

Research Article

Farmers' knowledge, attitudes and practices towards rodent pests and their management in rural Pothwar, Pakistan

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Abstract

Rodents are important constraint in the agricultural systems of Pakistan. Farmers' knowledge, attitudes and practices (KAP) towards rodent pests and their management was assessed through a survey. A structured questionnaire was administrated to farmers (n=114) in four villages of Pothwar, Pakistan. Farmers considered high prices of fertilizers as the major constraint in crop production. This study revealed that rodents were perceived as the major pests in both crop fields (62%) and storage (61%). Farmers identified wheat crop as the most susceptible to rodent attack. The harvesting stage was considered the most critical stage to rodent damage, due to high rodent population. Farmers practiced rodent management individually and considered rodenticides as the most effective way to control rodents (88%). The majority of farmers belief that the crop production is affected due to rodent pests and in order to decrease rodent losses farmers should work together. A large portion of respondents (77%) indicated that they lacked assistance in managing rodents. Overall, the results indicated that farmers were aware of rodent damage to crops, but lacked training on control strategies. For successful rodent pest management in Pothwar, farmers' education and training focusing on community based rodent management practices are required. In order to reduce the use of rodenticides and minimize pre- and post- harvest losses due to rodents, ecologically based management practices are highly recommended.

Keywords: Crop damages; Farmers' beliefs; Pothwar; Rodent management; Rodent pests

Introduction

Agriculture is the major component of Pakistan economy, contributing 18.9% to its Gross domestic product (GDP) and 43.2% of the labor force is associated with this sector [1]. An important problem in agriculture is the decrease in the crop yield due to rodent damages [2]. There are reports of losses of 15% and 7% in coconut and sugar cane crops, respectively from Sindh, Pakistan [3]. Also,

in the grain markets of Pakistan, an estimated average population of 40 rats/grain shop and an annual grain loss of 740 kg/shop have been reported due to various rodent activities [4].

In other developing countries of the world, rodents are considered as an important constraint in boosting agriculture [5], causing both pre- and post- harvest losses [6, 7]. In several studies, rodents were ranked either as the most important [8-11] or as the second

most important pest in the crop fields [12]. There are reports of rodents causing 10-15% of loss of rice crops in Indonesia [13], and 26.4% loss of maize crop at the harvesting stage in central Ethiopia [14]. Rodents can also cause severe post-harvest losses which can result in a financial crisis for poor rural communities. In Tanzania, post-harvest losses due to rodents were reported to reach 40.4% in open cribs [15]. Similarly, in Laos, estimated grain losses of up to 10.3% during the dry season and 7.4% during the wet season have been reported [16]. In recently years, in the rural communities in Bangladesh and Myanmar losses of more than 70 kg and 130 kg of rice per year, respectively, due to the rodent pests [17]. Rodents also cause damage to buildings and households; are a nuisance for the people [18]. Rodents have also been recognized as vector and reservoirs of various zoonotic pathogens [19].

In developing countries, rodent management has always remained a major challenge for poor farmers due to their lack of knowledge about the proper control methods. Farmers consider rodents as an uncontrollable pest, and are reluctant to apply new rodent management practices [20]. In different African and Asian countries, the common control methods used by the farmers are rodent trapping, rodenticides and flooding or digging rodent burrows [9, 10, 21]. During the past decade, ecologically-based rodent management (EBRM) has been successfully conducted in many Asian countries [13, 22]. EBRM practices are recommended in Pakistan to minimize agricultural losses due to rodents. EBRM depends on a strong understanding of the ecology of the major pest species present in the area. EBRM needs to be coupled with the farmer's indigenous knowledge and practices towards rodent management. Understanding farmers' perceptions and beliefs towards rodent management can assist scientists and

extension experts to plan future management strategies within the context of existing practices of farmers [23]. In Pothwar, Pakistan, little is known about the rodent pest species, their biology and distribution. Five rodents species have been reported in the cropping system of Pothwar: *Golunda ellioti*, *Nesokia indica*, *Tatera indica*, *Bandicota bengalensis*, and *Mus spp.* [24]. Comprehensive studies on the biology of rodent pests in both crop fields and rural commensal habitats are lacking. Also, the impact of rodent pests on the farmer communities, and perceptions of the farmers towards rodent pests and their management are not known. Hence, the aim of our study was to assess farmers' knowledge, beliefs and practices towards rodent pest management. The findings of this study along with the ecological studies on the pest species would be helpful to plan future rodent management strategies for the Pothwar region.

