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Comparison of Different Methods of Rodent Control in Paddy Rice Farm Fields in Argungu Area, Kebbi State, Nigeria

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Abstract

In Asia and Africa, where they can seriously harm paddy rice, rodents are especially problematic for subsistence and low-income rural farmers. Methods of controlling rodents ranged from traditional to more modern mechanical, chemical and ecologically based rodent management (EBRM). In this study, we tested the effectiveness of two common rodent pest control methods practices by paddy rice farmers on paddy rice crops in Argungu floodplain (fadama) paddy rice farms. Number of paddy rice shoot destroyed was used to assess the effectiveness of rodent bait trap and food substances masked with rodenticide methods of control. Food substances masked with rodenticide method of rodent control appeared to be more effective as a control measure against the rodent damage on the paddy rice crop. Lack of awareness of chemical rodenticides harmful effect to the environment and other non-target species among the farmers is well noticed. Mass awareness campaign on the harmful effect of chemical rodenticides and adopting ecologically based rodent management (EBRM) are highly recommended.

Keywords: *Paddy rice; Rodents; Rodenticides; Farmers*

1. Introduction

One of the world's most significant food crops is rice (Oryza sativa) (Bambaradeniya and Amarasinghe, 2003; Odoukpé et al, 2023). Rice makes up one-fifth of the world's grain supply and serves as the main source of sustenance for more than half of the world's population (Elphick, 2010; Odoukpé et al, 2023). More than 100 countries cultivate rice (Platt et al, 2021). Although the Asian continent is typically linked to rice cultivation (the world's largest producer), yet it is the most rapidly growing food source in Africa (Nwanze, et al., 2006). It is widely grown across different agro-ecological zones ranging from the Sahel to the forest zones and is differentiated by the length of the growing season (Peel et al., 2007). It has many natural pest such as weeds, insects, rodents, fish, birds, molluscs, and crustaceans, Microorganisms such as phytophagous nematodes, fungi and viruses (Odoukpé et al, 2023). The narrow brown leaf spot of rice caused by Cercospora oryzae Miyake can leads 60% of rice yield reductions and post harvesting losses due to insect and rodent attacks cause losses ranging from 10 to 40% of stored rice (Shivappa et al, 2021). Indeed one of the most popular of these natural pests for rice fields is undoubtedly rodents (Odoukpé et al, 2023).

One of the world's most important vertebrate pests that cause significant damage to agricultural production are rodents (Aulicky, 2022). In Africa and Asia, rodents are especially problematic for subsistence and low-income rural farmers because they can seriously harm crops and result in food shortages (Fiedler, 2018). In the spatially and temporally varying agro-ecological habitats, there are 463 species of rodents, 77 of which cause crop damage and 12–20 of which are major crop pests. These species include members of the genera Rattus, Bandicota, and Mus, which are found in a variety of environments across Africa (Brown and Khamphoukeo, 2010; Monadjem et al. 2015; Constant et al, 2020). For resource-poor farmers across Africa rodents pose a significant threat to food security and agricultural productivity (Swanepoel et al. 2017) and are currently recognized as pests in many agricultural systems in dire need of control. The greatest significant obstacle to rice production is thought to be rodents (Sunitha et al, 2023). Rice losses often peak at the maturity period (Constant et al, 2020). In Southeast Asia for instance, there have been reported losses by rodents which amount to approximately 10% annually for rice crop (Singleton et al., 2008), with over 50% yield loss experienced in some certain years of rodent outbreaks (Cuaterno, 2008). The use of synthetic pesticides with its negative impacts on the environment and human health is a very common practice for the rice protection (Shivappa et al, 2021).

In Africa, rodents have posed a threat to commercial winter cereal farming as well as summer subsistence small grains (Fiedler, 2018). Using a variety of management techniques depends on the farmer's ability to prevent rodent pest damage to grains and cereals. These methods are generally categorized in to Cultural control/Mechanical control, Chemical control and Biological control.

