Chapter

Sustainable Control of Rats by Rodenticide Application and Natural Propagation of Barn Owls (Tyto Javanica)

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Abstract

Rat infestation in crops has been dealt with the crudest method of hunting and trapping to reliance on natural enemies to application of rodenticides and the present approach of IPM by combining baiting with biological control by a suitable predator. Sustainability is the key feature where rat pest is kept below the carrying capacity of the habitat avoiding harming nontarget animals and preserving the environment. Combining rodenticides with predators calls for a balancing act whereby the latter is not exposed in as much as possible to intoxication by the former through secondary poisoning. Long-term exposure to the first-generation anticoagulant rodenticide (FGAR) has given rise to bait resistance, prompting the formulation of highly toxic second-generation rodenticides (SGAR) that may overcome resistance in rat but lead to bioaccumulation of rodenticide residues in the predator leading to lethal or sublethal effects on the latter, which defeats the purpose. Therefore, the choice of rodenticides and applications may bring out the desired effects for a sustainable rat control programme in combination with predators as natural enemies. This paper reports on a number of studies to achieve sustainable rat control programme by combining available rodenticide formulations with the natural propagation of barn owls *Tyto javanica* in oil palm plantation in Malaysia.

Keywords: sustainable rat control, first-generation and second-generation anticoagulant rodenticides (FGAR and SGAR), biological control, the barn owl *Tyto javanica*, oil palm plantation

1. Introduction

Rat infestation is an age-old problem around the globe. Dealing with rat pest in crops or plantation posed a long time challenge that has been tackled over the ages from the crudest method of flushing and hunting [1, 2] to mechanical trapping [3, 4] to translocation of exotic predators or classical biological control [5–12] to the applications of rodenticides of a certain active ingredient or another as a stand-alone or in combination with the propagation of a selected predator [13–18]. However, sustainability is the keyword whereby keeping the rat population below the carrying capacity of the habitat almost indefinitely and at the same time reduces the potential of harming other animals and the environment as a whole.

In agriculture and plantation where food is overly abundant to the depredators such as rodent in this case, keeping the rat population low would be particularly a challenge. Even if a method is improvised whereby huge population of rats is removed at any one time, the turnover rate is incredible that soon the vacant space will be reoccupied in no time, bringing the infestation level to where it originally was. Therefore, to design a sustainable control programme is not straightforward, and one may have to consider a number of options to get the near optimum result. In this chapter, conventional methods of baiting rats with rodenticides will be maintained but in combination with biological control approaches as outlined in the all too well familiar concept of integrated pest management (IPM).

2. Overview of rat control in Malaysia

In the olden days, rat infestation can be described as a plague, destroying whole fields of rice crop ready to harvest. The sight of fallen tillers at day break can be a so heart-rendering sight. Rats seemed to have migrated en masse from someplace else to take advantage of the ripened rice grains. In the 1900s up to the 1940s as per documented, hunting parties involving the whole village were organized to flushed out rats from their burrows and the surrounding areas and actually chasing and beating them as they showed up [19, 20]. Tens of thousands of rats were systematically bludgeoned to death in such campaigns. Despite of the decimation in numbers, there was no guarantee that the population will not be restored or replaced by a neighbouring colony. However, this gave some assurance and a temporary measure for a grain harvest of the season later after the Second World War with the advent of anticoagulant rodenticide; the warfarin became the quick answer to the rat infestation problem. It has remained in the market for decades since, although other more potent and toxic compounds found their way into the market. These classes of rodenticides are fittingly called anticoagulants from their mode of action which induces perforations of the blood vessels leading to massive loss of blood as a result of the suppression of the clotting factor in the blood. They eventually took over the more acute poisons with almost immediate effect upon consumption such as zinc phosphide. Although the application of the latter has been made unlawful, farmers are known to still subscribing to it and other unspecified compounds. Applications of the warfarin or what was eventually labelled as first-generation anticoagulant rodenticides (FGARs) have led to resistance as a consequence of prolonged exposure of the rat population over an extended period [21, 22]. Over-reliance of the warfarin has been attributed to the phenomenon of commensal rats in urban areas as well their agricultural counterparts, developing high tolerance and even complete resistance to the former [23, 24]. Not only warfarin has been made ineffective; rats are also not succumbing to other FGARs compounds perhaps by way of cross resistance. These have prompted the chemical companies to develop second-generation anticoagulant rodenticides with potency or toxicity that may reach 10fold compared to FGARs. Compounds such as bromadiolone and brodifacoum have been in the market for a reasonably long time that it is anticipated that rats will eventually overcome them as a result of long-term exposure. Apart from being highly toxic, which may expedite the development of resistance, they are also harmful to the other creatures which may consume the bait or the predators that become exposed to the compound indirectly by feeding on the prey. Indirect feeding may also involve a secondary or a top predator consequently causing tertiary poisoning. The residues of the active ingredient will build up the food pyramid or down the food chain, accumulating in the tissues and vital organs in the process. The end or top predator will bear the brunt as the bioaccumulation of the residues has reached a level that is fatal [25–27]. Another more destructive impact is the sequesterian of the residues on the eggs through the process of ovulation, leading to lower fecundity, addled eggs, lower clutch size and smaller less healthy brood [28, 29]. Many raptors in the temperate regions have become extinct in certain parts of their geographical distribution in Europe and North America [30]. Therefore, unsustainable rodenticide application has a huge impact on the wildlife at the end of the food chain [31]. Thus, to redeem the situation and reclaim our natural ecosystem, a more benign approach has to be discovered to replace the standard conventional rat baiting method.

