Establishing Local Barn Owl Populations in Smallholder Plantations to Sustainably Control Rat Pest Populations in Malaysia

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1.0 INTRODUCTION

The two most widely grown crops in Malaysia and Southeast Asia in general are oil palm and rice. Both are attacked by rats; adaptable and fast reproducing animals that in tropical environments can be fully active outside all year round (Wood & Fee, 2003). *Rattus tiomanicus* is the dominant species especially in matured palms (Wood, 1968), whereas the rice field rat *Rattus argentiventer* is normally found in nurseries and young oil palms (Wood, 1982). Rats are destructive pests that not only prey on mature palm trees but also cause harm to newly planted trees and shrubs. Rats will eat the apical tissue of young shoots when they are in the nursery stage, which can result in the young shoots dying or disrupting their normal development. On young oil palms, the petiole that is responsible for the formation of the fronds is the most desirable part. When this is damaged, the formation of new fronds is inhibited. When the palm has reached maturity, the inflorescence and the fruit bunch are the primary targets of the attack by rats. Damage to the inflorescence will prevent the plant from flowering, while damage to the fruits will reduce the crop's yield (Wood, 1982). Besides food availability, rats are prevalent in oil palm plantations because of the favorable environment provided for breeding and hiding from predators (Hafidzi, 1995).

Most rat control strategies implemented in Malaysian oil palm estates involve the use of baits laced with anticoagulant rodenticides. Using barn owls (*Tyto alba*), as a biological control solution is one Integrated Pest Management (IPM) strategy that has been widely promoted and suggested for addressing rat problems. This strategy is frequently implemented in conjunction with the use of rodenticides. The utilization of wild barn owls, referred to locally as 'Burung Pungguk,' for managing rodent pests is practiced in numerous global regions and within diverse agricultural contexts. In natural settings, barn owls' nest in tree cavities, fissures, and rock crevices (Charter et al., 2010). When natural sites are limited, owls readily occupy provided artificial nest boxes (Wendt & Johnson, 2017). As a result, artificial nest boxes are commonly used to increase nesting habitat and thus sustain barn owl populations. Once established, the owls have the potential to eliminate rodent pests and increase predation pressure on rodent populations. Hence, setting up barn owl nest-boxes is a sustainable pest management practice that can concurrently reduce use of harmful rodenticides. Following this, the main objective of the project was to install nest-boxes in smallholder plantations to establish a local barn owl population that in turn, can control the rat pest population. The project began in early 2023 and was carried out at Bandar Baharu and Serdang, Kedah, Malaysia. This is the first project aimed at establishing barn owls in an oil palm plantation belonging to a smallholder project in Malaysia. The objective is to promote the concept of sustainable oil palm cultivation among smallholders. The project is a collaboration between the Malaysian Palm Oil Green Conservation Foundation (MPOGCF) and the Barn Owl and Rodent Research Group (BORG), Universiti Sains Malaysia.

Project Objective

1. To promote barn owl habitats: Installing artificial nest boxes in selected smallholder plantations to establish a local barn owl population that in turn, can control the rat pest population.
2. To train and support smallholders: Training, resources and technical assistance to smallholders will be provided to enhance their understanding of barn owl conservation and effective rat control practices. This includes educating smallholders on proper installation and maintenance of nest boxes, implementing habitat management techniques and promoting sustainable pest management approaches.

2.0 METHODOLOGY

Community engagement

The project was launched on 14 March 2023 at Masjid Al-Huda, Bandar Baharu, Kedah and involved members from MPOGCF, BORG and the local community at Bandar Baharu that involved with project. It served to educate the local community on the project as well as to increase the awareness of barn owls and their role as biological control agents. Activities during the launch included an education booth as well as a demonstration on nest box installation (Figure 1).

Figure 1 (A-F) Activities at the launch of the Barn Owl for Oil Palm Smallholders Initiative (BOSI) at Masjid Al-Huda, Bandar Baharu, Kedah.

