AJAB

Asian J Agri & Biol. 2017;5(4):263-269.

Original Research Article

Grain losses caused by the commensal rodents in rural Pothwar, Pakistan

Muhammad Mushtaq, Surrya Khanam

Department of Zoology, PMAS-Arid Agriculture University, Rawalpindi, Pakistan

Received:
July 13, 2017

Accepted:
September 21, 2017

Published:
December 17, 2017

**Corresponding author email:*
mushtaq@uaar.edu.pk

Abstract

Commensal rodents are serious pests of household food storage items and cause significant losses to the farming community in many parts of the world including Pakistan. The aim of this study was to investigate the extent of damage caused by the commensal rodents in various types of household structures in rural Pothwar. Losses were calculated on the bases of average population of rodents per structure, amount of cereals consumption by rodents and the average amount of food, a rat consumes in a day. Regression of daily captures on cumulative captures suggested a population of 1,060 rodents (3.02 per structure) from 350 structures (houses, shops and farm houses) of 12 sampled villages of Pothwar. Results on the grain losses caused by commensal rodents reflected that 9700.24 kg of wheat and other cereals were annually lost due to rodent's consumption, from all the sampled structures, from an average village of Pothwar. In addition, sufficient amount of food items were contaminated by the rodent urine and / or feces and thus are unavailable for human use and may cause health issues.

Keywords: Cereals, Grain losses, Commensal rodents, Rural Pothwar.

Introduction

Rodents are the highly successful and diversified mammalian group, consisting of almost 42 percent of all the mammalian species, comprising of 29 families and some 2700 species (Aplin et al., 2003). Some species of rodents are serious pests of stored products, agriculture and cause severe economic losses resulting in malnutrition and even famine. The economic losses due to rats on world-wide basis have been reported to 33 million tons annually of bread grain and rice in storage and it has been estimated that 130 million people could be fed each year with the food spoiled by world's rat population (FAO, 1999). Damage to stored products is mainly caused by commensal rodent species, which also cause public health problems (Prakash, 1988; Stenseth et al., 2001; Khan, 2013).

A number of diseases are spread through rodent urine, saliva and feces (Meerburg et al. 2009). The populations of commensal rodents increase in the habitats having accumulated human garbage and the favorable environments in urban and rural areas of the world. In the residential areas, the rodent populations are abundant in human habitations with structural deficiencies, presence of pets and / or livestock, lack of sanitation facilities and / or proximity to the vacant lots (Langton et al., 2001; de Masi et al., 2009).

In Pakistan, there are 43 species of rodents, the majority being rats and mice (Roberts, 1997). The house mouse (*Mus musculus*), the Norway rat (*Rattus norvegicus*) and the house rat (*Rattus rattus*) are the dominant commensal rodent pest species of the world, including Pakistan.

All the three species are responsible for causing severe economic losses and spreading a number of diseases to man and / or the livestock (Brooks et al., 1990; Beg et al., 1994; Mushtaq-ul-Hassan et al., 1995).

In addition, several other field rodent species have also been reported in and around the rural human habitations of rural Pothwar (Mushtaq et al., 2016). The knowledge about loss of agricultural commodities by rodent communities may be helpful in motivation of farmers to invest in developing rodent management strategies. The specific objective of this study was to estimate economic losses caused by the commensal rodents to the farming community of the rural Pothwar; a rain-fed part of the northern Punjab (Pakistan).

Material and Method

Study area

Pothwar is the 5th largest ecological region of Pakistan (Figure 1). This region covers 2.9 percent of the area and almost 5.6 percent of human population of the country. The area is basically rain-fed; agriculture largely depends upon on the occasional natural precipitations. Wheat and groundnut are the major cash crops of the area; and the farmers/ business community stock these crops in their houses and / or godowns, where these are exposed to rodent damage (Figure 2). Maize is the other important summer crop of the region.