3. Biological control of rats in oil palm

Resorting to biological control would be the method of choice as predators would keep prey population in check. In a natural environment where the ecosystem has reached an equilibrium, the population of prey and predator dynamics would always be in tandem [32–34]. This would lead to a stable relationship as there would not be cycles of trough and population crash as a result of over predation. Such an ideal association may be possible in a natural habitat where the vegetation and food resources limit the population size. The carrying capacity of the habitat for any particular prey and in turn predator would always be in keeping with the availability of resources which is heterogenous for the most part. In a monocropping situation, there is an overabundance of a particular resource to a handful of consumer species which are best to adapt and exploit the resources. As a consequence the carrying capacity of these handfuls of species may explode by several folds compared to the more heterogenous natural habitat. This in turn will bring about huge crop and economic losses. The predators may be incapacitated to deal with such high density of prey and may not be able to grow in population size to match the prey availability [35]. After all food limits not only the population density of the prey but also the nesting sites and foraging space. Therefore, the lower number of predators than what the habitat can actually support will only harvest a fraction of the surplus individuals of prey [36, 37]. This will only sustain an exceptionally high prey density which translates into high volume of crop damage. Therefore, identifying a suitable predator for a rat prey would have to take into consideration the adaptability and the carrying capacity of the habitat of the said predator.

Small mammals such as rodents would be the prey choice for most medium size predators like civet cats, mongoose, monitor lizards, the more agile snakes and birds of prey [38–47]. These resident predators casually prey on rats apart from other invertebrate prey, amphibians, small reptiles and mollusc. The varied prey is suitable for a forest habitat that is home to a myriad of invertebrates to compensate for the scarcity of rodents and larger prey which are occasionally present. Some of these animals also sample roots, tubers, fruits and other plant matter. The diet structure may not be suitable for candidacy of a biological control agent. The feeding capacity may not fulfil the criteria for an effective predator of the prey. Furthermore the range of food of such predators makes them less than ideal to be recruited as a biological control agent. Snakes and reptiles in particular have a lower food requirement by virtue of its poikilothermic nature. It may not require as much food to sustain its metabolism. Therefore, they consume less food and remove fewer prey than homeotherms.

4. The role of raptors

Birds of prey or raptors especially eagle are day hunting predator. Although the diet of eagles may consist of a range of prey, they are predominantly small mammals such as rodents. However, rats are nocturnal animals, and in terms of temporal distribution, the prey and predator are not compatible. Therefore, eagles and the like are out of the question. Having discounting the eagle and allies, the owls on the contrary are nocturnal birds of prey. They are active from dusk to dawn, and their eyes and habits are designed for hunting rodents in the cover of darkness. There are two types of owl: the true owl and the barn owl. In Malaysia and Indonesia, the two largest oil palm producers in the world, many wildlife have become adapted to inhabit and forage for food. Owls particularly barn owl has become a common resident especially where artificial nest boxes are provided. In those plantations where artificial nest boxes have been established, the barn owl population has grown considerably to effectively deal with rat infestation, especially in combination with a suitable rodenticide bait.

