvibazar, Rajshahi, Magura
04	মেটে মেছো পেঁচা	Buffy fish owl	*Ketupa ketupu*	Sundarban, Khulna
05	নিমপোখ, কণ্ঠী নিম পেঁচা	Collared Scops owl	*Otus lettia*	Mymensingh, Brahmanbaria, Satkhira, Hobogonj, Pirojpur, savar, mirpur, Dhaka, Rajshahi, Narayanganj, Jessore, Jhenaidah
06	ভারতীয় নিম পেঁচা	Indian Scops owl	*Otus bakkamoena*	Thakurgaon, Rajshahi, Natore, Pabna
07	ছোট নিম পেঁচা	Oriental Scops owl	*Otus sunia*	Rajshahi, Sylhet
08	এশীয় পেঁচা	Asian barred owlet	*Glaucidium cuculoides*	Rangamati, Hobigonj,
09	দাগিঘাড় কুটি পেঁচা	Collared owlet	Glaucidium brodiei	Bandarban
10	খুড়ুলে পেঁচা	Spotted owlet	*Athene brama*	Gazipur, Barishal, Rajshahi, Thakurgaon, Dhaka, Rangpur, Chandpur, Chattagram, Dinajpur
11	ছোটকান পেঁচা	Short eared owl	*Asio flammeus*	Rajshahi
12	মেটে হুতোম পেঁচা	Dusky eagle-owl	*Bubo coromandus*	Sundarban
13	খয়রা গেছো পেঁচা	Brown wood owl	*Strix leptogrammica*	Diginala, Khagrachari, Lawachara, Moulvibazar
14	চিতি-পেট হুতুম পেঁচা	Spot-bellied eagle-owl -	*Bubo nipalensis*	Khagrachari, Chattagram, Bandarban

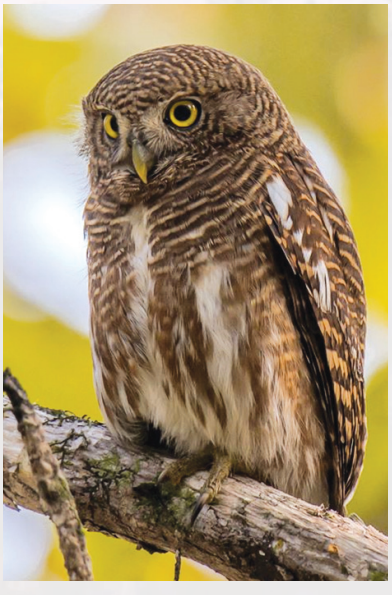
Sources: Anon., 2007, 2013, 2016

Pictorial view of different owl species

Barn owl

Brown fish owl

Brown hawk owl



Asian barred owl

Spotted owlet

Buffy fish owl

Dusky eagle owl

Spotted beiled eagle owl

Short eared owl

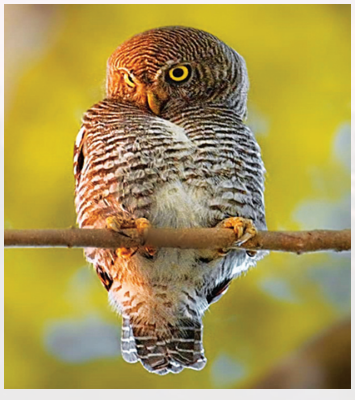
Brown wood owl

Collared owlet

Collard scops owl

Indian scops owl

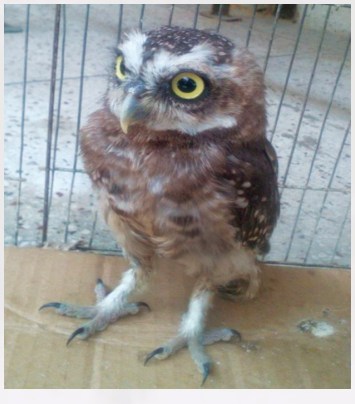
Oriental scops owl



Jungle owlet

Collard scops owl

Barn owl



Spotted owlet

Fig. 12: Pictorial view of different owl species available in Bangladesh.

Description and Biography of a Typical Owl

Description of owl: The facial disc of **owl** is white with a brown edge, and with a brownish wash between the lower edge of the eyes and the base of the whitish-pink bill. Eyes are brownish-black. The crown and upper parts are yellowish-brown to orange-buff, covered partly by a pale ashy-grey veil marked with scattered white spots surrounded by black. The tail is similar, with a few darker bars and with white dots near the tips of the feathers. Under parts are whitish or pure white with a few small, dark drop-shaped spots (often more on females). Legs are feathered white nearly to the base of the mostly bare toes, which are pale greyish-brown and dirty yellowish underneath. Claws are brownish-black.

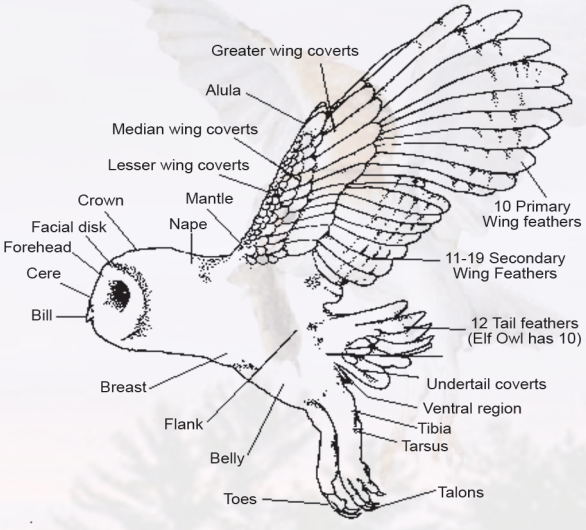


Fig. 13: Morphological features of a typical barn owl

Size: Length 29-44cm. Wing length 235-323mm. Tail length 110-125mm. Weight 250-480g. Females often heavier than males.

Habits: Generally nocturnal, although it is not uncommon to see this species emerge at dusk or be active at dawn, occasionally being seen in flight during full daylight. Flight is noiseless, with wingbeats interrupted by gliding.

Voice: Owl calls infrequently, the usual call being a drawn-out rasping screech. The courtship call of male at nest is a shrill repetitive twittering. Adults returning to a nest may give a low, frog-like croak. When surprised in its roosting hollow or nest, it makes hissing and rasping noises and snapping sounds that are often called bill snapping, but possibly made by clicking the tongue.

Hunting & Food: Owls specialize in hunting small ground mammals, and the vast majority of their food consists of small rodents. Voles (field mice) are an important food item, as well as pocket gophers, shrews, mice and rats. Barn owls breed rapidly in response to mouse plagues. Other prey may include baby rabbits, bats, frogs, lizards, birds and insects. Prey are usually located by quartering up and down likely looking land - particularly open grassland. They also use low perches such as fence posts to seek quarry.

Breeding: Owls breed any time during the year, depending on food supply. In a good year, a pair may breed twice. Rodent plagues increase the number of barn owl dramatically. During courting, males may circle near the nest tree, giving short screeches and chattering calls. The majority of Barn Owls nest in tree hollows up to 20 meters high. They also nest in old buildings, caves and well shafts. three to six eggs are laid (occasionally up to 12) at 2 day intervals. The eggs are 38-46mm x 30-35mm in size, and are incubated within 30 to 34 days. Chicks are covered in white down and brooded for about 2 weeks, and are fledged in 50 to 55 days. After this, they remain in the vicinity for a week or go to learn hunting skills, and then rapidly disperse from the nest area. Young birds are able to breed at about 10 months.

Mortality: Owls are short-lived birds. Many die in their first year of life, with the average life expectancy being 1 to 2 years in the wild. In North America the oldest known barn owl in the wild

lived for 11 years 6 months. In Holland, a wild barn owl lived to be 17 years 10 months old. In England, a captive female barn owl retired from breeding at 25 years old of age.

Habitat: Owl is found in virtually all habitats but much more abundantly in open woodland, heaths and moors than forested country. They usually roost by day in tree hollows but have also been found in caves, wells, out-buildings or thick foliage.

Distribution: Owl is one of the most wide-spread of all land birds. They are found in all continents (except Antarctica) and large islands and occur over the whole of Australia, including Tasmania. They occur throughout most of Britain and Europe and across many parts of Asia, Africa, and in much of North America. In South America they are found in areas of suitable grassland, as well as on oceanic islands such as the Galapagos. They were introduced to Hawaii in 1958.

Classification/ Systematic Position

Phylum	-	Chordata
Subphylum	-	Vertebrates
Class	-	Aves
Order	-	Strigiformes
Family	-	Strigidae (Tail longer)
	-	Tytonidae (Tail shorter <leg)
Genus	-	*Tyto* (consists of 10 species).
Species	-	*Tyto alba* (consists of 35 sub-species). Out of them, 18 sub-species recorded in BD

Bangladesh has 15 species of owls (family Tytonidae: 1 species; family Strigidae: 14 species), of which **3 are endangered**, one is vulnerable; seven could not be evaluated.
Three species of owls were collected (Fig. 14-17) and reared in small aviary at Entomology Division, BRRI, Gazipur for further study at species level.

Identification of collected owl from different locations

Salient Features of Long-eared owl:

- About 350mm tall with a wing span of 950mm (Fig.15).
- Mottled pale and dark brown under parts and upper parts.
- Rounded brown face, orange eyes with dark iris and long ear-tufts (when raised).
- Overall impression in flight of a large brown bird (though surprisingly small when perched).
- Buoyant flight in a back and forth motion but rarely seen.
- Lives in woodland and farmland habitat.
- Has a rarely-heard repeated "**hoo - hoo - hoo"** call uttered only in the breeding season.
- Extremely nocturnal but communal roosts can occasionally be found in thick cover in the winter.

Fig. 14: Owl inside small cage (Dorsal View)

Fig. 15: Long-eared owl from (Front view) Roumari, Kurigram

Salient Features of Barn Owl:

- About 330mm tall with a wing span of 900mm (Fig.16).
- It has big head and yellowish with black stripes
- Beak like a hook.
- White, Eyes wide with a disc-shaped face (Fig. 17)
- Forward facing eyes giving good stereoscopic vision
- Round-shaped wings and short tails.
- Soft fur, white or yellow on the bottom.
- Have sturdy claws (Fig. 18).
- Largely white under parts.
- Golden buff upper parts with grey markings.
- Overall impression in flight of a large white bird.
- Slow, buoyant flight in a back and forth motion.
- Lives mainly in open farmland habitat (not woodland).
- Seen but not often heard, they call rarely.
- Barn Owls don't hoot! They shriek, hiss and snore.
- Often seen at night whilst driving but dawn and dusk sightings are most common.
- Females tend to be darker than the mail.
- Barn Owl pellets are different from other owl pellets.
- They are cosmopolitan and occur on all continents except Antarctica, and are absent from some oceanic islands.

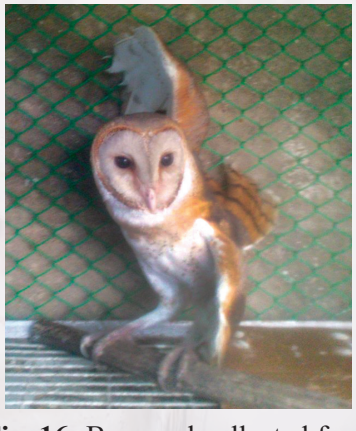


Fig. 16: Barn owl collected from BRRI, Gazipur

Fig. 17: Eyes wide with a disc-shaped face

Fig. 18: Owl with sturdy claws and stereoscopic vision

Salient Features of Asian barred owlet:

- About 350mm tall with a wing span of 900 mm (Fig.19)
- Mottled pale brown under parts with upper breast streaked dark brown.
- Mottled pale and dark brown upperparts.
- Rounded brown face, yellow eyes and short, often indiscernible ear tufts.
- In flight, it is a large brown bird (but under parts can look almost white).
- Lives in farmland, moorland and wetland habitats, including marshes.
- A male's rarely heard song is a low "boo-boo-boo-boo-boo", whilst females give a 'ree-yow' call.
- Both nocturnal and diurnal, they can be seen hunting in daylight in suitable habitat.

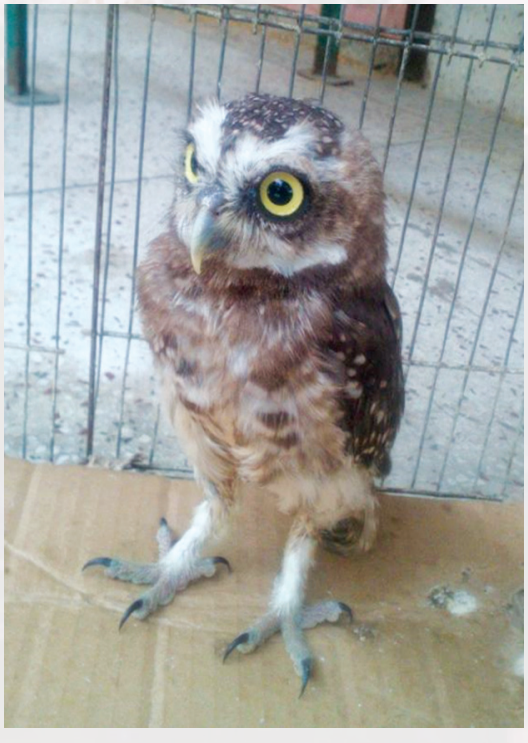


Fig. 19: Asian barred owlet found in kurigram

Fig. 14-19. Three different species of owls reared in confined cage at Entomology Division, BRRI, Gazipur.

Activity 2: Food preference of owl species and the forms of their pellets

About 90 pellets were collected from the reared owl species as well as from owl watching towers. The fresh pellets of barn owl were dark color, oval-shaped, spread bad smell but the collected pellets became graish-brown when air-dried for 3-5 days (Fig. 20). Air dried pellets were easily analyzed by 0.5N NaoH solution, however BARI used warm water for separation. Thus flesh, bone, skulls, hair, feathers of vertebrates, and chitinous exoskeletons of arthropods were separated easily what barn owl feed on. The species of rats or other food materials were identified by studying skulls and bones found in pellets and comparing with the reference materials.

Barn owl from nest box

Picture after 15 days of feeding

Owl regurgitate pellets

Owl watching tower

Pellet with bone

Rat bone from pellet

Management of rice rats using barn owl

Fig. 20: Different size and forms of pellets regurgitated by reared owls at small aviary condition.