Study site and installation of Nest Boxes

The study was conducted in smallholder oil palm plantations located in Bandar Baharu and Serdang, Kedah. This region primarily consists of a mix of agricultural land (oil palm and paddy fields), residential areas and towns with oil palm as the main crop. The selected plantations have been cultivated with oil palm for periods ranging from 4 to 20 years. The area experiences a tropical climate characterized by distinct wet and dry seasons. A total of 14 nest boxes were installed in Bandar Baharu, Kedah and 6 nest boxes in Serdang, Kedah as illustrated in **Figures 2** and **3**. The nest boxes are made from wood (50 cm width x 70 cm length x 30 cm height). The nest boxes were placed at least 5m from the ground with entrance facing a north and east direction. The coordinates for each nest box are provided in **Table 1**.

Figure 2: Location of nest box used in this study are marked with yellow sign and labelled with the number of nest box in Bandar Baharu, Kedah.

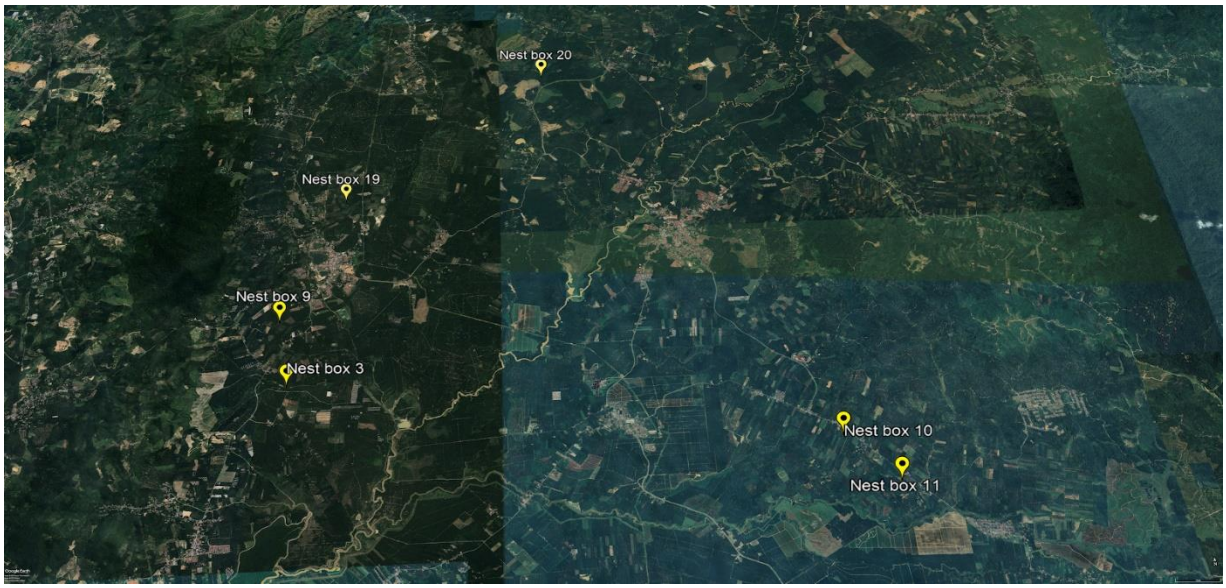

Figure 3: Location of nest box used in this study are marked with yellow sign and labelled with the number of nest box in Serdang, Kedah.

Table 1: Details of nest box location in Bandar Baharu and Serdang, Kedah.