5. The barn owl *Tyto javanica*

The barn owl *Tyto alba* is believed to have arrived at Peninsular Malaysia from the island of Java, perhaps at the turn of the century based on the first documented observation [48]. The first recorded breeding was documented in Johore in 1969 [49]. A vagrant species, the barn owl has a worldwide distribution except for Antarctica where it is absent as well as the remote atolls in the Pacific. It is associated to farm and agriculture landscape, where it typically seeks refuge or nest in barns and other farm buildings. While barn owl is a common sight in the fields and natural landscape of Europe and North America, it is not common in the agricultural landscape of Malaysia. Rice farmers were not familiar with the owl prior to the late 1980s, whereby they were first introduced by the Department of Agriculture as part of the rat control programme in the ricefield in the state of Selangor and Perak [50]. The infrastructure which largely consists of concrete buildings may not be suitable as refuge for owls. Therefore, artificial nest boxes were installed which boost the local owl population. A year after the implementation of the programme, crop damage as a result of rat activities has dropped considerably from around 10–15% to less than 2% [15]. The damage levels were maintained at that low level for 5 years straight and gradually increased to around 5% which was attributed to the dilapidated condition of the nest boxes. They were made of plywood and apparently were not durable and no longer habitable. Not only the lower crop loss was substantially lower, rat baiting was cut down from eight to just a single round per season. With only two baiting rounds necessary per year to bring down the base rat population lower than the carrying capacity of the ricefield habitat, so that the owls can suppress the population turnover rate, the economic benefits are tremendous.

6. Rat infestation in oil palm

Barn owl programme in the ricefield was actually preceded by a pioneer programme in the oil palm. Oil palm was first grown in the country in 1917 and cultivated on a commercial scale in 1950. Unlike in its original home where it grows naturally, in Malaysia oil palm is a cultivated crop with a high productivity. The release of the pollinating weevil *Elaeidobius kamerunicus* on a large scale has pushed the palm oil production to unprecedented levels. The oil palm fruit bunch provides nutritious food source for birds and small mammals, particularly squirrels and rats. Squirrels particularly the plantain or red-bellied squirrel *Callosciurus notatus* and the grey squirrel *Callosciurus caniceps* are common in oil palm plantation [40, 51]. While the squirrels sample the oil palm fruitlets nibbling away its rich mesocarp and kernel during the day, rats feed on them at night [52]. In the early stage, these rodents may visit oil palm plantations especially those that are contiguous with the natural forest to feed and return back to their natural habitat where they breed and forage. However, with these rodents particularly rat with a high learning capacity and adaptability, they eventually adopt the oil palm plantation as home. The first rat species that is known to adapt successfully in the oil palm plantation is the wood rat *Rattus tiomanicus*, which originally live in the shrubs and secondary forest [53]. When they start to nest in the spaces within the bases of the oil palm fronds, the oil palm plantation is the new adopted home for *R. tiomanicus.* Thus, it is now by and large associated with oil palm [54]. With the high availability of such nutritious food, the carrying capacity of the crop for rat was estimated at over 350 rats per hectare. In its natural habitat where food is scarce and with diverse niches which support more species of small mammals, the interspecific competition is greater [3, 4, 46, 47, 55]. Thus, the population density of *R. tiomanicus* can be manyfold higher than its original natural habitat. Losses attributed to *R. tiomanicus* and other rat species to a smaller extant can reach anywhere from 5% up to 30% or even higher in some situations [56].

In areas where oil palm plantation is adjacent to the ricefield, the common rat species found is the ricefield rat *Rattus argentiventer.* In that situation *R. argentiventer* is the dominant species, but studies have shown that its presence is transient, i.e. up to 4- or 5-year-old stand only. Other rat species may take over such as *R. rattus diardii,* which is common in areas near human habitation or *R. tiomanicus.* At any rate, the rat density hovers from 200 to 400 individuals per hectare. Damage is confined not only to the fruitlets but also to the apical bud at the nursery and young planting stage [56–59]. At 30–36 months when the young oil palm starts to crop, while the crowns are low lying, damage can be severe on the fruit bunches. Rats may also devour the male and female florescence, and they may also feed on the larvae of the pollinating weevils, reducing the fruit set. Recently invasion by a much larger species the bandicoot rat *Bandicota indica* in plantation in the northern state of Perlis showed that not only do they completely devour the florescence but they also feed away the base of the outer frond of young palms, killing them in the process [59].