In addition to that different types of food eg., small frogs, Flesh of snails, oyesters (mollusca group) were offered to reared owl species as their daily intake (Fig. 21) and different forms of regurgitated pellets were collected and analyzed (Fig. 25 & 30).

Immature stage of Snails

Mature stage of Snails (Flesh was feed to owl)

Fig. 21: Additional food for owl, found on the grasses of lawn (Mollusca Group), BRRI, Gazipur

Pellets morphometric characters

A total of 60 pellets of Barn owl were collected from Gazipur and 25 pellets collected from Rajshahi. The pellets were found to black when collected fresh or dark grey in colour when dry. The old pellets were pale in colour and loosely bound. The size of pellets varied from small to large depending upon the number and size of prey consumed. The average weight of fresh barn owl pellets were 7.64 ± 0.64g and dry 5.73 ± 0.51g with a range of 2 to 17g in Gazipur and the pellets weight have no significant difference between the weight of Gazipur and Rajshahi collected pellets

(Table 15). The morphometric measurement of all the pellets collected revealed average length of 47.41±2.32 mm, 48.5 ±2.51 mm (range 25.0 – 88.0 mm), breath 28.10± 1.83 mm, 32.75 ± 1.62 mm (range 10.0 – 65.0 mm) and thickness 18.28 ± 1.32 mm, 22.30 ±1.54 (range 8.0 - 43.0 mm at both Gazipur and Rajshahi district respectively. The weight the barn owls' pellets of the study area were larger in size. The weight of barn owl pellets recorded the present study are similar to those in other works (Alvarez-Castaneda *et al*., 2004, Nadeem *et al*., 2012).

A total 40 pellets (25 from Gazipur and 15 from Rajshahi) of spotted owlet were collected from two locations. The pellets were dark black to brown in colour. The average length of pellets of spotted owlet were 27.0 ± 1.93 mm, 25.27± 2.11 mm (range 13.0 – 40.0 mm), breath 15.04 ± 1.35 mm, 16.27± 1.47 mm and thickness were 11.6± 0.97 mm, 12.27 ± 1.51 mm at Gazipur and rajshahi location respectively. The average weight of regurgitated pellets was found 4.27± 0.60 g and 3.04 ± 0.34 g (range 1.0 – 5.99 g) at Gazipur and Rajshahi locations, respectively (Table 16). The pellets length, breath, thickness and weight of spotted owlet had no significant differences between two locations. The weight, length and breath of spotted owlet pellets reported in the present study are similar to those reported to other works (Malhorta and Singla, 2018; Ali and Santhanakrishnan 2012; Nadeem *et al*, 2012).

Table 15. Size and shape and weight of pellets of Barn owls and Spotted owlet collected from Gazipur and Rajshahi district.

Owl species	Locations	Length (mm)	Breath (mm)	Thichness (mm)	Weight (g)	
					Wet	Dry
Barn owl	Gazipur	47.41±2.32	28.10± 1.83	18.28± 1.32	7.64 ± 0.64	5.73 ± 0.51
	Rajshahi	48.5 ±2.51	32.75 ± 1.62	22.30±1.54	8.20 ± 0.57	5.90 ± 0.45
Spotted owlet	Gazipur	27.0 ± 1.93	15.04 ± 1.35	11.6± 0.97	4.27± 0.60	2.63 ± 0.31
	Rajshahi	25.27± 2.11	16.27± 1.47	12.27 ± 1.51	3.04 ± 0.34	2.03 ± 0.29

Diet of barn owl pellets

The regurgitated pellet consisted of hair, small pieces of vertebrate bones whole insect or pieces of insect integuments, insect appendages etc. However, some of this material was so crushed that it was very difficult to identify the taxa to which they belonged. Vertebrate bones found in the Owl pellet, formed the basis of identification of small mammals.

All the barn owl pellets collected from two locations were found to contain bones and insect remains. Remains of total 314 prey items were found in 65 pellets. These were of 56 rat, 26 shrew, 3 mice), one frog (unidentified), 15 snail, 11 crabs, 89 coleopteran insects, 31 orthopteran insects, 15 Homopteran insects, 10 different seeds and 39 unidentified materials (Fig. 22).

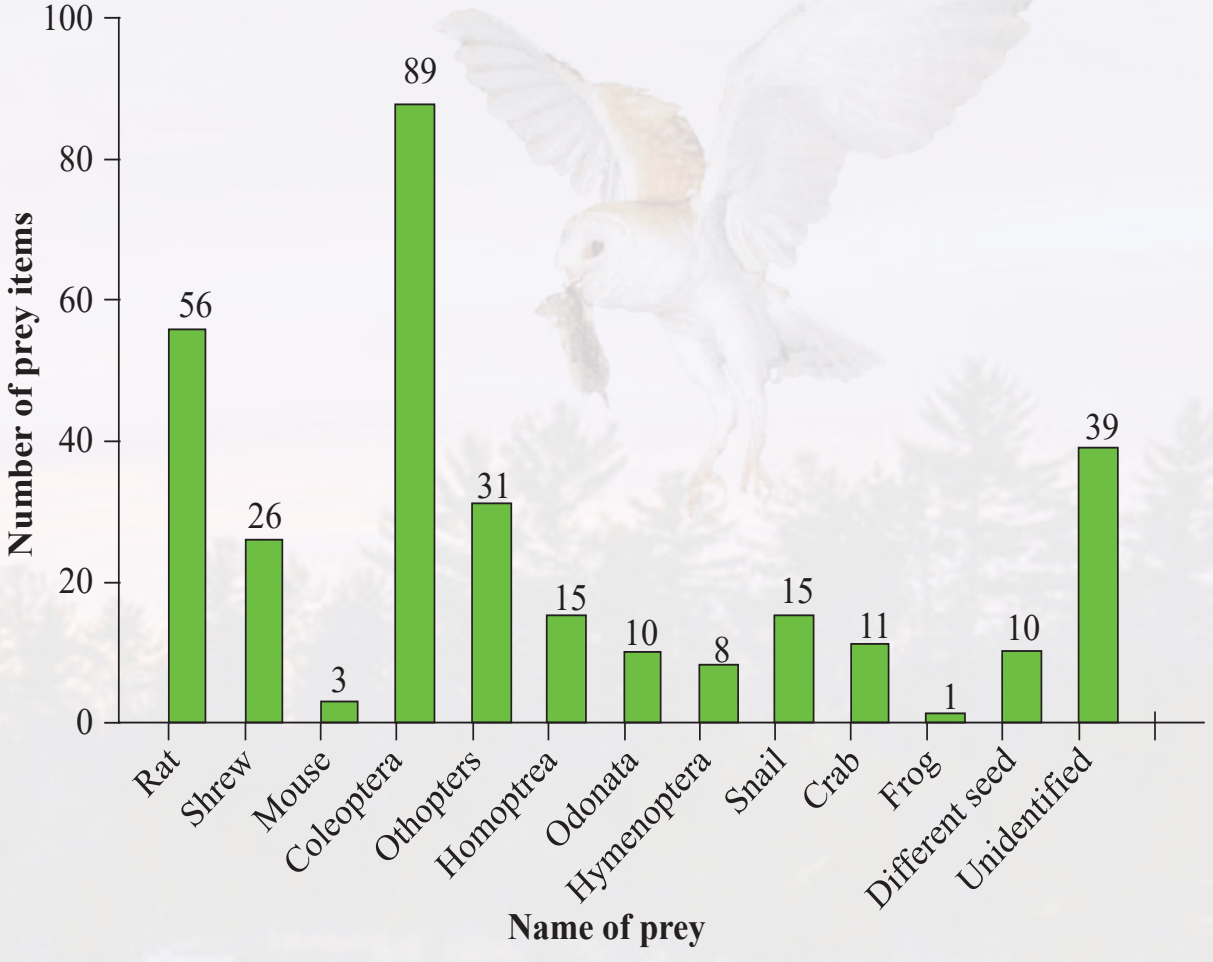


Fig. 22: Total number of prey items found in pellets of Barn owl at two locations.

Analysis of 39 pellets of barn owl in Gazipur, numerically the diet contained vertebrate 48.84% and 30.41% insect 20.75% other invertebrate species (Table 16). Among the small mammals, rat was 42.51%, followed by Shrew, *Suncus* sp (4.14%) and *Mus* sp (2.19%). Among the insect the coleoptera order were contributed (14.72%), Orthoptera (10.38%) and Homoptera (2.56%). In case of Biomass, vertebrate contributed 66.39%, and insect and other invertebrate contributed 33.61% of the die. In Gazipur. Other's invertebrate diet contain snail, frog, crab and also contain different seeds. However, 25 pellets in Rajshahi numerically 65.89% diet of barn owl contain small mammals and insect only 4.26%, followed by crab (2.74%) and different seed (18.5%) was also presented in diet. Small mammals contributed 32.65% rat and 33.24% *Suncus* sp. Whereas as % biomass small mammals contributed 89.32% of the total diet of barn owl in Rajshahi site. Different seed contained rice husk, date seed, brinjal, pumpkin, different spices etc. The diversity and species richness index revealed that both value were higher in Gazipur than Rajshahi indicated that more species and more diverse foods were consumed by barn owl in Gazipur than Rajshahi. However, evenness and dominance index showed that the barn owl is not more or less dependent on one prey species (Fig. 23 - 25).

Table 16. Comparative picture of prey frequencies (% number) and biomass (%) consumed by barn owl at Gazipur and Rajshahi district in Bangladesh.

Prey Items	Gazipur		Rajshahi	
	% Number	% Biomass	% Number	% Biomass
Rat	42.51	54.45	32.65	41.16
Shrew, Suncus sp	4.14	6.32	33.24	48.16
Mus species	2.19	5.94	-	-
Coleoptera	14.72	8.74	4.26	1.02
Orthoptersa	10.38	2.69	-	-
Homoptera	2.56	0.65	-	-
Odonata	2.49	0.44	-	-
Hymenoptera	0.26	0.09	-	-
Millipeds	0.27	0.14	-	-
Snail	0.93	1.45	-	-
Crab	0.10	0.86	2.74	2.60
Frog	0.21	0.53	-	-
Different seed	7.26	7.23	18.50	3.20
Unidentified	4.73	4.69	8.59	3.84

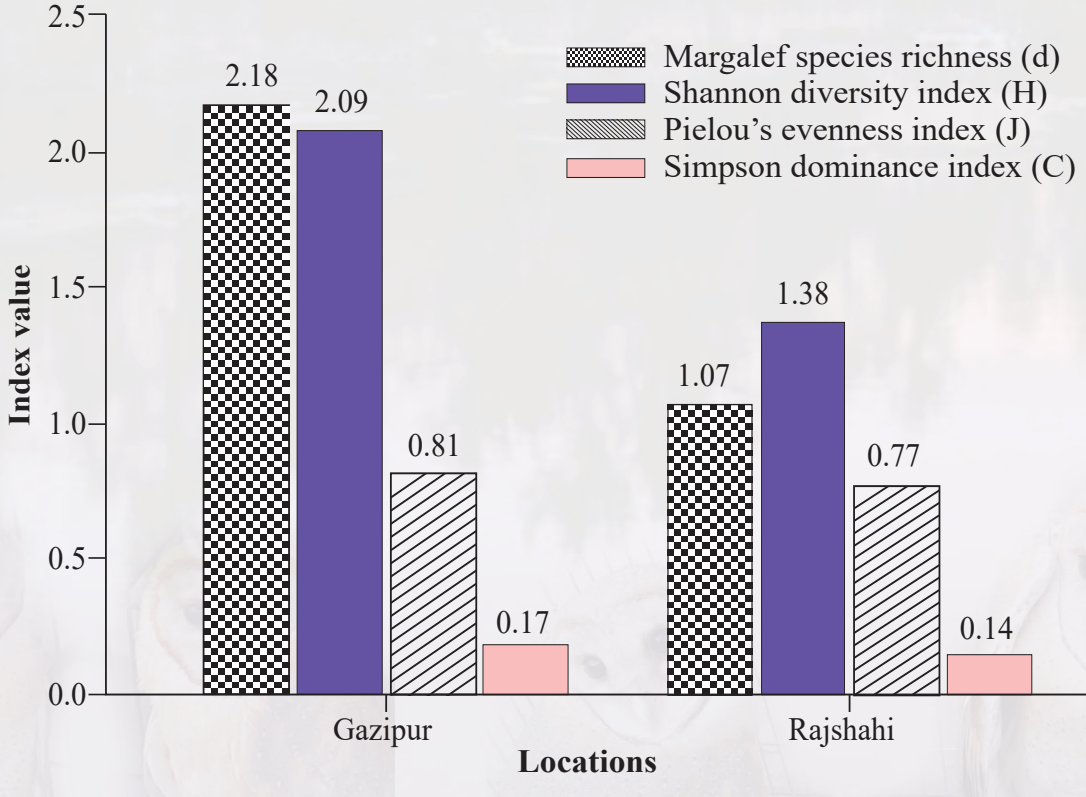


Fig. 23: Prey diversity in the diet of barn owl at two locations of Gazipur and Rajshahi.

Fig. 24.1: Different bone and skull of rat from barn owl analyzed pellet

Fig. 24.2: Different skull, bone of shrew, whole insect and snail from barn owl pellet

Fig. 25: Different skull, bone and crab leg, date seed and rice husk from barn owl pellet

Diet of Spotted owlet pellets

All the Spotted owlet pellets collected from two locations were found to contain bones and insect remains. Remains of total 341 prey items were found in 40 pellets. These were of 35 rodents (only mice), eight snail, 14 crabs, 108 coleopteran insects, 47 orthopteran insects, 31 Hemipteran insects, 25 Odonata, 21 Hymenoptran insect, seven different seeds and 45 unidentified materials (Fig. 26).