Nest box	Address	Location (Latitude Logitude)
1	Sungai Kecil Ulu, 34950 Bandar Baharu, Kedah	5°06'30.2"N 100°32'26.3"E
2	Sungai Kecil Ulu, 34950 Bandar Baharu, Kedah	5°06'25.5"N 100°32'24.1"E
3	Bagan Samak, Kedah	5°10'37.2"N 100°36'18.0"E
4	Sungai Kecil Ulu, 34950 Bandar Baharu, Kedah	5°06'32.9"N 100°32'48.3"E
5	Kampung Berjaya, 34950 Bandar Baharu, Kedah	5°06'18.1"N 100°33'08.5"E
6	Sungai Kecil Ulu, 34950 Bandar Baharu, Kedah	5°06'02.0"N 100°32'19.7"E
7	Kampung Parit Teropong, Jalan, 34950 Bandar Baharu, Kedah	5°06'19.7"N 100°32'13.1"E
8	Kampung Bukit Tok Gula, Sungai Kecil Ulu, 34950 Bandar Baharu, Kedah	5°06'42.4"N 100°32'28.7"E
9	Air Puteh, Serdang, Kedah	5°11'39.4"N 100°36'07.0"E
10	Kampung Baharu Dendang, 34130, Kampung Baharu Dendang, Selama, Perak	5°09'30.9"N 100°43'24.4"E
11	Kampung Sungai Lempong, 34150 Selama, Perak	5°08'49.3"N 100°44'01.7"E
12	Sungai Kecil Ulu, 34950 Bandar Baharu, Kedah	5°06'36.6"N 100°32'45.4"E
13	Sungai Kecil Ulu, 34950 Bandar Baharu, Kedah	5°06'56.8"N 100°32'51.1"E
14	Sungai Kecil Ulu, 34950 Bandar Baharu, Kedah	5°07'02.8"N 100°32'46.6"E
15	Kampung Teluk Kelantan, 34950 Bandar Baharu, Kedah	5°06'55.5"N 100°33'57.6"E
16	Kampung Teluk Kelantan, 34950 Bandar Baharu, Kedah	5°07'11.4"N 100°33'59.9"E
17	Kampung Teluk Kelantan, 34950 Bandar Baharu, Kedah	5°07'26.2"N 100°34'01.2"E
18	Permatang Kerat Telunjuk, 34950 Bandar Baharu, Kedah	5°06'59.1"N 100°33'25.4"E
19	Kampung Batu Enam Belas, 09800 Serdang, Kedah	5°13'46.1"N 100°36'52.3"E
20	Chong Meng Estate office, 09800 Serdang, Kedah	5°16'10.5"N 100°39'43.8"E

Field sampling and census

After the installation of nest boxes in the field, surveys were conducted in the respective smallholder plantation areas in Bandar Baharu and Serdang, Kedah. The nest boxes were monitored every three months to assess their occupancy. The barn owl occupancy rate in the nest boxes was recorded through direct observation by climbing to inspect the nest boxes or using a stretchable pole attached to a camera to observe their internal condition. Signs of barn owl occupancy include the presence of adult owls, feathers, pellets, droppings, eggs and potential owlets. Observations were recorded and pellets were collected for further analysis.