The frequent use of rodenticide which has been the mainstay of rat control in oil palm has led to some serious implications to the ecosystem. The most direct consequence is the unintended poisoning of nontarget species especially wildlife. Since rodenticides are all broad-spectrum, it is fatal to any mammals of birds which casually consume them. As the rodenticides are presented as baits, they are likely to be picked up by wildlife including forest rat species which lives near the forest edge and may undertake daily foraging inside the plantation. Apart from primary exposure, predators or scavengers can be duly exposed to secondary poisoning from feeding on prey or carcass that has succumbed to the effects of the rodenticide [60–65]. Bioaccumulation of the active ingredients may lead to long-term sublethal effects or immediate lethal effects [66–69]. Another implication which is counterproductive is the development of resistance individuals as a result of natural selection against rodenticide toxicity. It will eventually give rise to a population which is predominantly resistant, and the susceptible individual will systematically disappear over time [70, 71]. In such a situation, the rodenticide will be rendered ineffective, and a more potent rodenticide will have to be synthesised to overcome the resistant individuals. There is a possibility that resistant individuals will exhibit cross resistance to a range of other rodenticides of different active ingredients.

In the oil palm plantation, as a result of a long-term application of warfarin, a first-generation anticoagulant rodenticide has led to many rat populations which turned resistant, prompting planters to switch to brodifacoum, a second-generation anticoagulant rodenticide (SGAR) introduced in the early 1980s [72].

7. The use of barn owl for rat control in oil palm

Therefore, biological control using predators is the closest to depict nature. However, the capacity or predation rate will have to keep with the prey population density [8, 35]. Predators may act in a numerical fashion, i.e. increase in prey will bring about increase in predation rate. This can be realised theoretically by higher rate of hunting and consumption by an increase in predation numbers [73]. This can be achieved by either increasing production rate or higher immigration rate to take advantage of the higher prey density. Naturally this is difficult to achieve because there is a lag time for the predator numbers to keep up with the prey population. The consequence is higher crop damage before the predator can decimate the prey. The other responses of the predator can be functional, i.e. each individual predator increases its consumption on that particular prey species [74, 75]. Theoretically this is applicable, but in reality, the prey species may not be varied which is ideal for a generalist predator which simply switches prey type based on availability [76]. In a situation of a crop habitat where there's only one common species, it is impossible for the predator to modify its diet unless it immigrate or emigrate depending on the availability of the single prey type. These are the theoretical consideration when choosing a natural enemy to be recruited for an effective biological control programme for rats in oil palm [77].

The barn owl seems to be an ideal predator given the circumstances in the oil palm plantation [78]. It does not build its own nest. Natural potential nesting sites such as the hole in a trunk is next to impossible to come by. Thus providing artificial nest boxes which the owl readily occupies boosts numbers to match with the rat infestation levels. With the huge prey availability, nest boxes not only increase breeding pair to take up residence and breed; the reproductive level can increase to take advantage of the food availability. The clutch size that ranges from typically 4 to 7 is dictated by prey availability [10, 66, 78–80]. A clutch size of 10–12 eggs is documented during peak season of the rat prey. This is apparent particularly in the ricefield during the land preparation stage after harvesting where the subadult rats born of the season start to join the aboveground population [81]. They guarantee a good supply of food for a high brood size or owlet numbers of the season. The owls have a self-checking mechanism to regulate their population size. In times of low prey numbers, the clutch size is smaller to sustain most of the chicks. When food is particularly scarce, the chicks will be subjected to differential survival. Since the egg hatches asynchronously, i.e. at intervals of 2 to 3 days, the size of the chicks from the same brood is different. In fact there is a gradation in size or height of the chick from the largest to the smallest [10, 78]. In unfavourable season only the larger owlets will get sufficiently fed to grow to fledglings. The smaller ones will starve to death by virtue of not being able to compete for food with the larger siblings. Fledging success is typically high in the region of 80% unless owl population is subjected to application of highly toxic rodenticide in the environment [66, 78]. There has also been cannibalism, i.e. owlets being killed by the respective parents, and this behaviour may be triggered by insufficient food. In a way this is a mechanism that leads to a numerical response of sort.