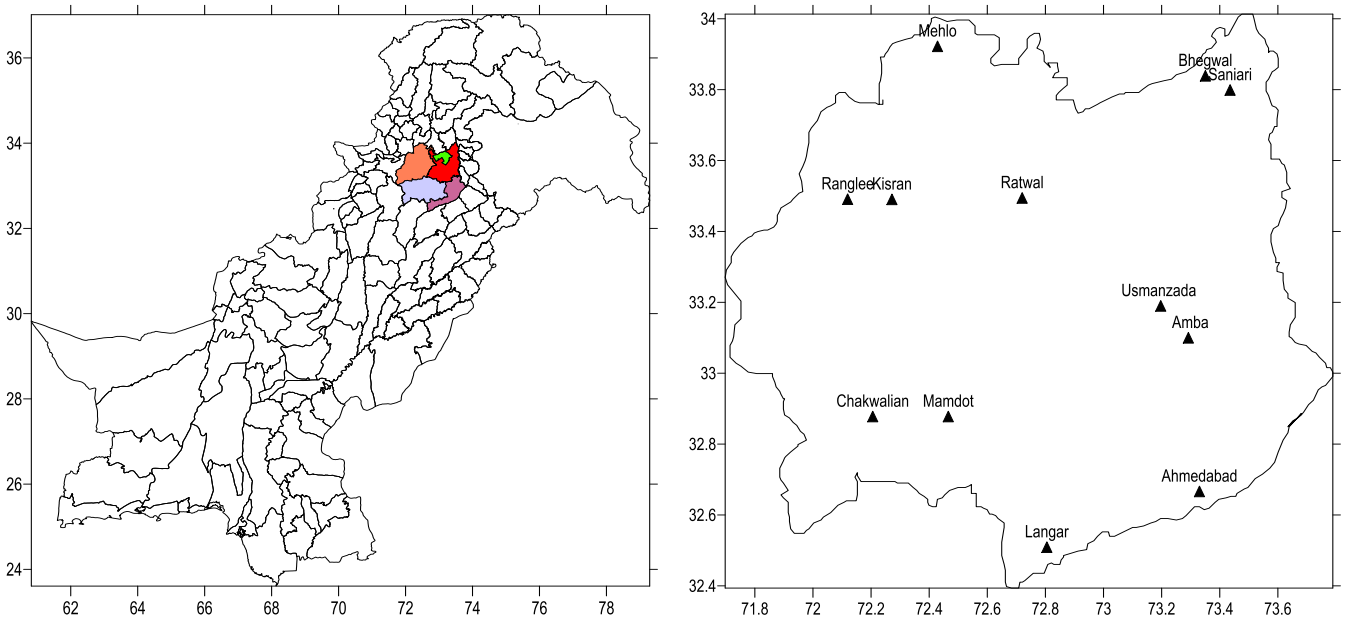

Figure - 1: Map of Pakistan showing Pothwar region (In focus, Pothwar map indicating location of the study sites).

Figure – 2: Pattern of crop storage and rodent friendly environment in rural Pothwar, Pakistan (A: typical storage pattern of harvested crops, B: rat damage to groundnut crop, C: a village shop, D: stored grains contaminated with fecal pellets, E: a typical village farm house, F: a damaged village house).

Rodent population estimation

Commensal rodent trapping was exercised during 2011-14 in 12 randomly selected villages of the Pothwar. From each village, six houses (human dwellings), three shops and one farm house was randomly selected for indoor rodents trapping. Fixed number of rat (n = 6; 17 x 9.5 cm) and mouse (n = 2; 11.5 x 4.5 cm) traps were set in each structure. The traps were baited with fresh seasonal vegetables and fruits. Trapping period varied between 4 and 6 nights. Each captured specimen was assigned a number and brought to the laboratory at Department of Zoology, PMAS Arid Agriculture University, Rawalpindi, for identification and other studies.

The population size of commensal rodents was estimated by using two methods, i.e., change in-ratio (CIR; Brooks et al., 1990) and regression of daily captures on cumulative captures (RDCC; Blower et al., 1981). In the CIR method, rat activity on the fixed number of tracking tiles (15 x 15 cm), placed on the floor in the sampled structure was recorded before and after rodent trapping and population size calculated using formula:

P1 = (T1 x n) / (T1 – T2): where, P1 = estimated original population, n = number of animals removed, T1 = proportion of the tiles scored positive before trapping, and T2 - proportion of tiles scored positive after trapping.

In RDCC method, daily decline in rodent captures was plotted against the cumulative total captures and a regression line worked out using the MS Excel programme 2010. The intercept point of regression line with X–axis gave the estimated population. The variance of regression estimate was calculated following Otis et al. (1978) and approximate 95% confidence limits calculated as:

N ± 1.96 x S. E.; where, N = estimated population, and S. E = standard error.

Economic losses

Grain losses (wheat and cereals), caused by the commensal rodent species, surviving in different types of structures, i.e., houses, shops and farm houses, in rural Pothwar were calculated, on daily and annual basis. The losses were computed on the basis of rodent population in human dwellings (estimated using RDCC method; Table 1), the average quantity of food grains consumed by different rodent species in the area, as reported by Mushtaq et al. (2016) and the average number of different structures (houses, shops and farm houses), in the sampled area. On the average, 3.02 rodent specimens were recorded from different village structures (Table 1); it was highest in the farm houses (4.28 specimens per structure), followed by village houses (3.42) and shops (1.80). Following Mushtaq et al. (2016), on the average 80% share in the diet composition of the commensal rodent species was wheat (43% individual share) and cereals (38% individual share). Similarly, on the average, a commensal rodent specimen consumes 20 grams of food material, daily (10% of their body weight; Meyer, 1994). During the physical survey of the rural Pothwar, it was recorded that an average village of Pothwar has, on the average, 500 houses, 30 shops and 20 farm houses, which were used in the current study for the computation of the grain losses due to commensal rodents, on daily and annual basis.