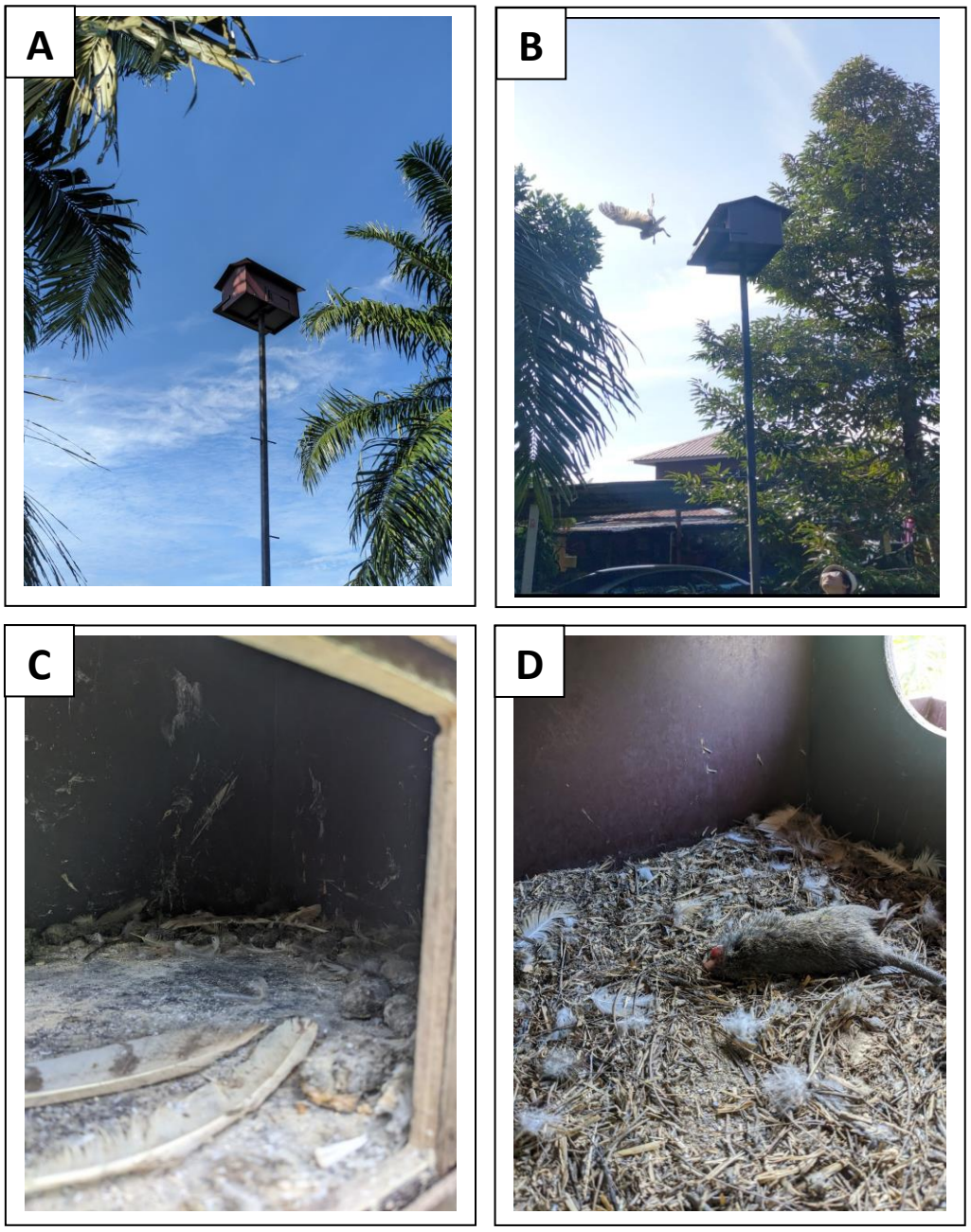

Figure 4: Survey of barn owl nest boxes in smallholder plantations. **(A)** One of the nest boxes that occupied by barn owl; **(B)** A barn owl flying out from a nest box; **(C)** Regurgitated pellets and nesting materials inside a nest box; **(D)** Rat carcass found in the nest box.

Pellet analysis

The collected pellets were soaked individually in water or alcohol and carefully processed by taking them apart to reveal the bone structures inside. The fur of the rodents was removed, and the bones were used for identification. Once all the bones were extracted from the pellets, they were stored in specimen bottles labelled with the location and date of collection. The extracted bones were identified using the identification key from Harrison & Quah (1962). The total number of preys in each pellet and species of rodents were recorded.