The high rate of prey removal which is not necessarily translated into prey consumed is another attribute of the barn owl. The male barn owl which has been observed to bring prey to the nest may take home more prey than what is necessary to feed the chicks. In many occasions the carcasses were left to rot in the nest boxes, and only a fraction of the prey was actually consumed. This is an added advantage as it increases the kill rate more than the daily food requirement. From casual survey in the fields, the number of rats removed from the fields by a breeding pair of barn owl is in the region of 800–1500 rats per breeding season. Thus, by having an optimum density of nest boxes in the plantation, barn owl can bring down rat numbers substantially.

However, the prolificity of the rat population leads to a high turnover rate which the owls cannot keep up. Thus, the baseline population of the rat needs to be lowered by the application of rodenticides. Barn owl in combination with a suitable rodenticide will bring about the desired effect, i.e. sustainable rat management in oil palm.

Barn owl has many of the attributes of owls which make them excellent nocturnal predators, features like the binocular vision and the almost complete 360 degree of the head turn. However, it lacks the feature of the more secretive owl, the typical owls. The barn owl relies on keen hearing more than eyesight, especially when hunting in the thickets and forest undergrowth. The differential positioning of the ear cavity enables the owl to detect its prey with near precision. Thus, the barn owl can hunt in darkness and rely on the sound made by a potential prey as the cue. The wing area to body weight ratio is particularly larger than most birds, so that it does not have to flap harder to create lift causing a lot of air turbulence. The owl only needs to glide effortlessly and strike at its unsuspecting prey.

The features that make the barn owl close to an ideal predator have prompted efforts of translocating owls to areas that are not known to have a local resident population [82]. Several attempts have been made to translocate owls from the Peninsular Malaysia to Sabah and Sarawak. There has been some spectacular success in this venture. Even though the oil palm landscape may not be similar with that in the Peninsular, with varied different species of rats abound, the translocated owls have established well and been breeding successfully [83]. In Lahad Datu, Sabah, owl's translocation programme that started with ten pairs of owl in 2015 has grown to a population of more than 700 individuals [84, 85].

8. Sustainability of application of biological control using barn owl

Since barn owl is a generalist predator and responds to prey availability by numerical response, i.e. increasing fecundity or immigration/emigration, the effectiveness as a natural predator of rats in the long run relies much on the prey/food supply [86, 87]. Since, in many occasions, infestation of rats in oil palm plantation has reached epidemic levels, the reliability of the owls may not fulfil the control requirement. There was an abundance of prey that only surplus individuals of the aboveground population will be harvested [35]. The infestation status will remain above the economic threshold or crop injury level. Therefore, the application of rodenticide has to be placed in combination with the barn owl programme. Warfarin as the classical FGAR has been applied in combination with barn owl propagation since the 1970s and well into the 1980s. Past studies have assumed warfarin has no apparent effects on barn owl fecundity and population status. When rat has shown evidence of resistance and plantations gradually or abruptly switched to SGAR particularly brodifacoum, barn owl population in a number of occasions experience a sharp decline or were completely wiped out [72]. The susceptibility of owls to the effects of bioaccumulation of SGAR residues in the vital organs and tissues has rendered the combination of the latter with rodenticide futile [63, 66, 88, 89].

The impact of FGARs may not be apparent in terms of immediate lethal effects. Studies on sublethal effects measured in terms of lowered nest occupancies, fecundity, lower brood size and lower fledging success have shown that FGARs can have some long-term effects on the viability of the barn owl population. It may lower the fitness of the individuals and eventually the population as a whole [90, 91]. A study investigating the sublethal effects of anticoagulant rodenticides in an oil palm plantation in Pahang, Malaysia, over four breeding seasons has indicated that FGARs like chlorophacinone lead to lower nest boxes occupancies, significantly lower brood size and lower fledging rates (**Table 1**). However, the result from the bromadiolone (SGAR)-treated area was significantly lower than chlorophacinone in terms of nest occupancy [92]. Another study in oil palm in Perak suggested that the brood size and the fledging rate were lower in brodifacoum (SGAR)-treated plot than warfarin (FGAR)-treated plot which in turn was lower than the untreated plot (**Table 2**) [66].