Cultural/Mechanical control: Generally, use of trapping to control rodents is well acknowledged in African countries (Belmain et al, 2015). For example, Plant protection technicians have a history of using rodent trapping campaigns in Madagascar to raise local awareness and encourage action (Constant et al, 2020). Trapping of rodents at the household level is appropriate in rural agricultural settings particularly where farmers lack other adequate resources for rodent control (Taylor et al. 2008). Hunting has also been proposed as one of several strategies to control rodent populations, especially in Southeast Asia, where rodents have been pursued collectively by focusing on government bounty campaigns targeting rodent burrow systems (Singleton et al. 2007). Hunting was thought to be ineffective in reducing the severity of observed rodent damage in South Africa and eastern Madagascar, while in Tanzania hunting "maybe" reduces rodent damage (Constant et al, 2020). Lack of support for hunting in some of the African countries may in part be explained by cultural beliefs and prohibitions that constrain social acceptance of the hunting of rodent for food (Constant et al, 2020). In Tanzania, those against hunting were largely Muslims who explained that hunting is usually not undertaken by local people, because it is associated with food consumption and Islamic beliefs prohibit people from eating rodent meat. Similarly, in eastern Madagascar, the hunting of rodents for food is considered dirty, disgusting and taboo; this conclusion is supported by data from the North-East (Borgerson 2015). Individual rodent control was preferred among smallholder farmers in eastern Africa. Coordinated community methods have been encouraged to increase the efficacy of rodent control compared to individual approaches because labour efforts are shared across larger-scales (Palis et al. 2011). Coordinated community methods for rodent control can help reduce rodent population growth through breeding or immigration if done continuously (Belmain et al. 2015). Synchronising planting may maximise the length of the fallow period causing rodent and populations to decrease because of a lack of food and shelter and a reduction in the duration of the breeding season (Leung et al. 1999). In Tanzania and Madagascar, where farmers practice slash and burn techniques after harvest or before planting maize crops, this temporarily clears food sources and shelter for rodents and can act as important strategy for managing habitats that support high numbers of rodents (Duplantier & Rakotondravony 1999). In Madagascar, rodent abundance is lower in dry farming areas that provide food for rodents for short periods of time and the plots

are often burned once per year (Duplantier & Rakotondravony 1999). The promotion of other land use practices that may lead to the removal of rodent habitats such as combination of crop synchrony coupled with productive land use management and sanitation programmes may be useful to reduce the availability of food resources for rodents. Synchronising control methods over relatively short periods of time at key periods, such as the onset of breeding, can also be effective, but this requires a detailed understanding of rodent population dynamics within particular agro-ecosystems (Brown & Khamphoukeo 2007).

Chemical control: Although all countries endorsed rodenticides, some African countries Tanzania and South Africa preferred acute rodenticides. The widespread application of rodenticides across Afro-Malagasy farming regions is linked private sector promotion and government interventions, such as the free or subsidised distribution of rodenticides (Makundi et al. 1999). The preference for cheaper and faster-acting rodenticides which have negative environmental effects in terms of the risk of non-target species mortality poses a challenge that is requiring concerted educational programs across all African countries.

Biological control: Biological control of rodents using domestic and indigenous predators such as cats, dogs, raptors and reptiles has garnered increasing research interest in Africa. Recent studies have demonstrated that the dual presence of cats and dogs in homesteads can reduce rodent activity, creating a „landscape of fear" among foraging rodents (Mahlaba et al. 2017). Some studies have explored the potential positive impacts of using nest boxes and perches to encourage owls and other avian predators into agricultural landscapes to reduce rodent numbers (Labuschagne et al. 2016). The feasibility of employing biological control measures depends on the social acceptance of these species. For instance, across Madagascar there was a consensus that domestic cats were an effective measure for controlling rodent pests and were socially acceptable owing to their familiarity as domestic animals. However, birds of prey and reptile predators were perceived as ineffective in South Africa and effective in Tanzania and Madagascar. Only rural farmers in Tanzania demonstrated a willingness to promote biological control measures in their community compared to South Africa and Madagascar.