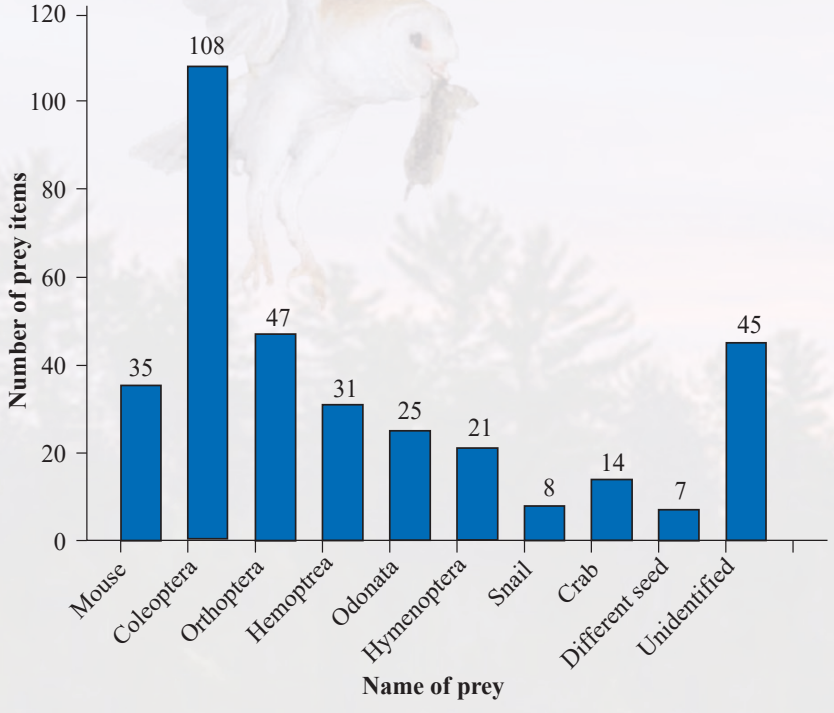


Fig. 26: Total number of prey items found in pellets of Spotted owlet at the locations.

The diet of spotted owlet contains *Mus* sp, insect, snail, crab and different seeds. The remaining parts of insects in the owl pellets comprised wings, legs, antennae and head. On the basis of these remnants, insects belonging to the orders Orthoptera (Grasshoppers), Hemiptera (Bugs), Coleoptera (Beetles) were recorded from the pellets. Analysis of 25 pellets of spotted owlet in Gazipur showed that insects (55.56%) were numerically predominant followed by small mammals only *Mus* sp (7%), snail (2.29%), crab (2.24%) and different seed (17.37%) (Table 17). However, most of the biomass consumed was due to insect (41.62%) followed by small mammals (15.52%), followed by snail (2.67%), crab (4.66%) and different seed (16.26%). Fifteen pellets analyzed in Rajshahi. During the collection period, the owlet seemed to feed more dependent on small mammals (Table 18), both by numbers and biomass consumption (32.13%; 49.06%), only *Mus sp* was consumed. Insects dominated through numbers (53.48%), but their contribution through biomass was only 38.96%. Crab was also consumed during this period, while frogs were not eaten and contributed only 3.42% by number and 8.84% through biomass. The diversity and species richness index revealed that both values were similar to Gazipur and Rajshahi indicated that more species and more diverse foods were consumed by spotted owlet in both Gazipur and Rajshahi. However, evenness and dominance index showed that the spotted owlet is not dependent on one prey species (Fig. 26, 27 to 30).

Table 17. Comparative picture of prey frequencies (% number) and biomass (%) consumed by spotted owlet at Gazipur and Rajshahi district in Bangladesh.

Prey Items	Gazipur		Rajshahi	
	% Number	% Biomass	% Number	% Biomass
Mouse	7.0	15.52	32.13	49.06
Coleoptera	27.19	22.35	29.22	25.49
Orthoptera	14.08	11.08	10.60	7.50
Hemiptera	4.16	2.90	7.09	3.65
Odonatan	6.54	3.50	3.04	0.96
Hymenoptera	3.59	1.97	3.53	1.36
Snail	2.29	2.67	1.53	1.60
Crab	2.24	4.66	3.42	8.84
Different seed	17.37	16.26	-	-
Un-identified	20.53	23.31	10.47	8.16

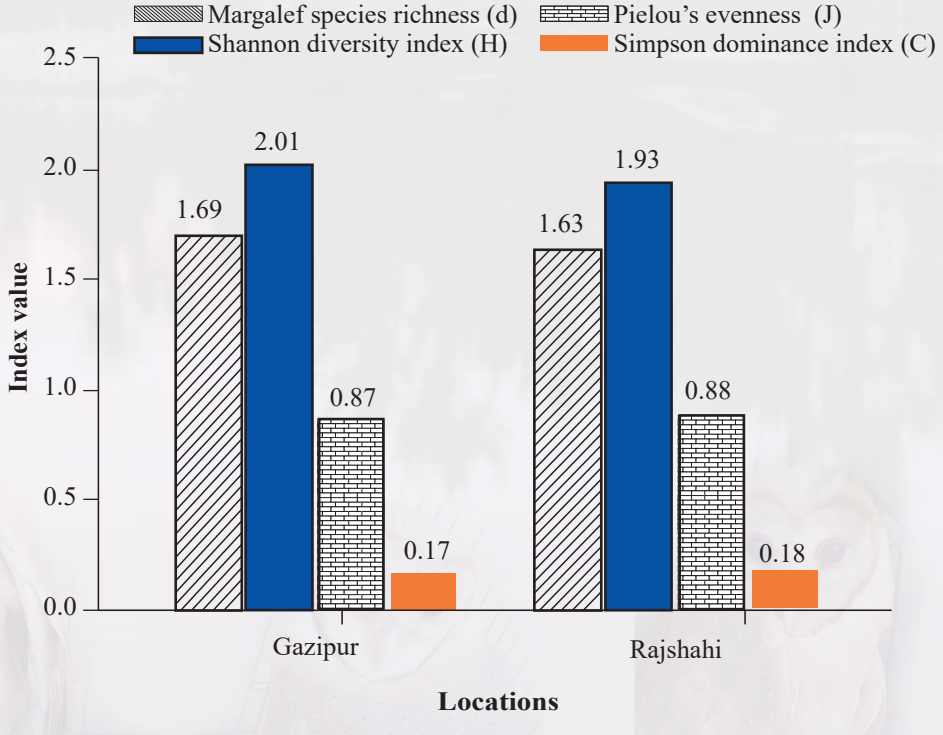


Fig. 27: Prey diversity in the diet of barn owl at two locations of Gazipur and Rajshahi.

Fig. 28: Different appendages of insects and crab of spotted owlet analyzed pellet

Fig. 29: Different appendages of insects, crab and different seeds of spotted owlet analyzed pellet

Fig. 30: Different bone of mouse, rice husk and snail from spotted owlet analyzed pellet

As pellet analysis serves as nondestructive means of diet determination for both prey and predator (Talmale and Pradhan, 2009), the aim was to accurately identify the prey species data for the studied owlet species. For the first time, key identifying characters of the dung beetles along with the illustrations were provided which may further be used by naturalists and conservationists for identification of these taxa in the pellets of spotted owlet (Paunikar *et al*, 2015). The study on the pellets of owl is ecologically and in conservation point of view very significant as it reveals the faunal diversity of insects, amphibian, reptiles and small mammals occurring in the area and this data can further be utilized in conservation planning and management of barn owl and spotted owlet species in Bangladesh. In addition, further study need to be done on the collection of rat skull and bone separated from Barn owl pellets with good reference materials (Fig. 31-32).

Size and weight of barn owl pellets

The size and weight of barn owl pellets were larger than the other pellets. This was also described by other study (Hassan, 1998; Ahmad, 2000; Alvarez-Castaneda *et al*., 2004, Nadeem *et al*., 2012). The pellets size varied considerably throughout the year due to diet and size of prey consumed. Supported by Stegemen (1957) and Hardy (1977) stated that the size of the pellets greatly varied, which depended on the composition of the diet and the size as well as nutritive value of taken prey. The barn owls of our study preyed on rat, shrew regularly, produced larger pellets perhaps because of the presence of bone, skull, crab in them. In the present study higher number of shrew and lower species diversity were found in Rajshahi compared to Gazipur because Rajshahi agriculture farm were rice and wheat ecosystem and surrounded nearby human residential area, whereas Gazipur was diverse ecosystems and more species diversity were recorded in diet. Nadeem *et al*., (2012) studied the pellets of barn owl and spotted owlet at Punjab, Pakistan and observed that the barn owl mainly consumed *Suncus murinus* (60.2%), birds (24.1%) and rodents (12.7%), while the spotted owlet depended on *Mus* species (36.8%), *S. Murinus* (20.1%), birds (14.1%), reptiles (8.9%) and insects (6.7%) for its food. In the present study 42- 89% contributed small mammals (rat, 42.51%, shrew, *Suncus* sp 48.16%) and insects contributed 4.26 – 30.41%.

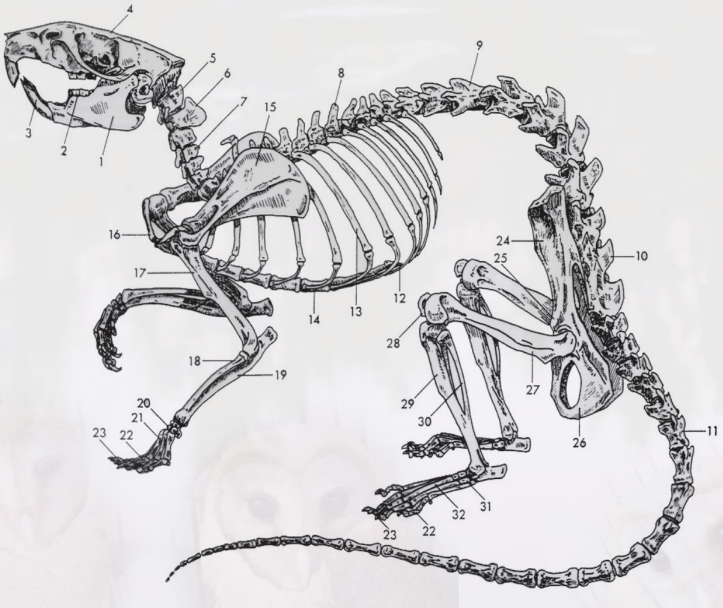
In the present study among rodents, mouse, *Mus* sp found to be the major contributor of spotted owlets diet. Among invertebrate, the diet mainly consisted of insect followed by snail, crab. Insect consumed by spotted owlet were mainly of orders coleoptera, followed by orthoptera, hemiptera, odonatan, hymenoptera and some unidentified order. Different authors have reported the diet of the spotted owlet covering of insect, earthworms, mice, lizards, frogs, and birds (Sandhu 1978; Majumdar 1984; Ali & Ripley 1987). In the present study, however, the remains of earthworms, lizards, frogs, and birds were not observed in the pellets of spotted owlet. Zade *et al*. (2011) examined 52 pellets of Spotted Owlet in Maharashtra, India and determined the percent relative frequency of occurrence of various food remains. The study revealed that insects belonging to the orders Orthoptera (Grasshoppers), Hemiptera (Bugs), Coleoptera (Beetles) and Dermaptera (Earwig) occupied 78.84% of the diet followed by small mammals (38.46%). The remnants of insects in the pellets comprised of wings, legs, antennae and head. Ali & Santhanakrishnan (2012) observed the diet of the Spotted Owlet comprising mostly of arthropods (84.9%), i.e., Coleoptera (40.9%) and Orthoptera (32.4%) insects followed by vertebrates (12.1%). Malhorta and Singla (2018) found insects alone constituted 53.8% and small mammals constituted 45% of the diet of Spotted Owlet. In the present study insect alone contributed 51.13% and small mammals contributed 32.13% of spotted owlet diet.

Paunikar *et al* (2015) examined the food habits of the Spotted Owlet in Tropical Forest Research Institute campus, Jabalpur, India by analyzing their regurgitated pellets and observed the remnants of three dung beetle species, *Onitis philemon, O. virens* and *O. brahma* and five species of small mammals, *M. booduga, Vandeleuria oleracea, M. meltada, Suncus etruscus* and *S. murinus*. In the present study, however, the diet of Spotted Owlet was found constituted only of *Mus sp* among small mammals, particularly the rodents.

The diet of the Barn Owl mainly comprised small mammals and insect while the diet of the Spotted Owlet comprised mostly insects and Mus spp. The presence of only mice among different rodent species found in the diet of Spotted Owlet and small mammals are dominant in the diet of barn owl indicates that they have potential in regulating rat and mouse population's in crop fields as one of the components in integrated rodent pest management. Studies may, however, be taken to attract them to the crop fields by installing artificial nest boxes, X-shaped perches or poles.

Rat skull and bone separated from Barn owl pellets need to be studied with reference materials.

Fig. 31: Owl pellets with different types of rat skulls and bones (need to be identified)



1. Mandible
2. Molar
3. Incisor
4. Skull
5. Atlas
6. Axis
7. Cervical vertebra
8. Thoracic vertebra
9. Lumbar vertebra
10. Sacrum
11. Caudal vertebra
12. Xiphoid process
13. Rib
14. Sternum
15. Scapula
16. Clavicle
17. Humerus
18. Radius
19. Ula
20. Carpals
21. Metacarpals
22. Phalages
23. Claw
24. Ilium
25. Pubis
26. Ischium
27. Femur
28. Patella
29. Tibia
30. Fibula
31. Tarsus
32. Metatarsus

Fig. 32: Reference rat skeleton with different name of bones (Source: ©1996 Carolina Biological Supply Company)

Rat damage Assessment

Rice: Per cent rat damage in different rice varieties cultivated at BRRI HQ, Gazipur were estimated using the method developed by Buckle (1994) during the Boro rice season 2019, Transplanted Aman 2019 and Boro 2020 seasons. The result showed that rat cut tiller was comparatively highest during booting to mature stages in the rice seasons, Boro 2019 and T. Aman 2019 though the per cent rat damage was below the 0.38% (Table 18). This indicating that most of the research fields were protected of using different rat management options including poisonous rodenticide. Therefore, surviving of a biocontrol agent in BRRI research field is challenging. So, rat prone / endemic areas like polder area in southern districts, poultry industries, bunds and social forestry are preferable to conserve owl in nature.

Table 18. Per cent rat damage on different rice cultivars were estimated at BRRI HQ, Gazipur during the Boro 2019, T. Aman 2019 and Boro 2020 seasons.