Materials and Methods

Study area

The present survey was conducted in Pothwar (32.5°N-34.0°N and 72°E-74°E) northern Punjab, Pakistan. Pothwar is a rain-fed area, comprising four districts of Punjab province (Attock, Chakwal, Jehlum and Rawalpindi) and Islamabad capital territory (ICT) (Fig. 1). It lies at the elevation of 350 to 575 m above the sea level. The total area of Pothwar region is 22000 km². The topography of the area is undulating, generally sloping from North East to South West. The area experience semi-arid to humid climate, with annual rainfall of the area ranges from 450 mm in southwest to 1750 mm in northeast with 70% rainfall occurring during the monsoon months from July to September [25, 26]. The Pothwar Plateau has great agricultural and social significance with cultivated area of around 10000 km².

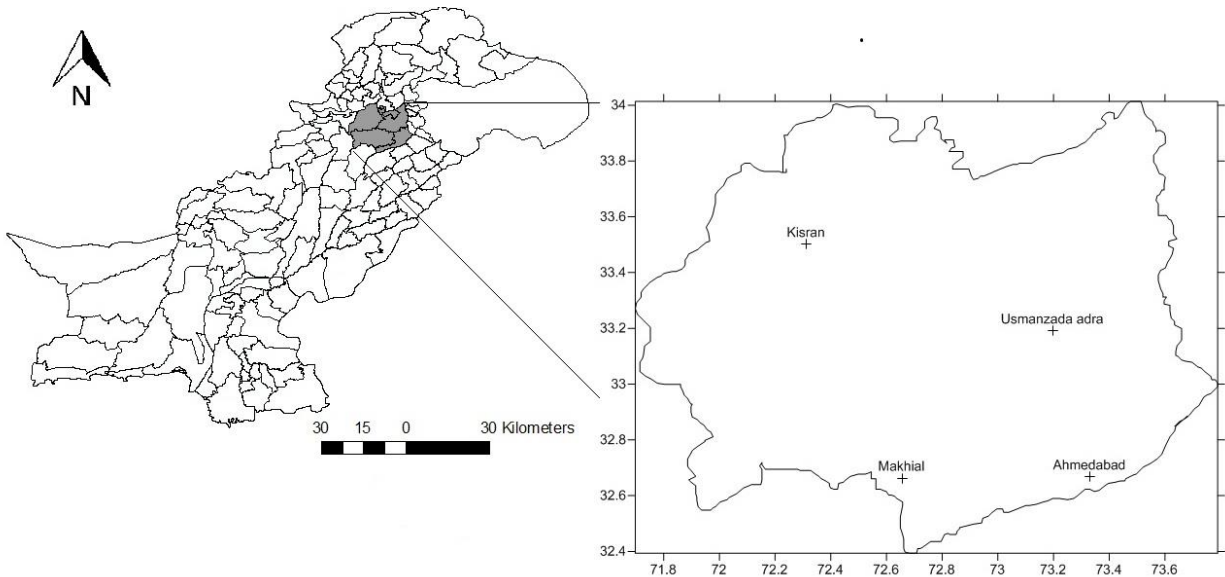


Figure 1. Map of study area, indicating the location of each of village surveyed in Pothwar, Pakistan

Farmer survey

The survey study was conducted while doing rodent trapping campaign in the rural indoor habitats of Pothwar, Pakistan between 2012-14. The study was conducted in four villages of the Pothwar, viz., Kisran, Ahmedabad, Makhial and Usmanzada Adra. During trapping campaign, a total of 746 small mammal species were trapped including eight rodent species and a single insectivore species. The trapped rodent species included: house mouse (*Mus musculus*) (n=436), black rat (*Rattus rattus*) (217), Indian gerbil (*Tatera indica*) (20), soft-furred field rat (*Millardia melitada*) (9), Indian bush rat (*Golunda ellioti*) (7), lesser bandicoot rat (*Bandicota bengalensis*) (1), short-tailed bandicoot rat (*Nesokia indica*) (1), and little Indian field mouse (*Mus booduga*) (1). Fifty-four individuals belonged to *S. murinus* were captured.