Results

Population estimates

Results on the trapping of commensal rodents (Table 1) revealed capturing of 824 rodents and shrews during 12,600 trap nights (trap success: 6.5%). The trap success was the highest for the farm houses (10.0%), followed by village houses (7.2%) and the lowest for shops (4.2%).

Regression of daily captures on cumulative captures (RDCC; Table 1) generated estimates suggest a population of 1,060 rodents (3.02 per structure; 95% confidence limit 1.26 – 4.78) for 350 structures of 12 villages, yielding a density of3.42/ house (n =210; 95% CL 1.50 – 5.34), 1.80/ shop (n = 105; 85% CL =0.12 – 3.48), and 4.28/ farm house (n = 35; 95% CL = 2.27 – 6.27) . Change in ratio method (CIR; Table 1) suggested a population of 1133 rodents and shrew; 772 for hoses, 226 for shops and 176 farm houses. As regards the relative abundance of different species, the house mouse (*Mus musculus)* was the most dominant species, representing 56.8% of all the commensal small mammals trapped, followed by the house rat (*Rattus rattus* 29.1%), house shrew (*Suncus murinus;* 7.4%), Indian gerbil (*Tatera indica;* 3.3%), the Indian bush rat *(Golunda ellioti;* 1.7%), the soft furred rat (*Millardia meltada;* 1.1%), short tailed mole rat (*Nesokia indica;* 0.2%), the Indian field mouse (*Mus budooga*; 0.2%) and bandicoot rat *(Bandicota bengalensis;* 0.1%)

Grain losses

Results on the grain losses caused by commensal rodents in rural Pothwar reflected that 0.026 kg of

wheat per structure (highest for farm houses: 0.036 kg, followed by village houses: 0.029 and shops: 0.015 kg) and 14.30 kg of wheat was consumed from all the structures, sampled, on daily basis, in the study area. Similarly, 9.49 kg per structure (highest for farm houses: 13.14 kg, followed by houses: 10.58 kg and shops: 5.47 kg) and 5219.50 kg of wheat was lost to rodents, annually.

In case of commensal rodent consumption on other cereals (maize, sorghum, rice, masoor, moong, mash), 0.023 kg of cereals (highest for farm houses: 0.032 kg, followed by village houses: 0.026 and shops: 0.013 kg), per structure and 12.65 kg from all the structures, sampled, on daily basis, was lost due to rodent consumption. As regards the annual consumption, data, 8.40 kg per structure (highest for farm houses: 11.68 kg, followed by houses: 9.49 kg and shops: 4.74 kg) and a total of 4617.25 kg of cereals were lost to rodents, from all the sampled structures, annually, from an average village of Pothwar.

On the whole, 0.048 kg of wheat and cereals were being consumed per structure (highest for farm houses: 0.068 kg, followed by houses: 0.052 kg and shops: 0.029 kg), while 26.58 kg of wheat and cereals were estimated to be consumed by commensal rodents, on daily basis. Similarly, 17.64 kg of wheat and cereals were being consumed per structure (highest for farm houses: 24.82 kg, followed by houses: 18.98 kg and shops: 10.58 kg), while 9700.24 kg of wheat and cereals were estimated to be consumed from an average village of Pothwar per year.

Table – 1: Comparison of small mammalian population (overall and per structure) by using Regression of Daily Captures on Cumulative Captures (RDCC) and Change-in-Ratio (CIR) methods.

Structure type	Recorded population (n)		Estimated population		
			RDCC method (95% confidence limits)		CIR method
	Total	Per structu re	Total	Per structure	
Houses	541	2.57	720 (691.43 - 748.57)	3.42 (1.50 - 5.34)	772
Shops	157	1.49	190 (180.69 – 199.31)	1.80 (0.12 - 3.48)	226
Farm houses	126	3.60	150 (137.72 – 162.28)	4.28 (2.27 - 6.27)	176
Over all	824	2.35	1060 (1019.61 – 1100.40)	3.02 (1.26 - 4.78)	1133

Table – 2: Estimates on food grain losses caused by commensal rodents in rural human habitations of Pothwar during 2011-14.