Season	Crop Stage	Total tiller (No.)	Rat Cut Tiller (No.)	Per Cent rat damage
Boro 2019	Heading stage	1595	3	
	Milking stage	15682	59	
	Dough stage	1745	1	
	Hard dough stage	1519	1	
	Mature stage	80650	318	
	Sub-Total	**101191**	**382**	**0.38**
T. Aman 2019	Transplanting stage	51812	0	
	Mid-tillering	13377	100	
	Booting	16325	181	
	Sub-Total	**81514**	**281**	**0.34**
Boro 2020	Transplanting stage	217	0	
	Mid-tillering	4443	0	
	Booting	3855	0	
	Heading stage	7202	0	
	sub-Total	**15717**	**0**	**0.00**

Wheat: Percent rat damage in different growth stage of wheat differed significantly in active burrow count methods and cut-uncut methods around the owl watching tower areas (Figure 33 & 34). Significantly the lowest number of active burrow (0.6) was recorded in 0-25-meter distance around the watching tower followed by 25-50 m (active burrow, 1.5) distance and the highest number of active burrows was observed in 50-75 m (active burrow, 7.5) distance from watching tower in Rajshahi. In case of cut and uncut methods follow the same trend as active burrow count methods. (Table 19). Wheat and barley damaged by rat in the form of active burrows and grain damaged at Gazipur also follow the same trend as Rajshahi (Fig. 37 & 38). Rat damaged and numbers of active burrow were higher as increase the distance from the watch tower areas (Fig. 35 & 36).

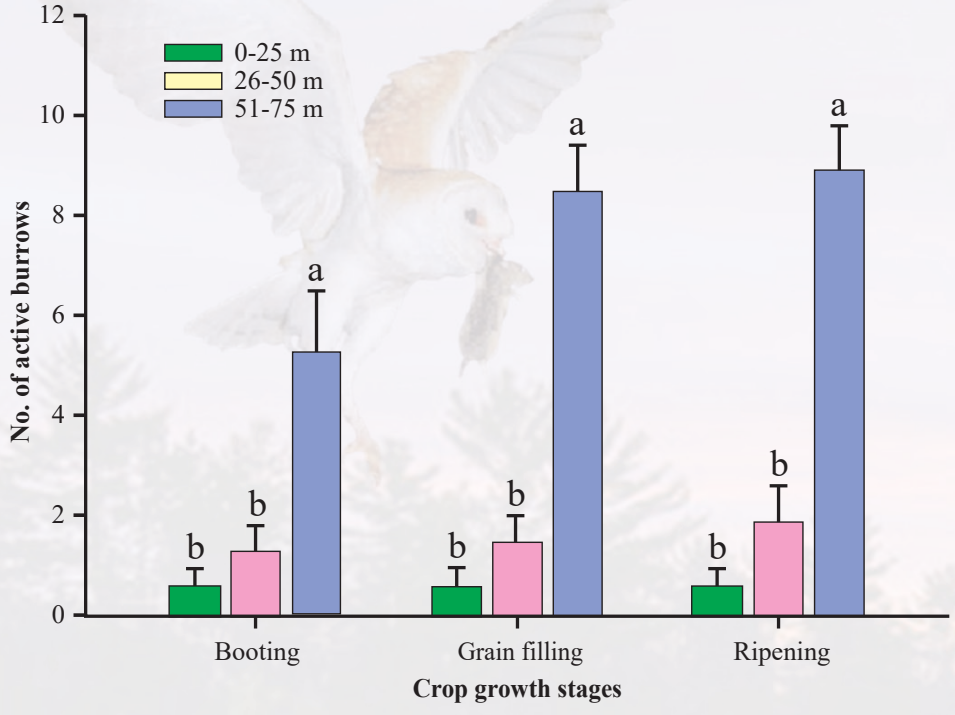


Fig. 33: Extent of rat damage in different growth stage of wheat around the watching tower area at Rajshahi by active burrow count method.

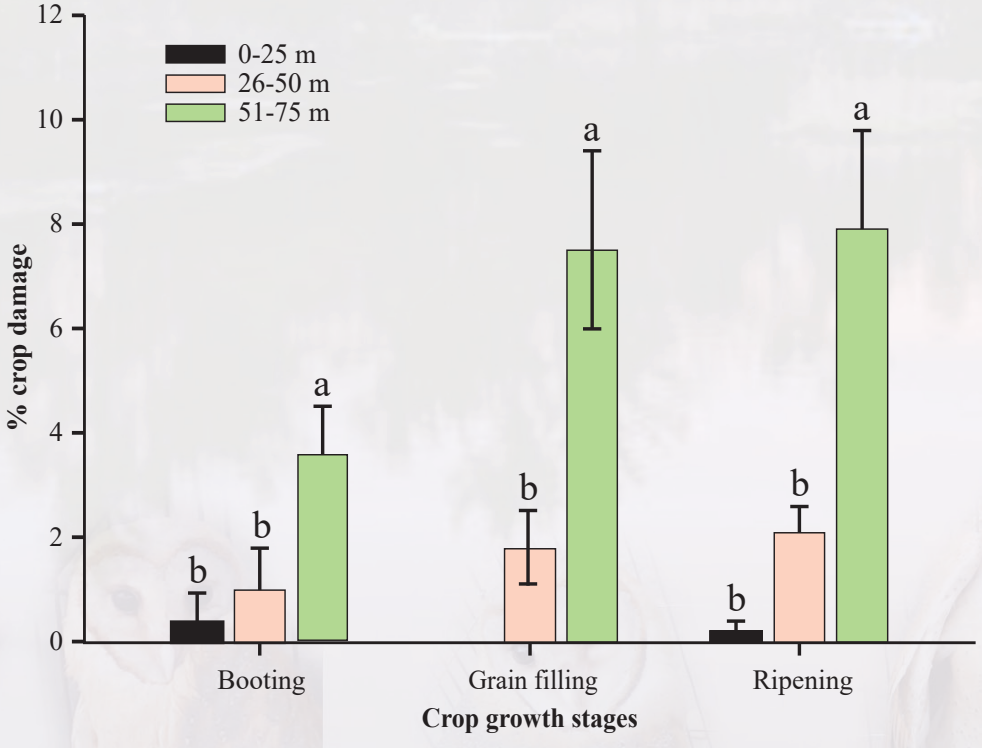


Fig. 34: Extent of crop damage in different growth stage of wheat around the watching tower area at Rajshahi by cut and uncut count method.

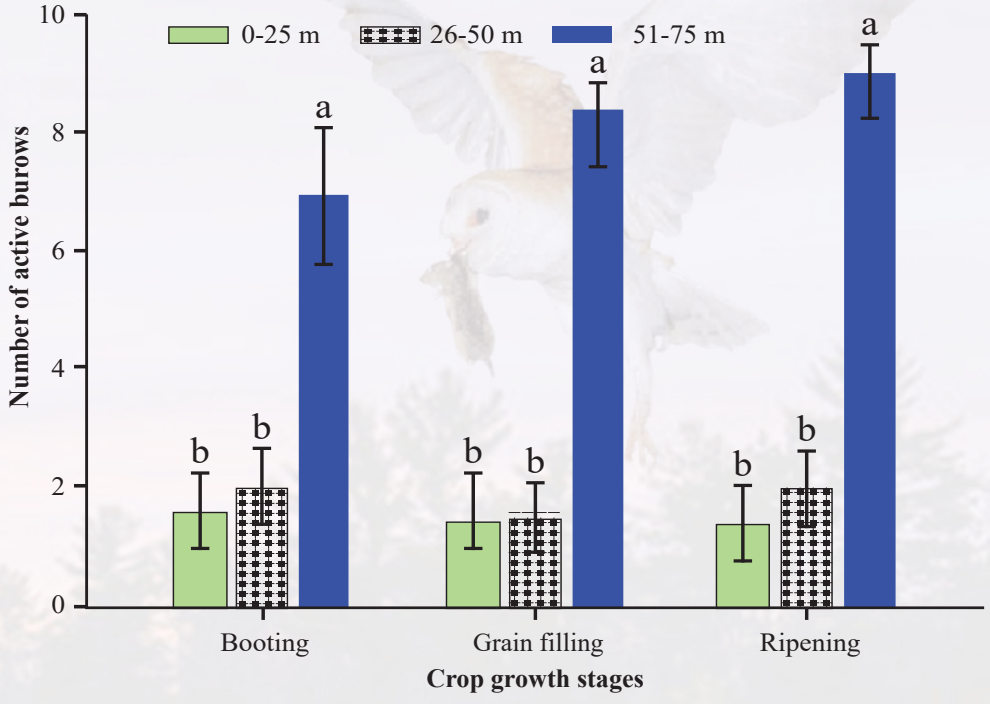


Fig. 35: Extent of rat damage in different growth stage of wheat around the watching tower area at Gazipur by active burrow count method.

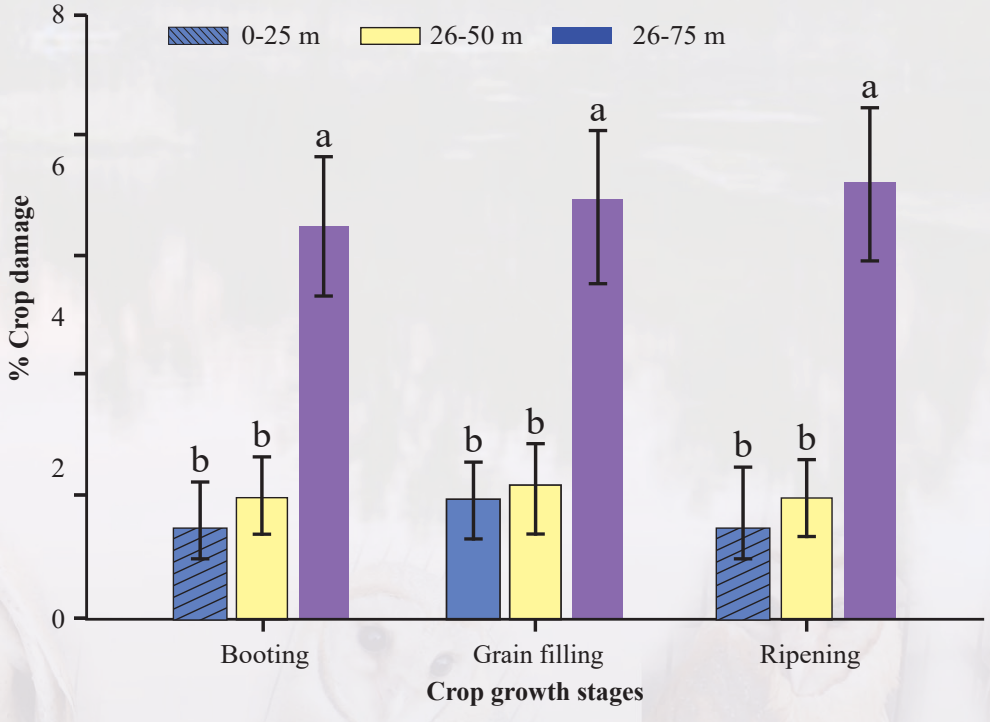


Fig. 36: Extent of crop damage in different growth stage of wheat around the watching tower area at Gazipur by cut and uncut count method.

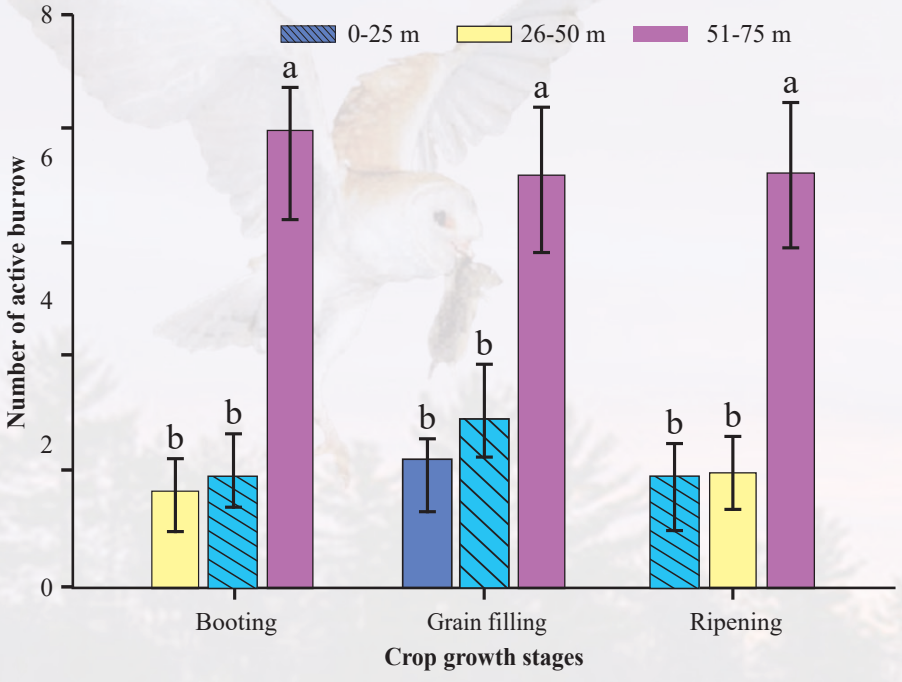


Fig. 37: Extent of rat damage in different growth stage of barley around the watching tower area at Gazipur by active burrow count method.

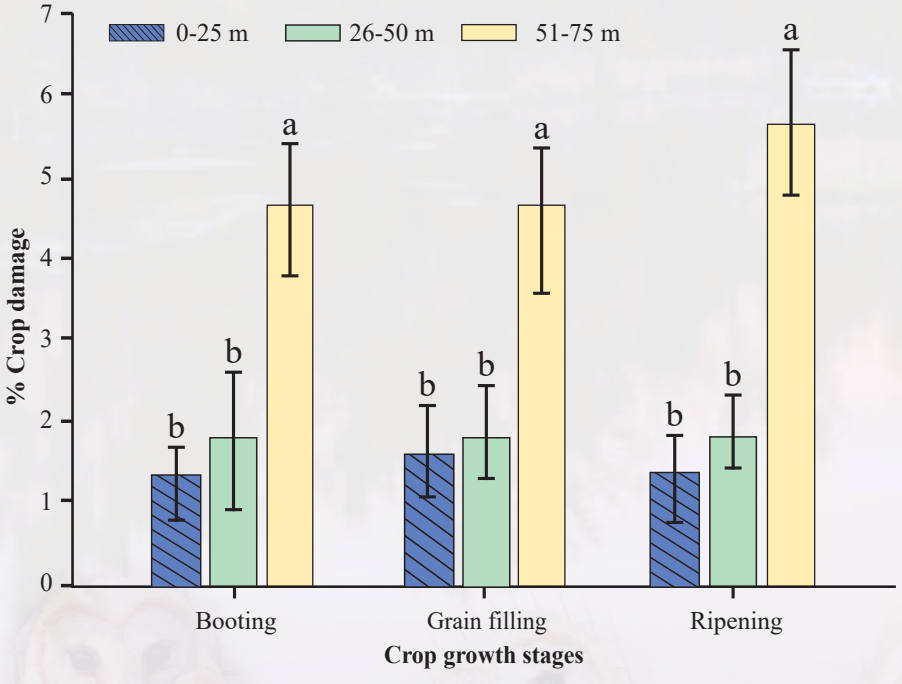


Fig. 38: Extent of crop damage in different growth stage of barley around the watching tower area at Gazipur by cut and uncut count method.