For survey study, 30 male farmers were interviewed in each village except for village Kisran, where 24 farmers were interviewed. The survey questionnaire was adapted from

previous studies undertaken in other regions of Southeast Asia [6, 27, 28], and was tailored according to the agricultural system of Pakistan. After pretesting, the survey was translated from English into Urdu (National language) to make it understandable for the farmers. There were thirty eight questions in the survey and the questionnaire was divided into three main sections. The first section summarized information on the social and demographic characteristics of the farmers (including age, family size, marital status, occupation, income, farm size and land type). The second section comprised of information on the farming practices such crops grown, constraints in crop production and status of crop pests. The third section covered farmer's knowledge and perceptions about rodent pests, damages and management practices. In order to assess their beliefs about rodents, farmers were asked a set of questions with defined responses as: true, not true, not sure/might be true.

Data analysis

Descriptive statistics were used for the demographic characteristics. The results of the questionnaire are presented in percentages. A principal component analysis (PCA) with varimax-rotation was performed to identify the number of components for 14 items of the KAP survey, including crop production constraints and farmers beliefs and perceptions about rodent pests. An eigenvalue > 1.0 was used as criteria for component extraction. All the analyses were performed using IBM SPSS Statistical Package Version 16.0.

Results

Sociodemographic characteristics of farmers

Of the 114 respondents interviewed, majority of respondents (37%) were between 30-40 years of age. The majority of respondents were married (82%) and the mean family size was seven (SD ± 3.1 , range= 2-17). Most of the respondents had secondary level education (33%) or higher secondary/above (28%). Farming was the major occupation of 42% of the respondents, the rest of them were involved in other occupations along with farming. Monthly income of 42% of the respondents ranged between 10000 and 20000PK Rupees (100-200US\$). The majority of farmers (88%) had their own land, with average farming experience of 14.4 years (SD ± 10.1 , range= 2-50 years) and the average land area was 2.84 ha (SD ± 5.2 , range= 0.05-48 ha) (Table 1).

Farmers' crop and pest knowledge

Most of the farmers planted crops in both summer and winter. In Pothwar, wheat (*Triticum aestivum*) was the main winter crop (83%), followed by mustard (*Brassica campestris*) (16%) and legumes (1%). Winter crops were planted in October-November and harvested in May-June. Among the summer crops, pearl millet (*Pennisetum glaucum*) (33%) was the major crop, followed by sorghum (*Sorghum bicolor*) (30%), maize

(*Zea mays*) (25%) and peanuts (*Arachis hypogaea*) (11%). In summer, farmers planted multiple crops at the same time. Summer crops were planted in July-August and harvested in September-October. The major constraint in increasing yield from agriculture fields are presented in (Table 2). The majority of farmers considered high prices of fertilizers as the major constraint in increasing yield from agriculture fields (90.6%) followed by water shortage (90%), low soil fertility (85%), absence of rainfall during some years (85%) and rodent pests (80%) (Table 2). Across four villages, no significant differences were found among farmers concerning the problem of high prices of fertilizers ($\chi^2 = 11.3$ df = 6, P = 0.06), water shortage ($\chi^2 = 11.4$ df = 6, P = 0.28) and less fertile soil ($\chi^2 = 10.1$ df = 6, P = 0.25), but there were significant difference in the responses concerning the problem of less rainfall ($\chi^2 = 31.3$ df = 6, P = 0.00), rodent pests ($\chi^2 = 17.9$ df = 6, P = 0.04), low quality seed ($\chi^2 = 22.7$ df = 6, P = 0.01) and labour cost ($\chi^2 = 18.5$ df = 6, P = 0.05) across four study sites and with in each site (Table 2)

Farmers considered wheat as the most affected crop due to rodent pests (54%), followed by peanuts (32%). Harvest stage was considered as the most susceptible stage to rodent damage both in wheat (48%) and peanuts (44%). Some farmers perceived that rodents can be controlled more effectively at the booting stage (27%), and an equal number of farmers (27%) also believed that it is impossible to control rodents at any growth stage (Fig. 2). The major pest in the crop fields were rodents (62%), followed by insects (20%) and wild pigs (11%). Mostly, the farmers assessed crop losses due to rodents by observing plant damages (51%), followed by rodent burrows (18%), directly observing moving rodents (14%) and their footprints (10%). Eight of the farmers (7%)

assessed losses by observing multiple signs of rodent presence.