Rice is grown in both lowland and upland ecosystems in Nigeria. The lowland production system accounts for about 25% of the country's total rice production area, with yields as high as 2 to 8 tonnes/ha, while the upland production system accounts for about 30–35% of the country's total rice production area with yields between 0.8–2.0 tonnes/ha (Idiong, 2007). Studies examining, specifically pest control methods of West African rice farmers are rare (Adesina et al, 1994). The common methods of rodent pest control among subsistence paddy rice farmers in Argungu includes traditional/mechanical and chemical control methods. Therefore, it is essential to compare the effectiveness of the rodent pest control methods commonly used by subsistence paddy rice farmers to offer the more feasible practices of managing and controlling rodent pest to environment and other biodiversity species.

2. Methodology

2.1. Study Area

Argungu is located on latitude 12.75°N longitude 4.54°E in the Northwestern part of Nigeria (Kebbi state), and mostly characterized by lowland with a highland area of up to 300 m dissected by large flowing river (River Sokoto) (Figure 1). Geologically, the area is of sedimentary rock composing of undifferentiated sands, gravels, clays (mostly in the upland areas) and floodplains around the riverine communities (Adelana et al. 2008). Thus, two types of soil can be identified in the area: sandy soil in the upland area and clayey and hydromorphic (clay, clay loam, sandy loam, loamy sand) in the floodplain (Fadama) area. The climate of the area is tropical continental type; with two clear marked seasons, the dry and wet seasons resulting from two contrasting air

masses, the tropical continental and tropical maritime originating from the Sahara Desert and the Atlantic Ocean, respectively. The wet season lasts May–October. While the dry season lasts November–April. The mean annual rainfall is 800 mm. The average temperature is 27°C which can rise to above 40°C in the dry season (Sa'ad et al, 2021).

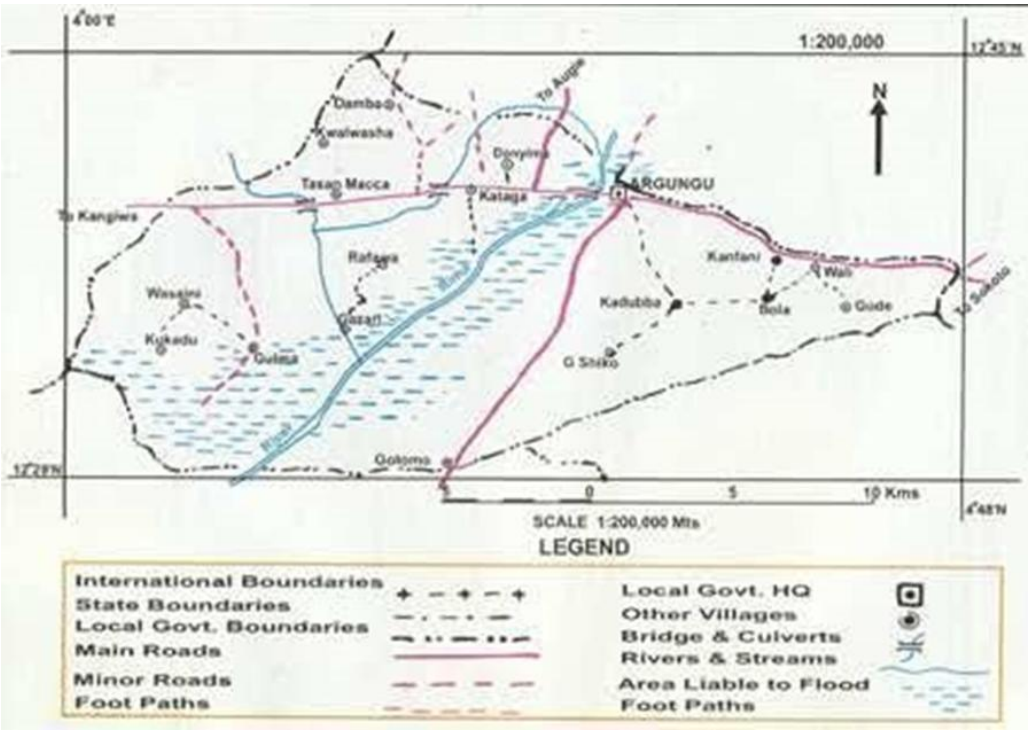


Figure 1: *Map of Argungu Local Government Area, Showing Floodplain (Fadama) Area*