Potato, sweet potato and groundnut damaged by rat and number of active burrows were differed significantly among different distance (0-25 m and 25-50 m and 51-75 m) from the watch tower. The active burrows were ranges from 1-1.8, 1.2-1.6 and percent damaged ranges from 0.6-1.0, 0.6-1.8 at

0-25 m and 25-50 m distance from the watch tower in potato and sweet potato respectively compared to 51-75 m distance from the watch tower at Gazipur (Table 19). Number of active burrows and nut damaged in ground nut was also followed the same trend as potato and sweet potato at different distance from the watch tower (Table 19). Because owl can be easily search and detected the prey within 50 m that why the rat damaged and active rat burrows were lower within the 50 m. Malhotra and Singla (2018) studied the live active burrows count at four different radius such as 0-100 m, 101-500 m, 501-1000 m and 1001-2000 m distance around roosting and nesting sites at Punjab, India and found that numerically lower active burrow within 100 m radius and being highest at 1001-2000 m radius but no significant among four distances. In another study (Johnson and St George, 2020) a rigorous estimate of the number of rodents that barn owls remove from the landscape to nest box by using remote nest box cameras at wine grape orchard in California, USA. Results indicate that each barn owl chick received 170.2 ± 8.92 rodents before dispersing from the nest box. Combined with the average number of chicks fledged (3.62 ± 1.40), this finding indicates adults deliver on average 616 rodents per nest box. They also estimated a barn owl family could remove 3,466 rodents in a full year (estimates ranged from 1,821 to 7,563). An analysis linking videography to owl telemetry data suggested that 43% of rodents killed were taken from vineyard habitat, which nearly matches the availability of vineyard habitat around the monitored nest boxes (46%). Their results suggest barn owl nest boxes could contribute meaningfully to integrated pest management.

Table 19: Extent of rat damage of potato, sweet potato and groundnut around the watching tower area at Gazipur.

Crop	Watch tower distance (m)	Extend of rat Damage	
		Number of Active burrow (Mean ± SE)	% Tuber/pod damage (Mean ± SE)
Potato	0 -25	1.0 ± 0.32	0.60 ± 0.24
	26 -50	0.80 ± 0.37	1.00 ± 0.45
	51 -75	3.4 ± 0.68	3.0 ± 0.45
Sweet potato	0 -25	1.20 ± 0.37	0.60 ± 0.24
	26 -50	1.60 ± 0.40	1.80 ± 0.58
	51-75	3.40 ± 0.51	3.20 ± 0.58
Ground nut	0 -25	1.60 ± 0.51	1.00 ± 0.31
	26 -50	1.60 ± 0.51	1.80 ± 0.49
	51-75	5.20 ± 1.2	4.40 ± 0.24

Placement of owl watching tower and nest boxes in rice, wheat and vegetables field.

Owl watching towers (WT) are effective from dusk to down (Fig. 39) and the collected and observed pellets of owl from WT confirmed the rat predation (Fig. 40: Rat skeleton found in regurgitate pellet). Fortnightly collection of owl regurgitated pellets at different heights of watching towers showed that three and half meter height gave highest number of pellets among the other two height indicating 3.5 m was the good height for rat perching (Fig. 41). It can also be used as perching device during day time for insect feeding birds, black drongo (*Dicrurus adsimilis*). Pellets collected from the watching towers were analyzed carefully and showed that most of the pellets consist of rat bones, skins, exo-skeleton of insects (Fig. 39 & 40).

Fig. 39: Owl watching tower (WT) was placed at BRRI HQ and observed the pellet, daily

Fig. 40: Owl regurgitate and Collected pellets having Rat skeleton.

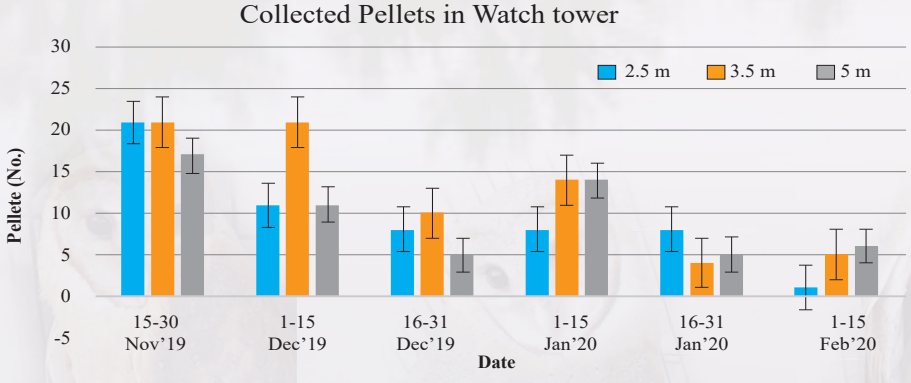


Fig. 41: Fortnightly collection of owl regurgitated pellets at different height of watching tower from 15 Nov 2019 to 13 Feb 2020, BRRI Farm, Gazipur

Development and validation of effective rat management technique in rice, wheat and vegetables ecosystem.

Development and validation of effective rat management technique: To develop ecofriendly rat capturing devices using pepsi-cans, buckets etc, four eco-friendly rat management (EFRM) techniques has been tested in BRRI farm, Gazipur to catch and kill the rice field rats without using any rodenticide(s) in rice eco-system (Fig. 42). The rat capture devices, used in rice field bunds or close to the bund, burrow systems were very effective (Fig. 43). The collected data processed and analyzed.

Fig. 42: Development of eco-friendly multi-capture rat device to be used in rice ecosystem

Fig. 43: Use of eco-friendly multi-rat capture devices in field during the reporting period.

Nest box occupied by owl

Nest box occupy mean the number of owl entered into the nest box and started for living. Owls occupied 55 % nest boxes in Rajshahi and that was 50 % in Gazipur, respectively (Fig 44). In Gazipur maximum nest box were occupied by spotted owlet (*Athena brama*) and in Rajshahi most of the nest box occupied by barn owl (*Tyto alba*). In addition, five different types of owl nest boxes were evaluated to find out the suitable box(s) for owl nesting (Fig. 45).

Examination of pellets from our and other study revealed that 70-80% of the Barn Owls diet is composed of rodents from agricultural fields and plantations (Tores *et al.* 2005, Charter *et al.* 2007). Browning *et al.* (2016) measured the effect of a population of barn owls on a rodent population in a 40-ha vineyard near Sacramento, California, USA. In First year 11 of 20 (55%) boxes were occupied by breeding pairs, fledging 40 young. In second year, 18 of 24 (75%) owl boxes were occupied, fledging 66 young; and in third year, three of 24 (12.5%) boxes were occupied, fledging nine young. Nocturnal observations revealed the owls hunted the study area heavily. Monthly pocket gopher surveys using the mound-count method indicated that gophers (rat species) declined on the vineyard with barn owl boxes relative to a control vineyard without barn owl boxes. Pellet analysis showed diet was composed mainly of Botta's pocket gophers (70.4%) and California voles (26.2%). Using these figures, and adding conservative estimates of adult consumption over the 165-day breeding season, and adult and fledgling consumption prior to dispersal, the total number of preys taken over the three breeding seasons was 30,020 rodents indicating 30,020 rodents were reduced over three years of 40-hectare vineyard. The presence of Barn Owls is thus welcomed by farmers in Israel. Since the establishment of the pest control project, many farmers use Barn Owls as an alternative method of rodent control and thereby drastically reduce the use of rodenticides. The high occupancy of nest boxes by Barn Owls detailed in this study demonstrates, as also found in other studies throughout the world, that not only were natural nest sites lacking in the area, but also that nest boxes offer Barn Owls alternative nest sites, that can increase owl numbers in agricultural fields both for conservation and biological pest control aspects. Nest box orientation

and habitation also affect the occupation of owl. Charter *et al.* (2010) studied the effect of exposure, orientation, and habitat on nest box occupation and breeding success of Barn Owls in a semi-arid environment. The occupation of nest boxes varied with exposure and orientation. A higher percentage of occupation and more Barn Owl nestlings per breeding attempt were found in nest boxes located in the shade than in the sun, and in those facing east/north rather than other directions. The temperature in the nest boxes varied, being lowest in those located in the shade and in those facing east. Nest boxes located in crop fields fledged more young per breeding attempt than those located in date plantations.

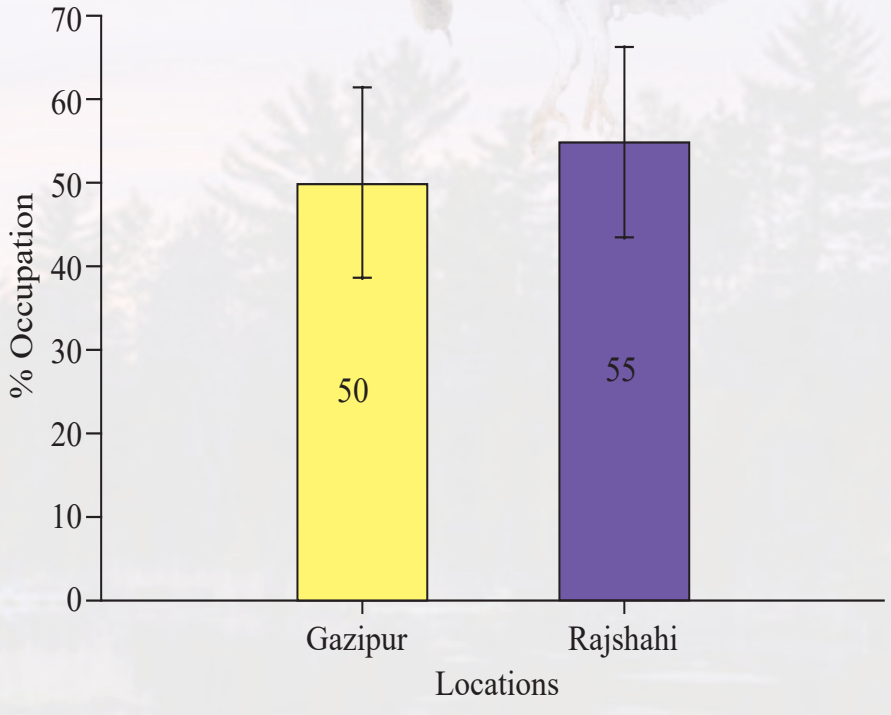
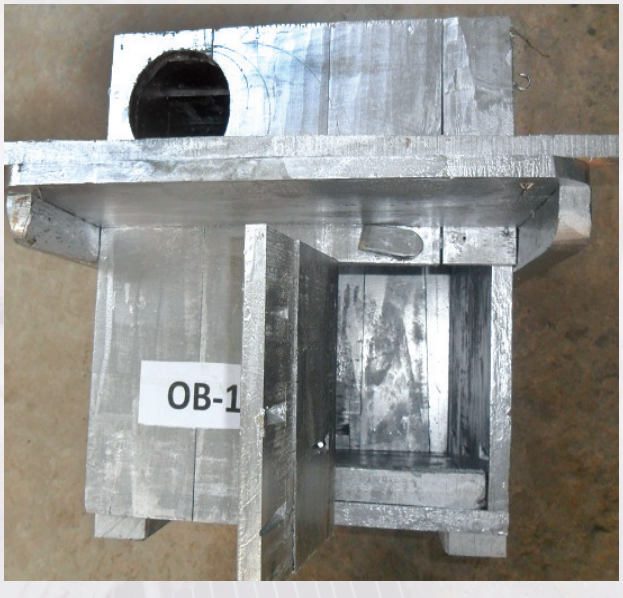


Fig. 44: Nest box occupation by owls as a function of exposure at two locations of Gazipur and Rajshahi.



Nest box occupancy by spotted owlet in Gazipur

Spotted Owlet at nest box in Gazipur

Fig. 45: Different types of owl nest box developed and tested at BRRI HQ and BARI HQ, Gazipur; and in Rajshahi Region (BRRI RS, Fruit Research Centre and Wheat Research Centre)

12. Research highlight (title of the sub-project, background, objectives, methodology, key findings, and key words):

A. a. Title: Local people perception and knowledge about owls and their conservation implications in three districts of Bangladesh

Background: Owl is an important biological control agent for rat management. In Bangladesh owl's species are gradually decreasing day by days due to lack of breeding source and places. Owl creates their nest usually in large tree hole. Large trees are gradually destroyed day by day, as a result their breeding sources are also decreasing. Local people perceptions and attitude are also important about owl for natural conservation. This type of information is scanty in our country.

Objective: To know the local people knowledge, perception and attitude about owl and their way of conservation.

Methodology: The survey was conducted during July -December, 2018 in the village of Gazipur, Rajshahi and Jessore districts. The study used an interview-administered questionnaire. The questionnaire included both open-ended and fixed response questions. The questionnaire was designed to evaluate the knowledge and perceptions of local people about Owl. Education and demographic information, including gender and age, were obtained from each respondent. Interviewers recorded all responses directly into standardized survey forms. Data were grouped and summed by response category. The responses were recorded on a data sheet and later transcribed into English and entered into a Microsoft Excel 2010 database. Where multiple responses were possible on an open-response question, data are presented as the percentage (%) of respondents giving each response, and may sum to over 100%.

Key findings: Most of the farmers (77.22 %) replied that they had seen only one species whereas 23.33% farmers reported on two species, 3.33% farmers reported on three species. Half of the farmers (50%) mentioned available owl species as Vutum pencha whereas 43.33% farmers mentioned it as Hutum pencha and only 32.22% farmers mentioned it as Laxmi pencha i.e. Barn owl. Most of the farmers (71.11%) responded that they liked owl as bird but 28.89% farmers did not like owl. Majority of the farmers (87.77%) thought that owl had no harmful effect on human and the environment. Most of the farmers (81.11%) thought that owl had no scary effect on human being as well as the environment. Only 18.89% farmer mentioned that it is a dangerous thing. About 85% farmers replied that owl has a beneficial effect on the nature. Only 14.44% farmers thought it has not affects on nature. Majority of the farmers (85.55%) treated owl as a rat feeder whereas 11.11% farmers considered it as environmental protector.