In storage, majority of the respondents identified rodents as the major pest (61%), followed by insects (32%). Stored food grain losses were assessed by observing the direct loss of stored grains (51%), followed by rodent faecal droppings in grains (20%), their footprints (12%) and hearing rodent chirping noises or directly observing the moving rodents (11%). Some of the responded (6%) considered multiple signs to assess rodent damages to their stored grains.

For rodent management, farmers were using rodenticides (74%), followed by trapping (3%), flooding burrows (7%) and 16% of the respondents were practicing both poisoning and trapping. Use of rodenticides was considered as more effective method (88%) to control rodents as compared to trapping (9%) or flooding of burrows (5%). The majority of farmers (58%) believed that there were no predators of rodents in the area, while 42% reported that a limited number of rodent predators existed, including domestic and feral cats (79%), mongoose (16%) and snakes (4%). The majority of farmers (81%) had no equipment/rodent trapping devices (cage traps and snap traps) for rodent control, and the main reasons identified were: their high prices (61%), followed by non-availability in the market (23%) and/or their inefficiency (19%).

Farmers' beliefs and perceptions

Farmers' perceptions about rodents were assessed through a set of questions with defined responses. Three point Likert scale was used as responses. Farmers perception about the need of rodent control showed no significant difference ($\chi^2 = 1.4$ df = 6, P = 0.86) among respondents across the surveyed villages. Other perceptions, including crop production is affected due to rodents, rodents are sources of pathogens causing disease, collective effort by farmers can decrease loss due to rodents, all farmers cooperate in rodent

management, and help or training provided by government/private sector on rodent management showed significant variation across surveyed villages and with in the same village (Table 3). Most farmers (98.1%) believed that rodent control is needed and the crop production was affected by the rodent pests (84.4%). The majority of farmers believed that rodents can cause diseases to people (82.3%). Most of the respondents believed that crop production can be increased if all the farmers cooperate in rodent management (83.7%), but eight of them (7.4%) thought that it does not help. Most of the farmers realized that they were not cooperating with one another (56.3%) in this regard. The role of government and/or private agencies in rodent management was reportedly not satisfactory. The majority of farmers responded that no help or training was available for rodent control (76.5%). However, some of them were of the view that government helps them (20.8%) (Table 3).

Principal component analysis

The Kaiser-Meyer Olkin value was calculated as 0.67, indicating that PCA on this dataset is possible. Bartlett's test of sphericity gave chi square value of 381 (significance level < 0.001). Exploratory PCA extracted five components with the cumulative variance of 63.3%. In this exploratory PCA, very few items were loaded in the third, fourth and fifth components. Also, the scree plot generated for the PCA showed that only the first two components explained much of the variance in the dataset, thereby requiring a second PCA including only the factors which explain much of the variance. For the confirmation of a number of factors to be retained, we also performed Monte Carlo PCA for parallel analysis. This analysis also indicated that the first two components should be retained for further PCA. A two factor model having 39.2% total cumulative variance was obtained. Principal component 1 (PC 1) explains 26.7 % of the

total variance and included mainly constrains items (C1-C6) and also few perception items (P2, P3 and P5). The second component (PC2) explained 12.5% of the total variance and comprises of mainly perception items (P1, P2, P4, P6 and P7) and a single constrains item (C7). “P2- Rodent control is possible” had a cross-loading over 0.4 but had its highest loading from the second factor. The items in PC1 showed high

component loadings ranging from 0.405 to 0.781. Similarly, item in the PC2 showed high component loadings, ranging from 0.381 to 0.779 (Table 4). The component plot in rotated space indicated the first component marked by high loadings mainly for the crop production constrains (Fig. 3), the second component showed high loading for the perceptions about the rodent problem.