2.2 Data Collection

In this research work, two experimental paddy rice farms were used to compare different rodent control methods. Experimental design; two paddy farms of 50x50m separated with approximately 500m distance apart were used. Similar variety of paddy rice nursery was planted on the same day and had similar treatment throughout.
Experimental farm (A) was treated with rodent bait trap and experimental farm (B) was deployed with food substances masked with chemical rodenticides to evaluate the effectiveness of the methods and damage afflicted to crops during the pre-harvest (growing) stage and harvest stage.

Data on rodent activities was collected using the number of paddy rice shoot destroyed in the experimental farm (A) and farm (B) on daily for two weeks. In each farm, one observer recorded the number of paddy rice shoot destroyed in each farm within a day (in the morning from 06:00 to 08:00am) and (in the evening from 05:00 to 07:00pm) for 14 days.

2.3 Data analysis

All the statistics were conducted in SPSS package version 26. Effectiveness of each control method was measured as the number of paddy rice shoot destroyed recorded in the morning and evening within a day in each study farm. Comparison of the number of paddy rice shoot destroyed in each farm between the periods of the day morning and evening and between the farms A and B was carried out using Wilcoxon Signed Rank Test Z at probability significant level of 0.05.

3. Results

An average of 19.180 ± 0.589 and 6.180 ± 0.291 paddy rice shoot destroyed were recorded in surveyed farms, (n = 256, 18.290 ±0.841) and (n = 90, 6.430 ±0.477) for the morning survey and (n = 281, 20.070 ±0.81) and (n = 83, 5.930 ±0.339) for evening survey (Table 1). Number of paddy rice shoot destroyed was statistically significantly high in the morning than in the evening in paddy rice farm equipped with bait trap control measure Wilcoxon Signed Rank Test (Z = 75.500, P = 0.004) Figure 1, while number of paddy rice shoot destroyed was not statistically significantly different between morning and evening period of the day in the paddy rice farm deployed with food substance masked with rodenticide Wilcoxon Signed Rank Test (Z = 23.500, P = 0.389) Figure 2. Overall, number of paddy rice shoot destroyed was statistically significantly high in the paddy rice farm equipped with bait trap control measure than the paddy rice farm deployed with food substances masked with rodenticide control measure Wilcoxon Signed Rank Test (Z = 21.062, P = 0.000) Figure 3.

Table 1. Number of paddy rice shoot destroyed recorded in morning and evening for paddy rice farm A and B.

Days	Farm A		Farm B	
	Morning Survey	Evening Survey	Morning Survey	Evening Survey
1	22	26	6	7
2	20	21	5	7
3	18	22	8	8
4	17	19	9	5
5	23	23	5	5
6	22	21	6	6
7	21	22	7	5
8	15	19	9	7
9	14	16	4	6
10	16	16	7	5
11	20	22	6	8
12	19	20	9	5
13	14	17	4	5
14	15	17	5	4
	n=256	n=281	n=90	n=83
Mean ±SE	18.290 ±0.841	20.070 ±0.81	6.430 ±0.477	5.930 ±0.339

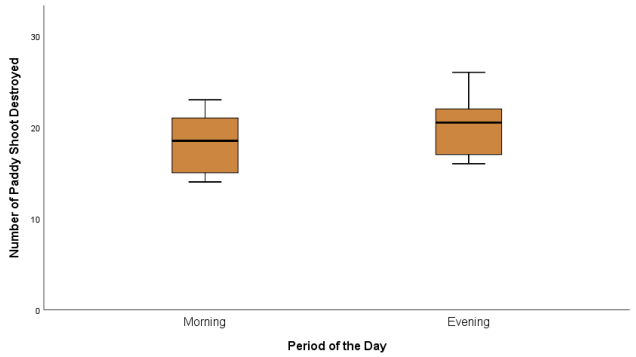


Figure 1. Paddy rice shoot destroyed between morning and evening periods for paddy rice farm A.