Key words: Local people perception, knowledge, attitude, owl, conservation.

A.b. Title: Relative abundance and documentation of available owl species in three districts of Bangladesh

Background: Understanding the diversity and structure of owl communities is essential to delineate the importance of regional or local landscapes for avian conservation. Determinations of owl population in different habitats are central to understanding the community structure and niche relationships, as well as for intelligent management of populations. Moreover, seasonal monitoring is equally important to trace the dynamic movement of owl species in such habitats. There is no information how many species of owls are available in our country.

Objective: To know the species of owls are available, their distribution and locality.

Methodology: The study was conducted in three districts (Gazipur, Rajshahi and Barishal) of owl species that are usually found in those areas and documented and it was carried out during June, 2018 to July, 2020. The study was carried out once in a month and Owls were counted by line transect, point counting and look and see methods and other owl species documentation were recorded by the help of some face book group such as Birds Bangladesh, Birds and Wildlife of Bangladesh etc.

Key findings: During the study of the project period 13 species of owl have been recorded and documented. Among them Barn owl, Spotted owlet, Brown Hawk owl, Brown fish owl, Collard scops owl etc were the most abundant species in different zone. All other owl species also presented in different locations but their density was comparatively lower.

Key words: Owl species, relative abundance, documentation.

A.c. Diets of barn owl (*Tyto alba*) and spotted owlet (*Athene brama*) at Gazipur and Rajshahi district of Bangladesh

Background: Diet analysis of owls can provide information on the existence of prey species within the owl's range, its capability to take such prey and relative abundance of prey species in the owl's diet. Such study is very important not only for its significance in conservation but also for their predatory potential. No information is available about owl diet composition from Bangladesh.

Objective: The present study was carried out to investigate the diet composition and feeding niches of the barn owl and the spotted owlet in Bangladesh.

Methodology: The study was conducted at BARI Head quarter central farm, Gazipur and Shampur, Rajshahi during January 2019 to October 2020. The regurgitated pellets of barn owl and spotted owlet were collected from two sites, namely BARI research field, Gazipur and Rajshahi. Total 40 pellets of barn owl, *Tyto alba* and 25 pellets of spotted owlet, *Athene brama* were collected form Gazipur, and 20 pellets of barn owl and 15 pellets of spotted owlet were collected from the roosting site of Rajshahi district. Regurgitated pellets of these two owl species were analyzed to understand their dietary composition.

Key findings: Regurgitated pellets collected from two locations determined barn owl and spotted owlet average weight, length, breadth and thickness to be 5.82g, 47.95 mm, 30.43 mm and 20.29 mm, and 2.33g,26.14 mm, 15.66 mm and 11.94 mm, respectively. The diel of barn owl mainly comprised small mammals such as rat, (47.85%), Shrew (27.27%) and insect Coleoptera (4.88%), crab (1.73%). Spotted owlet pellets contained small mammals only mice (32.29%), followed by insect (38.72%) of them Coleoptera (23.92%), Orthoptera (9.29%), Hemiptera (3.28%), Odonata (2.23%), snail (2.14%) and crab (6.75%) and unidentified (15.74%). The remains of insect and crab in the pellets comprised of wing, legs, heads, shell etc. The Barn Owl and spotted owlet consumed more than one prey per day and chiefly foraged in agricultural crop fields and consumed both small mammals and insects of agricultural importance under crop ecosystems.

Kew words: Barn owl, spotted owlet, pellet, diet composition

A.d. Placement of owl watching tower and nest boxes in rice, wheat and vegetables field.

Background: Owl is an important biological control agent for rat management. In Bangladesh owl's species are gradually decreasing day by days due to lack of breeding source and places. Owl creates their nest usually on large tree as a hole. Large trees are gradually destroyed day by day as a result their breeding sources are also decreasing. Therefore, an attempt has taken to provide alternate source for owl to watch rice field rats for their predation.

Objective: To develop and validate the effective rat management technique(s) using owl in rice and wheat based ecosystem.

Methodology: BRRI component has executed the research activities in rice based ecosystem. Multi-stage cluster sampling method was followed for this experiment. One hundred and nine (109) watching towers (WT) were placed at different heights in rice ecosystem (fields) at BRRI and BARI, Gazipur; and at BRRI RS, Cumilla and Rajshahi to facilitate barn owl for their preying at night using as perching device. Nylon net was used beneath the WT to collect the owl regurgitate pellets. Collected pellets were air dried and processed for analysis using 0.5N NaOH solution. In addition, five different types of owl nest boxes were evaluated to find out the suitable box(s) for owl nesting and breeding.

Key findings: Results showed that three and half-meter (3.5 m) height is suitable for effective preying. Owl watching towers (OWT) are effective from dusk to dawn. The newly developed burrows became inactive (dead) surrounding the 50m dia of WT, and increased in number (inactive burrows) by 15-20% fort-nightly. The collected and observed pellets of owl from WT confirmed the rat predation. OWT can also be used as perching device during day time for insect feeding birds, black drongo (*Dicrurus adsimilis*). Owl regurgitate pellets collected from the watching towers were analyzed carefully and found that most of the pellets consist of rat bones, skins, exo-skeleton of insects. Among the five different types of owl nest boxes, barn owl preferred triangular shape nest boxes for their nesting and breeding purposes.

Kew words: Barn Owl, Owl watch tower, perching, regurgitate pellet

A.e. Assessment of rat damage surrounding the watch tower areas and nest box occupied by owl

Background: Recently pest management strategies have emphasized on the ecologically sound method for rat control. Ecologically-sound rodent management provides the necessary platform for designing management strategies, which are environmentally safe. For these reasons, the use of owls e.g., barn owl, spotted owlet etc. is proposed as a potential biological control method. Barn owls are superior hunters, preying on small nocturnal mammals including mice, rats, voles, and gophers. Barn owls need open fields or grassy slopes in which to hunt for prey. A single pair of barn owls can consume over 2000 rodents a year. Installing barn owl nesting boxes and watching tower throughout the crop field is a sure way to diminish the number of rodents destructing our crops. Increasing owl population and conservation by installation of nest box is very important. There is very little scope for searching and capturing rodent prey from crop field for owl. Therefore, watching tower installation is also important for seating, searching and capturing prey. Very little study have been done in these regards.

Objective: To assessed the rat damage around the watching tower and the effectiveness of nest box for owl occupation.

Methodology: A study was carried out to assess the rat damage around the watching tower and the effectiveness of nest box for owl occupation at Rajshahi and Gazipur district. Watch towers were set at the field and nest box were installed in different tree above 12-15 feet from the ground level in both the location. Rice, wheat, barley, potato, sweet potato and groundnut crop damaged by rat were assessed at 0-25, 26-50 and 51-75 meters apart around the watch tower areas. Nest box occupancy was also recorded for nesting and roosting by owl.

Key findings: Percent rat damage in different growth stage of rice, wheat and barley differed significantly both in active burrow count methods and cut-uncut methods around the owl watching tower areas. Significantly the lowest number of active burrow (0.6) was recorded in 0-25-meter distance around the watching tower followed by 25-50m distance and the highest number of active burrows was observed in 50-75 m distance from watching tower both in Rajshahi and Gazipur. Rat damaged and number of active burrows were higher as increase the distance from the watch tower areas. In Gazipur, maximum nest box were occupied by spotted owlet (45%) (*Athena brama*) and in Rajshahi most of the nest boxes occupied (55%) by barn owl (*Tyto alba*).

Key words: Barn owl, spotted owlet, watch tower, rat damage, nest box, occupation

A.f. Development and validation of ecofriendly rat management technique in rice, wheat and vegetables ecosystem.

Background: Recently pest management strategies have emphasized on the ecologically sound method for rat control. For this, uses of different cultural and physical approaches are the best options for controlling rats other than biological control. Therefore, the attempts have been taken to address the issue of eco-friendly rat management using pepsi-cans, buckets etc.

Objective: To develop eco-friendly rat capturing devices using pepsi-cans, buckets etc.

Methodology Eco-friendly rat capture devices were prepared using different house hold materials like bucket, white bucket, small PVC pipes, pepsi-cans, cycle spokes, wires, infant baby milk cans and single capture live trap found in local market. Trap devices were prepared in such way for capturing rat in live. Different types of baits were used in the trap to attract rat in the devices. Prepared devices were placed in the rice field along with the bunds for 7 to 10 consecutive nights at the same place. The fresh water was used in the bucket in such a height, so that the trapped rat did not jump from the bucket and only can swim in water. The number of rat trapped was recorded in the next morning and removed from the bucket and finally, buried in soil at a safe place. In addition, bamboo made devices were tried to convert to trap rat in live.

Key findings: Four effective eco-friendly rat management (EFRM) techniques was tested in BRRI farm, Gazipur to catch and kill the rice field rats without using any rodenticide(s) in rice field eco-system. The rat capture devices used in rice field bunds, close to the bund or on burrow systems were very effective.

Key words: Rat trapping devices, eco-friendly rat management (EFRM).

A.g. Food preference of owl species and the forms of their pellets

Background: Barn owls are superior hunters, preying on small nocturnal mammals including mice, rats, voles, and gophers. Owls feed on what they can digest. Thus flesh, bone, hair,

feathers of vertebrates, and chitinous exoskeletons of arthropods are feed on and regurgitated in different forms of pellets. Therefore, it is essential to know the size, shape, color of regurgitated pellet at field condition.

Objective: To know the forms pellets of owl species.

Methodology: To know the forms pellets of owl species; different age categories of rice field rats i.e. juveniles, sub adults and adults were collected from the field and were kept in confine situation and reared for 7-10 days to check the presence of any chronic rodenticide inside its body. The safe and selected rats were weighted and released into the feeding box to a single captured owl in an aviary separately. The daily prey uptake as well as the number, shape and color of regurgitated pellets by different age category of owls were recorded. Air dried pellets were easily analyzed by 0.5N NaOH solution. Food preference of owl species did not conduct due to lack of owl aviary in BRRI.

Key findings: About 90 pellets were collected from the reared owl species as well as from owl watching towers. The fresh pellets of barn owl were dark color, oval-shaped, spread bad smell but the collected pellets became graish-brown when air-dried for 3-5 days. Thus flesh, bone, skulls, hair, feathers of vertebrates, and chitinous exo-skeletons of arthropods were separated easily what barn owl feed on. The species of rats or other food materials were identified by studying skulls and bones found in pellets and comparing with the reference materials.

Key words: Regurgitate pellets, prey uptake, watch tower

B. Implementation Status

1. Procurement (component wise): BRRI Component:

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment					
GD2 - Procurement of Furniture -	a) Executive Table b) Executive Chair c) File Cabinet d) Steel Almira e) Visitor/Front Chair-4 f) Computer Table g) Computer Chair h) Book Self	20000 10000 20000 24000 16000 5000 3500 14000	-	Not purchased	Supplied Furniture rejected by Central Receiving committee.
GD3- Procurement of Computer and Accessories	a) Desktop Computer b) Laptop c) Laser Printer d) Scanner e) UPS (Offline)	60000 60000 20000 10000 10000	a) Desktop Comp.-1 b) Laptop-1 c) Laser Printer-1 d) Scanner-1 e) UPS -1 (Offline)	59850/- 59850/- 19780/- 9890/- 9910/-	Purchased
(b) Lab & Field equipment					
GD_{1-} Procurement of chemicals and Apparatus -	Chemicals a) Ethanol 99% R grade b) NaOH drihydrate c) Formaldehyde Apparatus: a) Glass Jar b) Glass Cylinder c) Petridis d) Test tubes e) Ice Box (18L)		Chemicals a) Ethanol 99% R grade-10L b) NaOH drihydrate-6kg c) Formaldehyde- 2L Apparatus: a) Glass Jar (20) b) Glass Cylinder (50) c) Petridis (100) d) Test tubes-200 e) Ice Box (18L)	 34500/- 5700/- 4920/- 13958/- 39795/- 12490/- 19981/- 9920	Purchased
GD4- Procurement of Electronic Devices	a) Digital Camera b) Night Vision Camera c) Refrigerator (340L) d) Portable fan (52 inches)	25000 67500 45000 10600	-	Not purchased	Bidder not supplied
GD6- Procurement of GPS tags and software -	a) GPS tags / Radio tracking collars and others b) Software and its installation	320000 100000	-	Not purchased	Work order not provided by BRRI procurement section
GD7- Procurement of Field Instruments	a) Web cam & accessories b) Solar power system with rechargeable batteries	120000 125000	-	Not purchased	Work order not provided by BRRI Procurement section

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
GD8- Procurement of Field Equipments	a) Owl watching tower b) Owl nest boxes c) Rat traps d) Portable aviary e) Container f) Ladder g) Rearing cages (Different sizes)	108000 192000 20000 55000 10000 15000 50000	-	Not purchased	Bidder not supplied due to time constrain.
GD9- Procurement of rat enclosure sheet	Rat enclosure sheet (GP Sheet, 22gauge, 1.58m wide) for field	190000	-	Not purchased	Bidder not supplied
GD10- Procurement of barn owl observatory tower for rat enclosure	a) Erecting GI Poll b) IP Camera c) Solar power and others	130000	-	Not purchased	Work order not provided by BRRI Procurement section
(C) Other capital items					
GD5- Procurement of Motor cycle -	Honda CB shine SP -125CC, Origine- Japan (Including Registration charge and others)	175000/-	Honda CB shine SP- 125 CC, Origine- Japan (Including Registration charge)	174700/-	Purchased. Received Cheque was not drawn
Works					
WD1- Construction of owl and rat breeding ground	a) Construction of owl rearing and breeding room at BRRI HQ, Gazipur b) Repair and Renovation work of existing rat research old building room at BRRI HQ, Gazipur c) Construction of rat breeding ground at BRRI HQ, Gazipur	3250690.16 817947.39 753260.86	-	Not executed	OTM tender-cancelled due to different reasons*

NB: OTM tender cancelled*

***First time:** Tender uploaded to e-GP on July/2020 but cancelled due to wrong posting of budget source (as revenue).

****Second:** Tender uploaded in e-GP but cancelled due to the argue of NATP2 procurement section. The argue was "the procurement entity should be the sub-project PI, not Md. Zahid Hasan, Executive Engineer, BRRI.