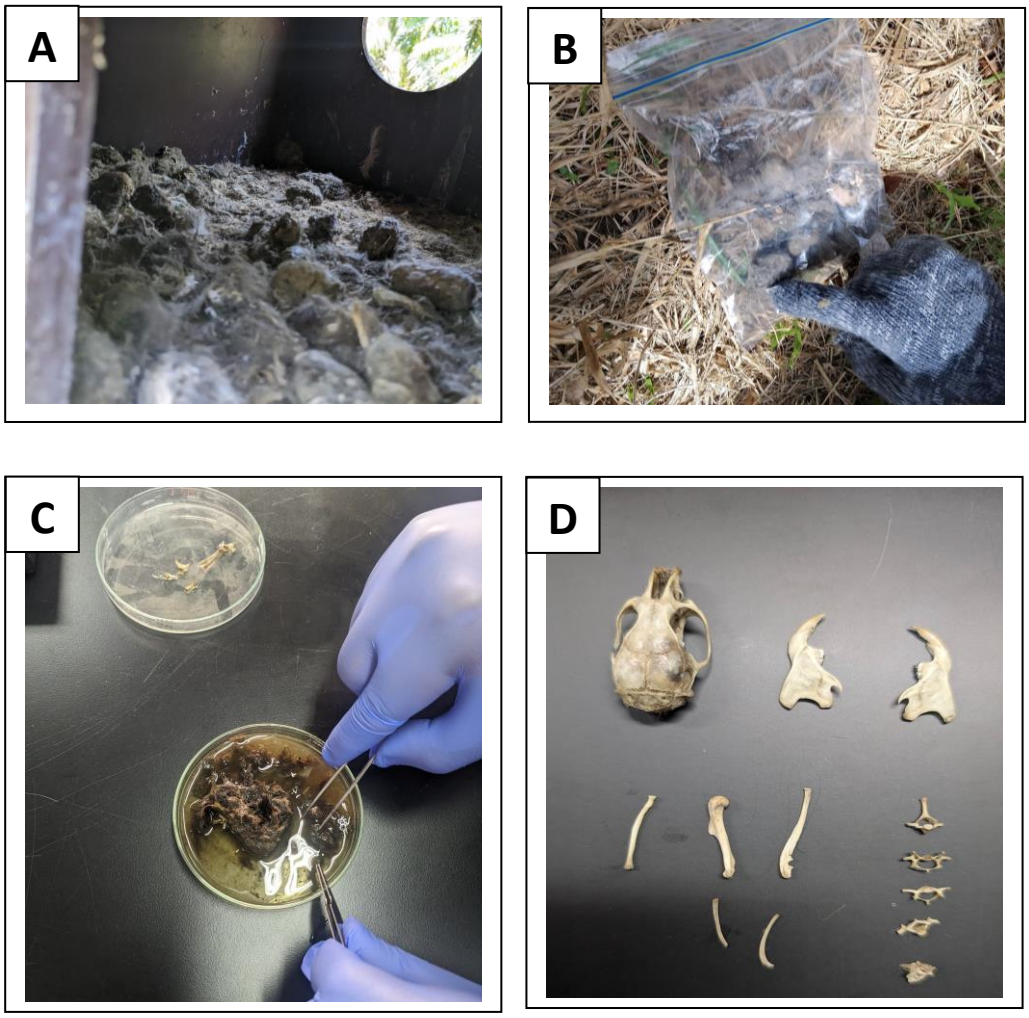

Figure 5 (A) Pellets inside the nest box; **(B)** Pellets collected from the nest box are stored in vacuum bags before being analyzed; **(C)** Pellet were dissected by using tweezers; **(D)** Rodent skulls and bone remains from pellets.

Rat damage assessment by project participants

To assess the impact of nest box installation on rodent damage, interviews were conducted with farmers in the respective plantation areas. Farmers were asked to compare the extent of rat damage to their crops before and after the installation of the nest boxes.

3.0 RESULT AND DISCUSSION

Occupancy rate of Barn Owls

The results of the occupancy rate of the barn owls throughout the study are shown in **Figure 7.** The occupancy rate of barn owl nest boxes varied significantly throughout the observation periods from October 2023 to December 2024. The initial high occupancy rate of 90% in October 2023 increased slightly to 95% by December 2023. This peak aligns with the barn owl breeding season, suggesting that nest boxes were actively utilized for nesting and raising young.

However, the occupancy rate declined sharply to 40% in March 2024. This drop can be attributed to the barn owl's non-breeding season when adult owls are less likely to occupy nest boxes as they focus on hunting and foraging activities rather than nesting. By June 2024, there was a slight recovery to 50%, potentially indicating early preparations for the next breeding season.

A more substantial increase was observed in October 2024, with an 80% occupancy rate. This resurgence correlates with the onset of another breeding season, as barn owls typically seek secure spaces for nesting during this period. Finally, the occupancy rate returned to 95% in December 2024, consistent with heightened nesting activity during the breeding season.