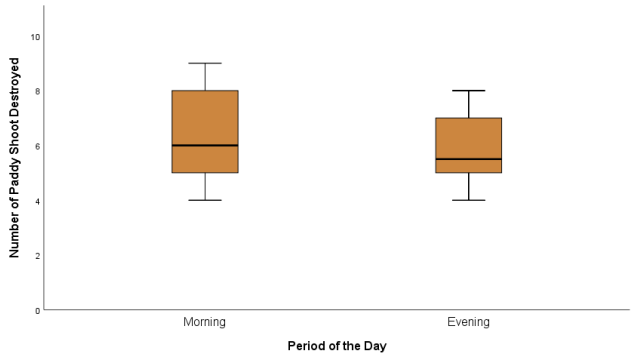


Figure 2. Paddy rice shoot destroyed between morning and evening periods for paddy rice farm B.

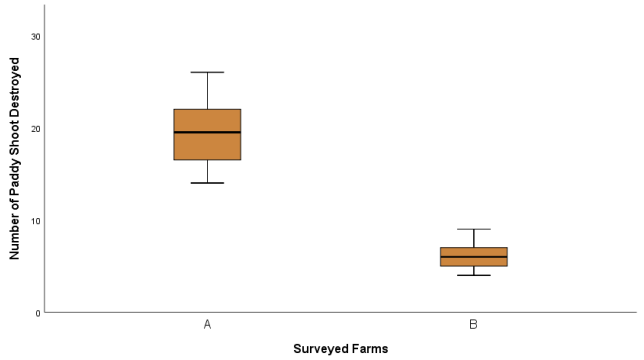


Figure 3. Paddy rice shoot destroyed between paddy rice farms, farm A equipped with bait trap and farm B deployed with food substances masked with rodenticide control measures.

4. Discussion

Farmers are suffering from rodents caused damage to their paddy rice during pre-harvest and harvesting stage. This study highlighted that rodents remained to be the important pests for rice production. The result of this study indicated rodents caused damage during the growing stage, which is consistent with the findings of Kumar et al (2013), which reported that pre-harvest losses due to rodents can comprise a significant proportion of the overall yield losses. The results of this study indicate that effectiveness of the control measures are largely important in the decision making of farmers' rodent control practices. Making a good

choice of control measure is crucial to minimize the loss incurred by farmers from the rodent destruction of their farm yield. We also highlighted the effectiveness of bait trap method is far less compared to the food masking with rodenticide method. Paddy rice shoot destruction is more frequent in the evening than in the morning. This indicated that rodent crop destruction is more severe in the evening than in the morning in the prone paddy farms. Bait trap and masking food substance are usually the only option open to the subsistence farmer, but other methods can be considered (Maurice et al, 2019). Masking food substances with rodenticide as a control measure appeared to be more promising than the bait trap method of control.

5. Conclusion

Our study has highlighted on the paddy shoot damage caused by rodents and farmers' common rodents' pest control methods. Moreover, the use of rodenticides was seemed as the most effective control measure despite it being the most costly measure. Application of Rodenticides is extremely deleterious to the non-target wildlife and environment due to direct exposure through consumption of the poisonous baits or secondary exposure through the consumption of poisoned animals. Therefore, alternative methods for rodent control such as ecologically based rodent management (EBRM) which encourage farmers to work together at specific times during the year, use nonchemical products, such as traps and organic lures, and aims to design and implement rodents pest management strategies that reflect the ecology and biology of rodents and also considers socioeconomic factors should be encourage. Additionally, if the government introduce platforms for the integration of (EBRM), the reliance on chemical rodenticides could be reduced, and further more government and farmers support organizations should provide educational guides on using rodenticides, strategic rodent control methods (e.g., time of year, areas of concentration), restoration of the natural predators and mass awareness campaign (education) on the negative implication of rodenticide to the environment and other wildlife species are highly recommended.

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Declaration of Conflicting Interests

The authors declare no potential conflicts of interest with respect to the research, authorship and publication of this article.

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