Low mean fledging rates of 2.65 and 2.20 in chlorophacinone (FGAR)- and bromadiolone (SGAR)-treated areas, respectively, suggest that owls are at considerable risk in maintaining a stable population. The nestlings were most likely to have succumbed to the toxic effects during their development stage. Similarly low fledging rates of 1.52 and 0.50 were recorded in the warfarin- and brodifacoum-treated plots, respectively. Henny [79] estimated that 1.9–2.2 fledging per breeding pair is the minimum reproductive rate to maintain a stable barn owl population. Based on these results, chlorophacinone and warfarin (FGAR) may not differ much compared to bromadiolone and brodifacoum (SGAR) as far as the long-term survival of owls for a sustainable rat control programme.

	Bromadiolone	Chlorophacinone	Rodenticide free
Occupancy	37.20 ± 1.14^{a}	51.79 ± 1.34^{bc}	83.33 ± 3.60^{c}
Clutch size	3.56 ± 0.10^{a}	3.69 ± 0.10^{a}	4.69 ± 0.11^{a}
Brood size	3.11 ± 0.06^{a}	3.38 ± 0.07^{a}	4.21 ± 0.12^{b}
Fledging rates	2.20 ± 0.10^{a}	2.65 ± 0.06^{a}	3.95 ± 0.07^{b}

Values in rows with different letters are significantly different (P < 0.05).

Table 1.
Occupancy rates, clutch size, brood size and fledging rates (mean % ± S.E) of barn owls in Pahang, Malaysia.

	Brodifacoum	Warfarin	Rodenticide free
Clutch size	4.83 ± 1.64^{a}	3.95 ± 0.68^{a}	5.43 ± 1.07^{a}
Brood size	2.06 ± 1.42^{a}	2.17 ± 0.80^{b}	4.21 ± 0.12^{c}
Fledging rates	0.50 ± 0.17^{a}	1.52 ± 0.73^{b}	4.40 ± 1.01^{c}

Values in rows with different letters are significantly different (P < 0.05).

Table 2.
Clutch size, brood size and fledging rates (mean % ± S.E) of barn owls in Perak, Malaysia.

	Bromadiolone	Chlorophacinone	Rodenticide free
Wing length (cm)	26.02 + 0.22	26.30 + 0.23	28.70 + 0.14*
Weight (g)	544.4 ± 7.05	565.0 ± 8.44	579.9 ± 10.07*

**Wing length and weight of barn owls in rodenticide free area were significantly longer and higher to barns owls exposed to bromadiolone and chlorophacinone.*

Table 3.
Mean wing length of barn owls exposed to bromadiolone (SGAR) and chlorophacinone (FGAR) in Pahang, Malaysia.

	Brodifacoum	Warfarin	Rodenticide free
Wing length (cm)	22.15 + 0.23	25.86 + 0.13	26.28 + 0.11*
Weight (g)	554.9 ± 8.72	585.8 ± 6.62	613.3 ± 5.98*

**Wing length and weight of barn owls in rodenticide free area were significantly longer and higher to barn owls exposed to brodifacoum and warfarin.*

Table 4.
Mean wing length of barn owls exposed to brodifacoum (SGAR) and warfarin (FGAR) in Perak, Malaysia.

Nestlings in the rodenticide-free plots show the longest wingspan and greatest body mass compared to the SGAR- and FGAR-treated areas in both Pahang and Perak (**Tables 3** and **4**). The reduction in wing length and body mass ranged from 10 to 16% to 7–10% from the sublethal effects of SGAR and 2–8% to 6–10% from the sublethal effects of FGAR, respectively. There were teratogenic signs in a few nestlings exposed to brodifacoum as a morphological evidence to support claims of secondary poisoning. Nestlings raised in rodenticide-free area fledged successfully upon release into the field, but those from treated areas need another 1 or 2 weeks before they can take to flight [66].

9. Conclusion

The barn owl is an effective biological control agent on rats. However, its natural or facilitated rearing by providing nest boxes in combination with rodenticide can have long-term sublethal effects on the former. The choice of rodenticide is crucial to sustain owl population in oil palm. SGAR can have a greater implication in terms of lowered fecundity and morphological impairments. However, the sublethal effects of FGAR only differ in terms of scale compared to that of SGAR. Therefore, baiting strategy and botanical-based or biological rodenticide need to be formulated for a sustainable rodent control with barn owl.

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