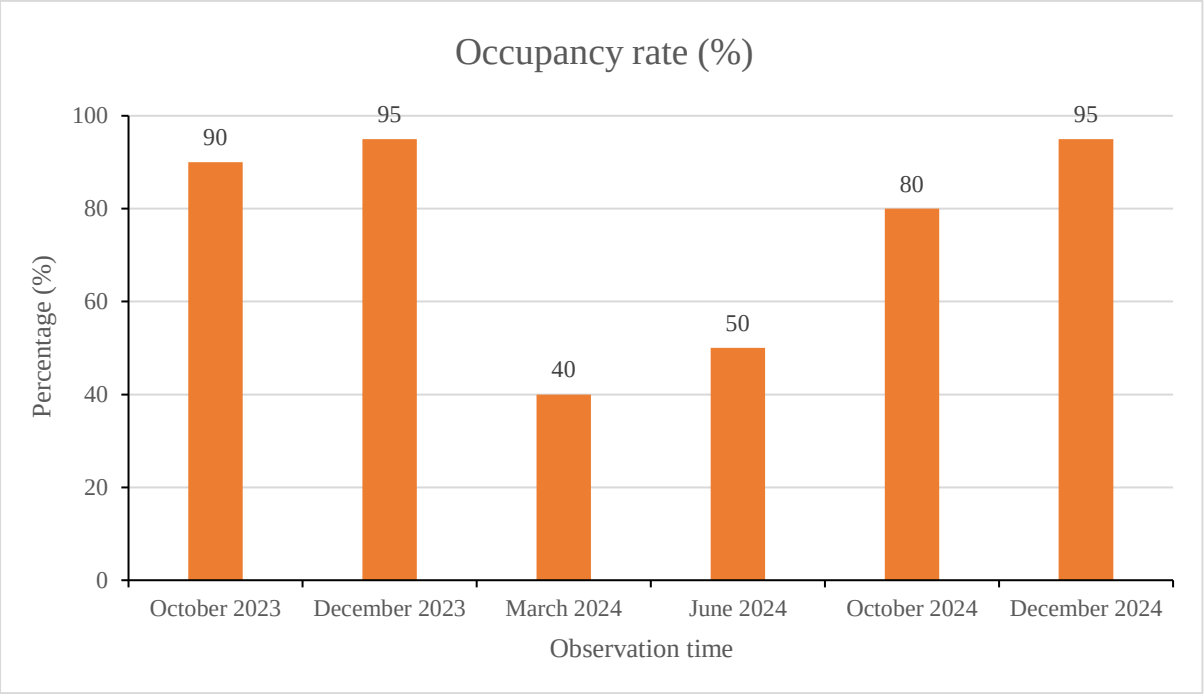

Figure 7: Barn owl occupancy rates in nest boxes at sampling sites.

Pellet analysis

Based on the **figures 8** and **9**, the barn owl pellet analysis provides insights into the activity within the nest boxes and the diet of barn owls over time. The first figure shows the number of pellets collected from the nest boxes during each observation period while the second figure illustrates the species composition of rodents identified within the pellets.

The number of pellets collected shows a trend similar to the occupancy rate of barn owls in the nest boxes. A higher pellet count, such as in December 2023 (101 pellets) and December 2024 (138 pellets), aligns with peak occupancy rates of 95% during these periods. This correlation reinforces the idea that barn owl activity in nest boxes is highest during the breeding season when the birds spend more time at the site and produce more pellets. Conversely, the lower pellet counts in March 2024 (49 pellets) and June 2024 (48 pellets) coincide with reduced occupancy rates of 40% and 50% respectively, likely due to the non-breeding season when barn owls are less dependent on the nest boxes.

The second figure highlights the diet composition of barn owls with a total of 484 rodent remains analyzed from the pellets. *Rattus tiomanicus* was the most frequent prey species comprising 52.89% of the total followed by *Rattus argentiventer* at 39.46%. These two species together accounted for over 92% of the barn owls' diet, indicating a strong preference for these rodent species. Other prey, such as *Rattus diardii* (3.72%), *Rattus norvegicus* (1.45%), and *Suncus murinus* (2.07%), were consumed less frequently, while 0.41% of the remains could not be identified.