Consumption of wheat and cereals		Daily losses (Kg)*			Annual losses (Kg)**	
Food item	Consumption Frequency	Structure type	Per structure	Overall	Per structure	Overall
Wheat	43%	House	0.029	14.50	10.58	5290.00
		Shop	0.015	0.45	5.47	164.10
		Farm house	0.036	0.72	13.14	262.80
		Overall	0.026	14.30	9.49	5219.50
Cereals	38%	House	0.026	13.00	9.49	4745.50
		Shop	0.013	0.39	4.74	142.20
		Farm house	0.032	0.65	11.68	233.60
		Overall	0.023	12.65	8.40	4617.25
Both	80%	House	0.052	26.00	18.98	9490.00
		Shop	0.029	0.87	10.58	317.40
		Farm house	0.068	1.36	24.82	496.40
		Overall	0.048	26.58	17.64	9700.24

*Based on 3.42 rodent specimens per village house, 1.80 per shop and 4.28 per farm house (on the average 3.02 specimens per structure) and each rodent specimen is consuming 20 g of food material daily. **The sampled villages had, on the average 550 structures (houses: 500, shops: 30 and farm houses: 20).

Discussion

One of the major global challenges of the current times is to ensure food security for the world's growing global population. According to estimates, between 2011 and 2050, the world population is expected to increase by 33%, growing from 7.0 billion to 9.3 billion and the food demand is expected to rise by 60% in the same period (Alexandratos and Bruinsma, 2012). During 2015-2050, half of the world's population growth is expected to be concentrated in nine countries, including Pakistan (United Nations, 2015). The agriculture has always been negatively affected by pest species whose feeding and / or other damage activities may lead to a serious loss of agricultural output (Sexton et al. 2007). In addition, certain environmental and other alterations, change the composition of animal communities, leading to the loss of native biodiversity resources and may result in the increased abundances of introduced and generalist species that thrive in urban and / or rural areas (Bradley and Altizer, 2006). Similar is the case with the commensal pest species (especially rodents), that thrive as a result of anthropogenic activities in many parts of the world. In Asia, a loss of 5% of rice production amounts to approximately 30 million ton, which may be enough quantity to feed 180 million people for almost one year (Singleton, 2003). In addition of the damage to crops due to the direct consumption, rat and mice also affect rural townships, damaging equipment (particularly plastic based materials and electrical equipment), spoiling and consuming products, causing a huge loss to the business opportunities from the in-ability to stock and sell products at risk (such as food and grains / cereals etc.), and incurring costs for the protection of goods and maintenance of better hygienic conditions (Bomford and Hart, 2002). Rodents, especially the *M. musculus*, can also be viewed as an "indicator species" of environmental degradation due to the negative effects they produce in modified ecosystems such as urban and / or rural areas (Gomez et al., 2009). Hussain and Iqbal (2002) reported that none of the sampled shop was negative for rodent signs in grain markets of Rawalpindi, Pakistan, while Ahmed et al. (1995) estimated that on the average, a grain shop may contain up to 40 rats in different major cities of the Punjab (Pakistan) and calculated the annual losses due to rats would approximately 4000 mt /year.

In rural different environments of the world, the most of work has been carried out in cropping systems and / or poultry farming systems, due to the significant losses caused by the pest rodent species in these systems. Worldwide, studies related to populations of small rodents in both urban and rural households are few. This limitation of knowledge also applies to the rural environments of the Pothwar, Pakistan. The present results, like many previous reports from developing countries, including Pakistan, indicates that rodent infestation poses a serious threat for lowering of income and in causing food shortage by causing substantial damage to food and cash crops worldwide (Stenseth et al., 2001; Khan, 2013). Mushtaq –Ul-Hassan (1992) reported from villages of central Punjab, Pakistan, where for every person there were 1.1 house rats. By extrapolating these results from regional study to the national level, it was calculated that 0.33 billion metric ton cereals (rice, maize, and wheat) worth US$ 30 million were consumed by house rats in the villages of Pakistan every year. In such circumstances, the heavy losses caused by the commensal rodents (direct consumption and indirect food spoilage) to the rural communities are really alarming, which needs to be addressed, properly. In addition, understanding of rodent ecology, adequate assessment of damages and training of specialists for the management of rodent pests is also needed (Jackson, 1977). In such situation, it is really important to develop environment friendly and in-expensive ecologically based rodent management techniques, which are being implemented, successfully, in several developing countries of the world (Aplin et al., 2003).

Economic impact of grain losses to the rural Pothwar community is significant. Not only a significant amount of grains are consumed by the commensal rodents; in addition, large amount of these grains are wasted due to the spillage and contamination. Furthermore, these rodent species may be harboring several disease causing agents. Studies are required to investigate in detail the zoonosis impact of these rodent communities and evaluation of different ecologically based rodent management strategies, in the area.

Acknowledgements

This research study was supported by Higher Education Commission of Pakistan, through a financial support provided under its "National Research Programme for Universities" (Research

Grant No. 20-1822). The revision of the manuscript by two anonymous reviewers is highly acknowledged.

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