*****Third:** Problems solved with the discussion of three procuring authorities (BRRI, BARC and Consultant of NATP2), but BRRI procurement section didn't upload the e-GP tender due to "the short period of time" of the sub-project (PID: 087).

BARI Component:

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment GD1	Executive Table-1 Executive Chair-1 File Cabinet-1 Steel Almira-1 Visitor/Front Chair-4 Computer Table-1 Computer Chair-1 Desktop Computer-1 Laptop Computer-1 Laser Printer-1 UPS-1 Scanner-1	20,000/- 10,000/- 20,000/- 24,000/- 16,000/- 5,000/- 3,500/- 60,000/- 60,000/- 20,000/- 10,000/- 10,000/-	Executive Table-1 Executive Chair-1 File Cabinet 1 Steel Almira-1 Visitor/Front Chair-4 Computer Table-1 Computer Chair-1 Desktop Computer-1 Laptop Computer-1 Laser Printer-1 UPS-1 Scanner-1	20,000/- 10,000/- 19,000/- 23,500/- 16,000/- 4,000/- 3,500/- 59,985/- 59,985/- 19,985/- 9,985/- 9,985/-	
GD2	Digital Camera-1 Night vision Camera-1	25,000/- 67,500/-	Digital Camera-1 Night vision Camera-1	24,985/- 67,490/-	
(b) Lab & field equipment GD4	Owl watching tower-40 Owl nest boxes-40 Container-4 Portable aviary-5 Receivers-1 Radio tracking collars/others-20	24000 140000 8000 7500 60000 400000	Owl watching tower-40 Owl nest boxes-40 Container-4 Portable aviary-5 Receivers-1 Radio tracking collars/others-20	28000 120000 12000 5000 74450 399520	
GD5	Web cam & others-8 Solar power system with rechargeable batteries-4	48000 50000	Web cam & others-8 solar power system with rechargeable batteries-4	47840 49920	
(c) Other capital items GD3	Motor cycle-1	1,48,890/-	Motor cycle-	1,48,800/-	

2. Establishment/renovation facilities: (Only BARI)

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	
Repairing and renovation of Owl rearing house WD1	5,30,000/-	5,12,000/-			
Repairing and renovation of rat breeding ground WD2	7,00,000/-	6,85,500/-			

3. Training/study tour/ seminar/workshop/conference organized: (Combined)

Description	Number of participant			Duration (Days/ weeks/ months)	Remarks
	Male	Female	Total		
(a) Training (Farmers)-2	53	11	64	one day	
(b) Workshop (Inception)	72	8	80	one day	
(c) Others (if any)					

C. Financial and Physical Progress: Combined

Fig in Tk

Items of expenditure/ activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	4696545.97	2094778.87	3329550.01	-1234771.14	32.54	
b. Field research/ lab expenses and supplies	11866470.00	6358900.62	4628621.00	1730279.62	45.24	
c. Operating expenses	991801.50	392739.83	531366.33	-138626.50	5.19	
d. Vehicle hire and fuel, oil & maintenance	843370.00	386574.68	318840.00	67734.68	3.12	
e. Training/ workshop/ seminar etc.	740044.00	234298.59	274934.00	-40635.41	2.69	
f. Publications and printing	330000.00	124730.23	100000.00	24730.23	0.98	
g. Miscellaneous	228543.53	90408.73	217233.00	-126824.27	2.12	
h. Capital expenses	1092800.00	791786.46	831220.00	-39433.54	8.12	
Total	**20789575.00**	**10474218.01**	**10231764.34**	**242453.67**	**100.00**	

BRRI component:

Fig in Tk

Items of expenditure/ activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	3139721	538025.86	1772797	-1234771.1	39.98	
b. Field research/lab expenses and supplies	8579020	3585670.62	1858891	1726779.62	41.92	
c. Operating expenses	294712	65787.84	216582	-150794.16	4.88	
d. Vehicle hire and fuel, oil & maintenance	250770	87574.68	7240	80334.6773	0.16	
e. Training/workshop/ seminar etc.	380044	64298.59	104934	-40635.412	2.37	
f. Publications and printing	150000	24730.23	0	24730.2263	0.00	
g. Miscellaneous	128584	13408.73	140233	-126824.27	3.16	
h. Capital expenses	595600	294586.46	334020	-39433.545	7.53	
Total	**13518451**	**4674083**	**4434697**	**239386**	**100**	

BARI component:

Fig in Tk

Items of expenditure/ activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent*	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	1556824.97	1556753.01	1556753.01	0.00	26.85	
b. Field research/lab expenses and supplies	3287450.00	2773230.00	2769730.00	0.00	47.78	
c. Operating expenses	697089.50	326951.99	314784.33	3067.66	5.43	
d. Vehicle hire and fuel, oil & maintenance	592600.00	299000.00	311600.00	0.00	5.38	
e. Training/workshop / seminar etc.	360000.00	170000.00	170000.00	0.00	2.93	
f. Publications and printing	180000.00	100000.00	100000.00	0.00	1.73	
g. Miscellaneous	99959.53	77000.00	77000.00	0.00	1.33	
h. Capital expenses	497200.00	497200.00	497200.00	0.00	8.58	
Total	**7271124.00**	**5800135.00**	**5797067.34**	**3067.66**	**100.00**	
*Unspend balance has sent to PD, PIU-BARC, NATP2 by two pay order dated on 20.12.2021						

D. Achievement of Sub-project by Objectives (Tangible form): Technology generated/ developed

General/ spf the sub-project	Major technical activities performed in respect of the set objectives	Output(i.e. product obtained, visible, measurable)	Outcome(short term effect of the research)
General	1. Recruitment of contractual staff 2. Purchase of aviary equipment and accessories	1. Two lab technician and an accountant worked in the sub-project 2. Small/portable aviary related equipments purchased	Sub-project activities were executed smoothly with the help of re**ecific** objectives ocruited staffs and purchased equipments
Obj.1: To study the bio-ecology of available owl species and their mass rearing techniques	1.1 Survey on owl species in different areas (Gazipur, Barishal and Jashore district) of Bangladesh	1.1 Farmers knowledge, attitude and perception about owl and their way of conservation were known.	1.1 Farmers base line information were known to control rat using owl.
	1.2 Collection, identification and documentation of available owl species in Bangladesh	1.2 Three species of owl were collected, reared and characterized. Thirteen species of owl were documented.	1.2 Study on owl is the initial work in Bangladesh. Information will helpful for further planning..
	1.3 Study on the food preference of owl species and the forms of their pellets	1.3.1 Barn Owl and spotted owlet consumed more than one prey per day and chiefly foraged in agricultural crop fields and consumed both small mammals and insects of agricultural importance under crop ecosystems. 1.3.2 The fresh pellets of barn owl were dark color, oval-shaped, spread bad smell but the collected pellets became greyish-brown when air-dried.	1.3.1 Small mammals are dominant in the diet of barn owl indicates that they have potential in regulating rat and mouse population's 1.3.2 Farmers are able to understand the difference of pellets regurgitated by different owl species.

General/ spf the sub-project	Major technical activities performed in respect of the set objectives	Output(i.e. product obtained, visible, measurable)	Outcome(short term effect of the research)
2: To develop and validate the effective rat management technique(s) using owl in rice and wheat ecosystem	2.1 Development of effective rat management techniques in rice ecosystem	2.1 Four different types of eco-friendly rat capture devices were developed in rice field ecosystem.	2.1 Eco-friendly and effective rat capture devices are used in rice field to keep the rodenticide free environment.
	2.2 Placement and observation of owl watching tower and nest boxes in rice fields	2.2.1 Significantly the lowest number of active burrow (0.6) was recorded in 0-25-meter distance around the watching tower followed by 25-50 m (1.5) distance and the highest number of active burrows was observed in 50-75 m (7.5) distance from watching tower both in Rajshahi and Gazipur. 2.2.2 Rat damaged and numbers of active burrows were higher as increase the distance from the watch tower areas. 2.2.3 Owl occupied 55% nest boxes in Rajshahi and that was 45% in Gazipur. 2.2.4 Triangular shape nest box is suitable for barn owl for their nesting and breeding	2.2.1 Owl watching towers (OWT) are effective from dusk to dawn. The collected and observed pellets of owl from WT confirmed the rat predation. OWT can also be used as perching device during day time for insect feeding birds, Black drongo. 2.2.2. Rodent damage can be reduced by conserving owl in nature through installing watch tower and nest boxes. 2.2.3 Nest box occupied by Owl indicating rat abundance in cropped area and such box was suitable for the bio-control agents like owl. 2.2.4 Triangular shape nest box used in project sites as well as in farmer's field. Rajshahi ecosystem is more suitable for Barn owl due to having higher tree plantation. However, Gazipur is suitable for spotted owl.
	2.3 Assessment of rat damage in treated (surrounding the watching tower, nest box) and untreated areas (control)	2.3 Rat damaged and number of active burrows were higher as increase the distance from the watch tower. In Gazipur maximum nest boxes were occupied by spotted owlet (45%) (*Athena brama*) and in Rajshahi most of the nest box occupied (55%) by barn owl (*Tyto alba*).	2.3 Rat damaged per cent and number of active burrows gradually increased as increase the distance from the watch tower. Owl used the tower as perch during night period. So rat damage was low close to the watch tower. Rat damage was comparatively higher during booting to mature stages in Boro 2019 and T. Aman 2019 season though the per cent rat damage was below the 0.38% in BRRI research fields.
3: To upscale the developed techniques and buildup public awareness on owl conservation for sustainable rat management	3.1 Development and validation of rat management techniques through owl conservation	3.1.1 Awareness on owl conservation is going on through popular articles in Krishikatha. However, mass rearing, release were not yet done. 3.1.2 Watch tower and rat capturing devices were further tested in BARI & BRRI HQ and in sub-project sites.	3.1.1 Awareness on owl conservation is going on through popular articles in Krishikatha. However, mass rearing, release were not yet done. 3.1.2 Arround 15 % active burrow become dead indicating the biocontrol agent working properly and reduced the number of active burrows.
	3.2 Training and awareness building activities	3.2 BARI trained up sixty-four farmers about awareness building on owl conservation, owl species composition, their biology and rat management for sustainable crop production	3.2 Farmers gathered knowledge about the effectiveness of new technology. As awareness building activities, published one booklet and one Training Manual on rat management and owl conservation

E: Information/Knowledge generated/Policy generated

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome(short term effect of the research)
Obj.1: To study the bio-ecology of available owl species and their mass rearing techniques.	1.1 Survey on owl species in different areas of Bangladesh	1.1 Local farmers perception, knowledge and attitude about owls, and their conservation implications in three districts of Bangladesh were known	1.1 Bio control agents (owls) were active and reduced the rat population at permissible level.
	1.2 Collection, identification and documentation of available owl species in Bangladesh	1.2 Relative abundance and documentation of available owl species in three districts of Bangladesh	1.2 Farmers or users able to know the available species in their areas
	1.3 Study on the food preference of owl species and the forms of their pellets	1.3 Diets of barn owl (*Tyto alba*) and spotted owlet (*Athene brama*) at Gazipur and Rajshahi district of Bangladesh	1.3 The collected and observed pellets of owl from WT confirmed the rat predation.
2: To develop and validate the effective rat management technique(s) using owl in rice and wheat ecosystem	2.1 Development of effective rat management techniques in rice ecosystem	2.1 Eco-friendly and effective rat capture devices (Pepsi can with bucket, baby milk powder can with bucket and PVC pipe with bucket and single capture rat trap) are used in rice field	2.1 Owl watching towers and Ecofriendly devices are used to keep the environment rodenticide free.
	2.2 Placement and observation of owl watching tower and nest boxes in rice fields	2.2 Owl watching towers (OWT) are effective from dusk to dawn. OWT can also be used as perching device during day time for insect feeding birds, Black drongo.	2.2 Barn Owl- a silent killer of rat need to be conserved in nature. Rodent damage reduced by conserving owl in nature by installing watch towers and nest boxes.
	2.3 Assessment of rat damage in treated (surrounding the watching tower, nest box) and untreated areas (control)	2 3 Assessment of rat damage surrounding the watch tower areas and nest box occupied by owl.	2.3 Based on the rat damage, farmers will take necessary action.
3: To upscale the developed techniques and buildup public awareness on owl conservation for sustainable rat management	3.1 Development and validation of rat management techniques through owl conservation	3.1 Ecofriendly rat management techniques were developed and validated to use in rice, wheat and vegetables ecosystem.	3.1 Awareness on owl conservation using popular articles in Krishikatha.
	3.2 Training and awareness building activities	3.2 As awareness building activities, published one booklet and one Training Manual on rat management and owl conservation	3.2 Farmers gathered knowledge about the effectiveness of new technology.

F. Materials Development/Publication made under the Sub-project

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet / leaflet/flyer etc.		Booklet	Biological control of rodent through owl conservation
Journal publication	1	Initiated	Ecofriendly rodent management in rice-wheat ecosystem, Bangladesh Rice Journal
Video clip/TV program			Have some video clips but not in presentation format
News Paper/ Popular Article	1	5	Krishi Katha: a) Hossain, M.M., Haque, S.S. and M.M.K. Kabir. 2016. Owl for Rat Management: An Environment Friendly Natural Process (in Bangli), pp. 16-19. *In:* National Rat Control Campaign 2016. Plant Protection Wing, DAE, Khamarbari, Dhaka. 31P. b) Hossain, M.M., Haque, S.S. and Hossain, M.M. 2019. Ecological Management of rat. Pp. 13-16. In: National rat campaign, October-November, 2019. Plant Protection Wing, DAE, Khamarbari, Dhaka. 32P. c) Hossain, M.M., Haque, S.S. and Hossain, M.M. 2019. Modern Technology to Protect Rice Field Rat.. Pp. 9-11. In: Special Issue of Krishi Katha. Plant Protection Wing, DAE, Khamarbari, Dhaka. 32P. 6th edition, 79th year. d) Hossain, M.M., Haque, S.S. and Hossain, M.M. 2020. Coordinated rat Management for food security. Pp. 5-8. In: Special Issue of Krishi Katha. Plant Protection Wing, DAE, Khamarbari, Dhaka. 32P. e) Hossain, M.M., Haque, S.S. and Hossain, M.M. 2020. Ecological Management of Rat- A Non-chemical and Biological Approach. Pp. 20-21. In: National rat campaign, October-November, 2020. Plant Protection Wing, DAE, Khamarbari, Dhaka. 32P.
Other publications, if any		Training Manual	Eco-friendly rodent management

G. Description of generated Technology/Knowledge/Policy:

i. Technology Factsheet (title of the technology, introduction, description, suitable location/ecosystem, benefits, name and contact address of author)

Title of the technology: Barn owl- a silent killer of rat need to be conserved in nature.