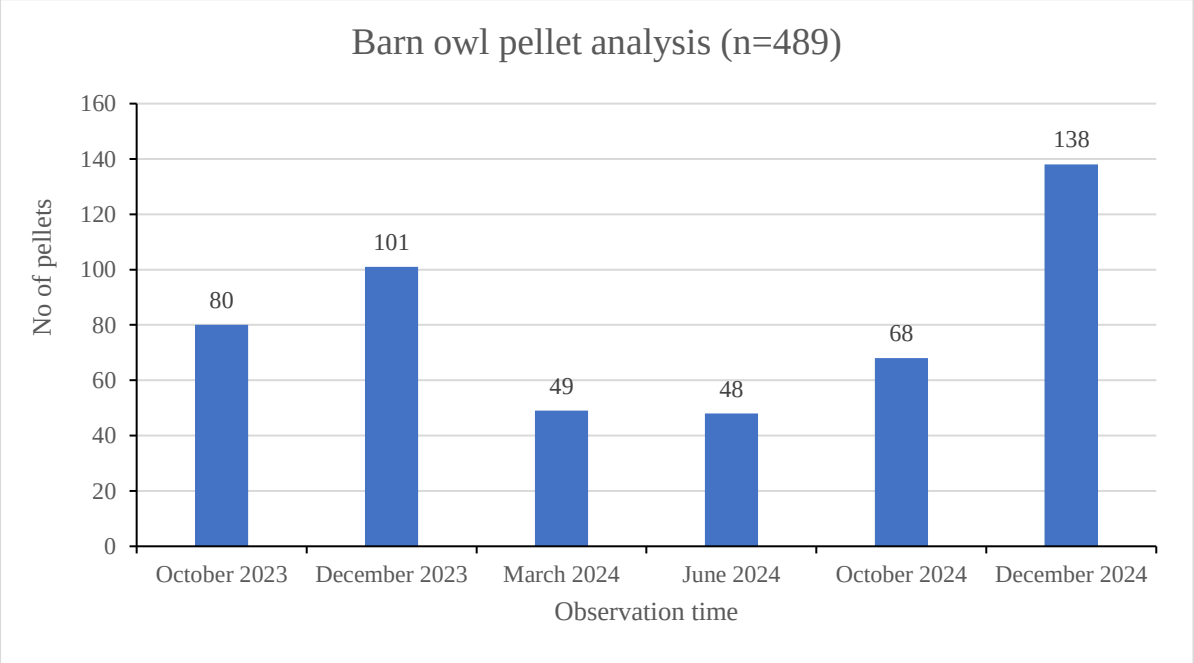

Figure 8: The number of pellets inside the nest box across the observation periods.

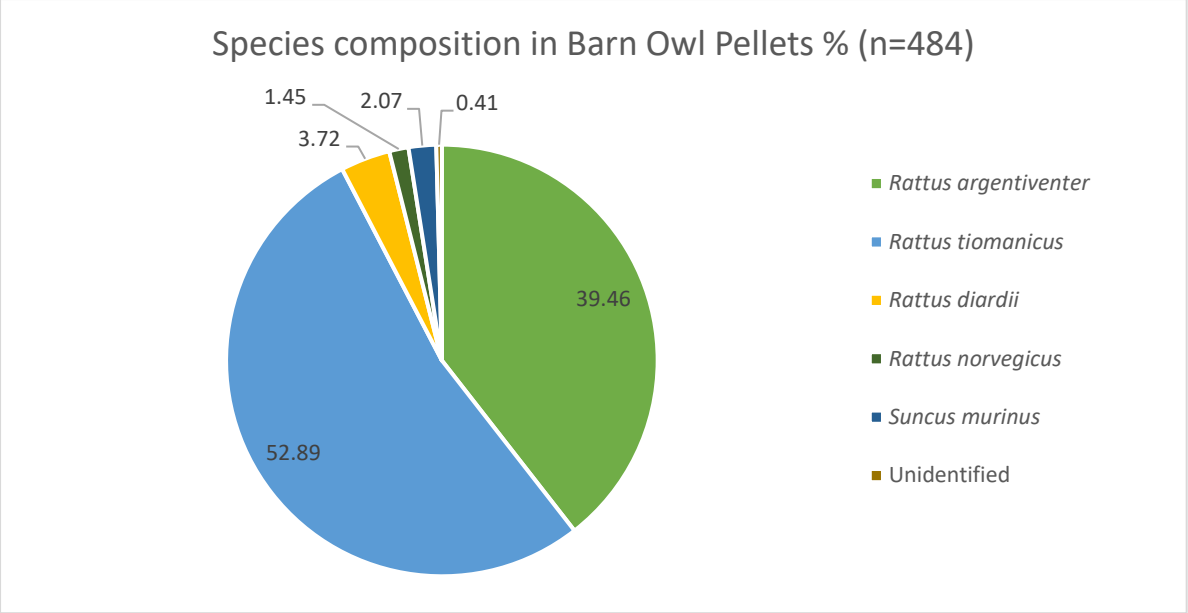

Figure 9: Species compositions of 484 Barn owl pellets collected between October 2023 to December 2024.

Breeding performance of Barn Owls

The **table 2** below shows the breeding performance of barn owls in terms of egg production, hatching success and fledging rates. Out of a total of 68 eggs laid, 60 successfully hatched resulting in a hatching success rate of 88.23%. This indicates that the majority of eggs were viable and successfully incubated.

Furthermore, out of the 60 hatchlings, **55 successfully fledged**, achieving a fledging success rate of **91.67%**. This high fledging rate reflects effective parental care, optimal brooding conditions, and adequate food availability during the growth period of the chicks.

Table 2: Egg hatching and Fledging Success in Bar Owls.

Total eggs	Hatched (n)	Hatched (%)	Fledging (n)	Fledging (%)
68	60	88.23	55	91.67

Rat population study

Based on interviews with several farmers who own and manage the barn owl nest boxes, there was a noticeable reduction in rat activity and crop damage after their installation. Prior to the installation of barn owl nest boxes, more than 20% of crops were damaged due to rodent activity. However, following the installation, crop damage dropped significantly to a threshold level of below 5%. Many farmers observed smaller areas of damaged crops, particularly during critical growth stages. Additionally, some farmers highlighted an improvement in overall yield and expressed satisfaction with the effectiveness of barn owls as a natural pest control method.

This substantial reduction in crop damage indicates that the project was successful in controlling the rodent's population in the study area, showcasing the barn owl's role as an efficient and sustainable biological control agent.

4.0 SUMMARY

1. The occupancy rate of barn owl nest boxes varied throughout the observation period (October 2023 to December 2024). Peak occupancy of 95% was observed during the breeding seasons (December 2023 and December 2024), while a decline to 40% was recorded in the non-breeding season (March 2024). The fluctuation in occupancy reflects seasonal behaviour related to nesting and hunting activities. We can conclude that breading season of barn owl in Bandar Baharu during October to December.
2. The number of pellets collected showed a positive correlation with nest box occupancy, peaking during breeding seasons (101 pellets in December 2023 and 138 pellets in December 2024). Pellet analysis revealed that barn owls primarily preyed on *Rattus tiomanicus* (52.89%) and *Rattus argentiventer* (39.46%), which together accounted for over 92% of the identified prey remains. Other prey species were consumed in smaller proportions.
3. The barn owls' breeding performance was highly successful, with a hatching success rate of 88.23% and a fledging success rate of 91.67%. These results reflect effective incubation, good parental care, and favourable environmental conditions for reproduction.
4. Farmers managing the nest boxes reported noticeable reductions in rat activity and crop damage. Crop damage decreased from over 20% to below the threshold level of 5% leading to improved yields. This indicates that the project was successful in controlling the rodent population in the study area.

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