Introduction: Barn owls are generally considered to be the most widely distributed raptor in the world, occupying all over Bangladesh. These birds are highly evolved for preying on rodents, equipped with powerful talons, a sharp beak, fluted feathers for silent flight, nocturnal habits, excellent night-time vision, and some of the most acute hearing animal on earth. Traditionally, rural populations in many places considered barn owls to be birds of evil omen. On the contrary, they help us a lot.

Description of the technology: Watching towers (WT) are to be placed in different rice ecosystem (fields) in Bangladesh to facilitate barn owl for their preying at night using as perching device. Three and half-meter height is suitable for effective preying. Owl WTs are effective from dusk to dawn. The newly developed rat burrows become inactive surrounding the 50m diameter of WT, and increase in number (inactive burrows) by 15-20% fort-nightly. Owls regurgitate the previous prey item as "pellet" before preying new one. Therefore, cone shaped nylon net is to be used beneath the WT to collect the regurgitated pellets. Collected regurgitate pellets from the WTs are the indication of the barn owl preying activity.

Watching Towers have the potential in regulating rat and mouse population's in crop fields and may be treated as one of the components in integrated rodent pest management options. In addition, WTs would also be used as perching devices during day time for insect feeding/predatory birds, black drongo (*Dicrurus adsimilis*).

Suitable locations: Anywhere in Bangladesh especially in rat endemic areas like rice, vegetablse and wheat field, polder, poultry industries and in hills ecosystem (bamboo growing areas) etc.

Benefits of the technology: Owl watching towers (WT) are effective from dusk to dawn. Newly developed rat burrows become inactive around 100 diameter areas. One pair adult with two offspring can feed around 1000 rats per year.

Name and contact address of author:
Dr. Md. Mofazzel Hossain
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Entomology Division, BRRI, Gazipur – 1701
E-mail: mofazzel70@yahoo.com, mofabrri@gmail.com

Remarks (if any): Owl watching tower need to be replicated in rat endemic areas

Related photographs


Barn owl


Owl watch tower


Regurgitated pellets


Skull and bones in pellet

ii. Technology Factsheet

Name of the technology: Biological control of rodent through owl conservation

Introduction: Rodents are one of the most important pests in crop field damaging crop from sowing to harvest also in stored house. Owls specially barn owl has been found to be very effective biological agent for controlling rodent. Its use not only increases farmers' income by reducing crop losses and saving the cost of chemical rat killer, it also saves crop fields from chemical pollution. An additional benefit is that farmers are less exposed to harmful chemicals.

Description of the technology: It is a biological control method. Rat can be controlled by conserving owls. Both owls and rats are active at night. The main food of owls is rats. Owls eat at least 1-2 rats per day and if there are children in the owl nest, they collect up to 4-25 rats per day. Owl habitat, breeding environment is declining day by day. Making owl nest boxes and setting in different trees and buildings to increase their habitat will create opportunities for owls to live there and create a breeding environment. If a X-shaped watch tower is set up in the field, owl will sits on it and watch to catch its prey, the owl will be able to sit on the watch tower at night and make it much easier to catch prey. The watch tower is not only a place for owls to sit, but also for various birds such as black drungo, finches, storks, etc. to catch insects during the day. It can also be called Smart tower. With this, the birds will eat the harmful insects of the crop during the day and the owls will use it for the prey of the rats at night. Our study found that the amount of crop damage caused by rats and the number of fresh rat holes (active burrow) in the vicinity of the watch tower was much lower than the area without the watch tower. Using watch towers to control rats in a natural way will be much easier and will save huge money resources. Watch tower will be used for every 50 meters away in the field will yield good results and the cost will be much less. If we use an owl nest box, we can get good results by setting up a nest box for every 10 acres of land. It is better not to use poison while using this method. It is safe for human and other beneficial animals and easily applicable technique.

Suitable location: This technique can be applied in all rat affected crop fields and poultry rearing areas. It can be used in any season and any places of Bangladesh.

Benefit of the technology: Rat could be controlled biologically by conserving barn owl with the help of nest box and watch tower. Conserving owls will not only result in better rat control preventing huge crop losses, but will also prevent indiscriminate use of rodenticide, thus preserving the ecological diversity and maintaining ecological food chain in the ecosystem.

Name and Address of the Researcher (including mobile and e-mail)

Dr. Md. Shah Alam
Principal Scientific Officer, Vertebrate Pest Division
Bangladesh Agricultural Research Institute, Gazipur-1701.
Mobile No.: 01911857586, E-mail: alamvpd@yahoo.com

iii. Effectiveness in policy support (if applicable): Department of Agricultural Extension (DAE) has been used perching technology to protect rice crops from damaging insect pest. This perching device can be modified to watching tower to control insects at day time and rats at night time. So that onetime investment can control both the pest easily. Thereby, WTs would also be used as perching devices during day time for insect feeding/predatory birds, black drongo (*Dicrurus adsimilis*).

H. Technology/Knowledge generation/Policy Support (as applied)

i. Immediate impact on generated technology (commodity & non-commodity)

Commodity:

- Active burrows developed by rat in field reduced
- Rat damage in different crop fields reduced
- Rat damaged in different infrastructure reduced

Non-commodity:

- Farmers income increased due to less infestation on crops and infrastructures. So, fund for management will be saved.

ii. Generation of new knowledge that help in developing more technology in future

Barn owl, a silent killer of rat and Owl Watch tower- a perching device for owl.

iii. Technology transferred that help increased agricultural productivity and farmers' income

The existing perching device (used for insect feeding birds)) can be modified to Owl watching tower to control insects at day time and rats at night time. So that onetime investment can control both the pest easily and economically.

iv. Policy support

Perching device can be modified to watching tower to control insects at day time and rats at night time. So that onetime investment can control both the pest easily.

I. Information regarding Desk and Field Monitoring

i. Desk Monitoring [description & output of consultation meeting, monitoring workshops/seminars etc.)

Time	Description	Output
Feb 28, 2019	Coordination meeting with all coordinators and PI	The coordination meeting was organized by BARI under the chairmanship of Director (Res), BARI. A detailed discussion on success and failure in implementing sub-project's and their targeted interventions towards agricultural development was shared with all participants with a view to overcoming it in the successive years. Similarly, A coordination meeting was also organized by BRRI under the Chairmanship of Director (Research), BRRI. Detail discussion was occurred on the progress of ongoing sub-projects.
30.04.2019	World Bank Mid-Term Review Mission at BARI with all Coordinator and PI	Presentation on CRG Sub-projects achievement & PBRG Sub-projects Progress by BARI. Discussed on PBRG Sub-project achievement on time. In BRRI, sub-project Coordinator and Director (Research), BRRI presented the summery progress of all CRG and PBRG sub-projects implemented in BRRI.

Time	Description	Output
18.11.2019	Monitoring and Evaluation team, PIU-BARC, NATP-2 organized annual review workshop, In this workshop, on-going sub-project activities were presented by PI.	Respected members discussed as well as evaluated the sub-project activities and put their valuable comments, constructive criticism and suggestions. Sub-project activities were impetuous on the basis of their suggestions.
15.07.2020	Virtual meeting on the Progress Monitoring of PBRG Sub-projects with all coordinator and PIs.	A detail discussion was held about the sub-project activities in covit-19 situation and progress.
21.11.2020	Monitoring and Evaluation team, PIU-BARC, NATP-2 organized annual progress review workshop, In this workshop, on-going project activities were presented by PI.	Respected members discussed as well as evaluated the sub-project activities and put their valuable comments and suggestions. Their comments and suggestions were helpful for the smooth running of the project.

ii. Field Monitoring (date & no. of visit, name and addresses of team visit and output)

Time	No. of visit	Name and addresses of Team visit	Output
31.03.2019	01	1. Dr. Md. Aziz Zilani Chowdhury Member Director (Crop), BARC, Farmgate, Dhaka 2. Dr. Md. Harunur Rashid, Director (Human Resource and Training Unit), BARC, Farmgate, Dhaka 3. Dr. Zakiah Rahman Moni, Senior Scientific Officer, Technology Transfer and Monitoring Unit (TTMU), BARC, Farmgate, Dhaka 4. Md. Abdur Rahman, Monitoring Associates, BARC, Farmgate, Dhaka	1. All sub-project staffs from BRRI and BARI need to be trained soon to implement sub-project activities smoothly. 2. Discussed on sub-project activities, progress and achievements. 3. Owl watching towers (WT) need to be replicated in rat endemic areas

iii. Weather data, flood/salinity/drought level (if applicable) and natural calamities

Rainy weather for long time disturbed the flight of owl. Owl could not prey properly at that time. Owl starved for food (rodent) and become weak. Covid-19 pandemic situation had both direct and indirect effect on owl and rat feeding activities.

J. Sub-project Auditing (covers all types of audit performed)

BRRI part

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
FAPAD		1,60,071.61	23.10.2018	
FAPAD	Labor need to recruit through out sourcing	10,69,085.00	17.11.2019	Observation managed by Broad sheet answer. Okay now.
FAPAD		17,25,649.50	02.11.2020	
FAPAD		18,14,330.00	19.10.2021	

BARI part

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
FAPAD		1,60,071.61	23.10.2018	
FAPAD		12,05,085.00	17.11.2019	
FAPAD		17,25,649.50	02.11.2020	
FAPAD		27,06261.23	18.10.2021	

K. Lessons Learned

i) Barn owls are mostly nocturnal. Diurnal activities of owl are limited. Sub-project staffs are active during day time. Night time activities with owl were limited. So, sub-project faced lot of problem to manage the implementing activities and it was challenging.

ii) Owls specially barn owl has been found to be very effective biological agent for controlling rodent. Its use not only increases farmers' income by reducing crop losses and saving the cost of chemical rat killer, but it also saves crop fields from chemical pollution.

iii) If X-shaped watch tower is set up in the field, the owl will be able to sit in the watch tower at night and make it much easier to catch prey. The watch tower is not only a place for owls to sit, but also for various birds such as black drongo, finches, storks, etc. to catch insects during the day. It can also be called smart tower for owl and black drongo.

iv) Three and half-meter height is suitable for effective preying. Owl WTs are effective from dusk to down. The newly developed burrows became inactive surrounding the 50m diameter of WT, and increased in number (inactive burrows) by 15-20% fort-nightly.

L. Challenges (if any)

- Sub-project started four months later after the signing of LoA, fund received lately.
- The approved budget for sub-project was not sufficient for the establishment of owl aviary and rat breeding ground. It was further approved later by the Executive Chairman, BARC. Finally, the owl aviary and rat breeding ground were not established at BRRI due to some unavoidable circumstances.

- In addition, the sub-project was more challenging to run in full swing due to un-availability of sub-project materials like owl aviary, rat breeding ground and tracking GPS etc.
- Long process was required for Lab. Technician recruitment. It took around eight months at the beginning of the sub-project.
- Sub-project has to wait for procurement section of BRRI to purchase project materials.
- Covid-19 pandemic had both direct and indirect effect on the implementation of the sub-project. Therefore, research activities were also hampered due to Covid-19.
- PI was unable to execute the sub-project activities smoothly as he transferred to BRRI Regional Station, Sirajganj after three months of the signing of LoA.
- No provision for any ornithologist in the sub-project. Therefore, species level identification hampered partly.
- Owl's fecal material is very corrosive to any metal surface. Safety measures were taken using hand sanitizer, Ethanol and different protection tools.
- Rat transmit Salmonellosis & Leptospirosis disease. Safety measures were taken during handled the rodents and owls.
- Hantavirus is a real danger whenever a person comes into contact with wild rodents, their hair, fecal matter or even their nesting material. Fortunately, we don't have Hantavirus in Bangladesh.

Limitations of using Owl:

- Motorways or duel carriage ways are not suitable for nest boxes.
- The feathers of barn owl are not water-proof and they cannot hunt in heavy rain.
- Lack of secure nest sites & their proper conversion.
- Risk to conserve owl in nature from pesticides & poisons such as DDT & Warfarin. Now, these are banned but new rodenticides, Brodifacoum & Difenacoum, are still a problem.
- Owls produce different kinds of sound. Farmer's believed that sound produced by owl at night is the sign of bad luck.

M. Suggestions for Future Planning (if any):

- Rat skull and bones separated from Barn owl pellets need to be studied with reference materials, or rodent skull specialist.
- Owl watching tower need to be replicated in rat endemic areas with technical know-how.
- Owl biology, ecology, habitat, preying techniques and their feeding preference should be studied rigorously.
- Ecofriendly rat trapping devices need to be fine-tuned with more research.
- More training on "Ecologically based rodent Management options" need to be executed in rat prone areas.
- More leaflets, booklet on owls and rodents need to be published both in Bangla and English.
- More popular articles should be published in news media that "Owl is a silent killer of rat- it should be conserved in nature".
- More knowledge should be gathered about owl handling for it's proper care.
- For successful and timely completion of any sub-project, allocation of fund /resources need to be ensured in time.
- To achieve any successes/visible output in any agricultural project, minimum time duration of the project should be 4-5 years with well / proper instrumentation.

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Signature of the Coordinator

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Dr Mohammad Knalequzzaman
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Barn owl (inside cage)

Long-eared owl

Asiatic owl

Three different species of owls reared in confined cage at BRRI, Gazipur.

Barn owl (front view)

Collecting pellets from watch tower

Regurgitated pellets from barn owl

Skull and bones of rat from a pellet

Eco-friendly rat capture and killing devices:

Bucket with PVC pipe for rolling

Bucket with Pepsi can for rolling

Bucket with baby milk can for rolling

Single capture live trap with bait.

Use of eco-friendly multi-rat capture devices in rice field

Triangular nestbox on tree

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