Table 1. Socio-demographic profile of the farmers (n=114)

Parameters	Number (%)	Parameters	Number (%)
Age		Monthly Income	
<30	20 (17.5)	<10000	34(30)
31-40	42 (36.8)	10000-20000	47(41.5)
41-50	33 (28.9)	20000-30000	19(16.8)
>50	19(16.6)	>30000	13(11.5)
Marital status		Source of income	
Unmarried	20(18)	Farming	18(15.8)
Married	94(82)	Government service	41(35.9)
Level of Education		Own business	48(42.1)
Illiterate	17 (15)	Daily Paid Labor	7(6.1)
Primary	27 (24)	Nature of Land type	
Secondary	38 (33)	Personal	99(87.6)
Higher secondary or above	32(28)	Leased	14(12.8)
	Mean ± SD		
Farming Experience	14.4± 10.1		
Land Area	2.84 ±5.2		
Family Size	7 ±3.1		

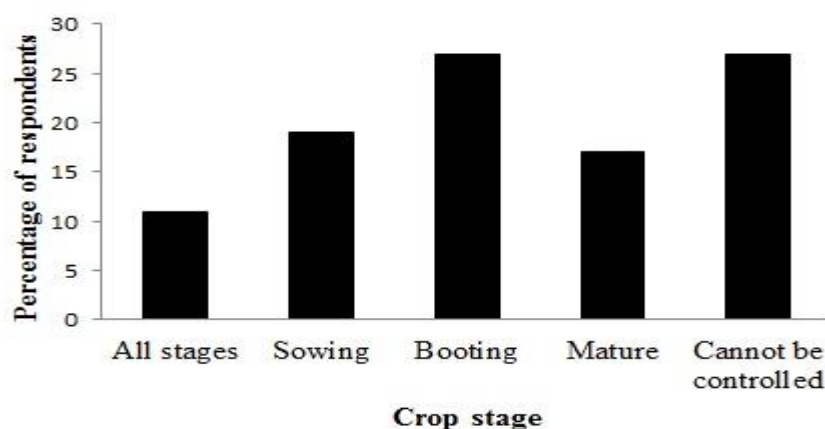


Figure 2. Farmers' ranking of different growth stages for the management of rodent pests in field crops (n = 113)

Table 2. Proportion (%) of farmers' responses to questions indicating different crop production constraints

Constraints	Responses	Villages					Total	Chi square	df	P-Value
		Ahmedabad	Makhial	Usmanzada adra	Kisran					
High prices of fertilizers	Yes	76.7	96.7	93.3	95.8	90.6	11.3	6	0.06	
	No	13.3	3.3	0.0	4.2	5.2				
	Not sure/No opinion	10.0	0.0	6.7	0.0	4.2				
Water shortage	Yes	76.7	96.7	86.7	100.0	90.0	11.4	6	0.28	
	No	13.3	3.3	13.3	0.0	7.5				
	Not sure/No opinion	10.0	0.0	0.0	0.0	2.5				
Less fertile soil	Yes	76.7	86.7	93.3	83.3	85.0	10.1	6	0.25	
	No	13.3	13.3	6.7	16.7	12.5				
	Not sure/No opinion	10.0	0.0	0.0	0.0	2.5				
Rainfall problems	Yes	73.3	66.7	100.0	100.0	85.0	31.3	6	0.00	
	No	13.3	33.3	0.0	0.0	11.7				
	Not sure/No opinion	13.3	0.0	0.0	0.0	3.3				
Rodent pests	Yes	73.3	69.0	93.3	83.3	80.0	17.9	6	0.04	
	No	13.3	31.0	6.7	16.7	16.9				
	Not sure/No opinion	13.3	0.0	0.0	0.0	3.3				
Low quality seeds	Yes	46.7	76.7	93.3	87.5	76.0	22.7	6	0.01	
	No	30.0	13.3	6.7	12.5	15.6				
	Not sure/No opinion	23.3	10.0	0.0	0.0	8.3				
Labor cost	Yes	50.0	63.3	89.7	81.8	71.2	18.5	6	0.05	
	No	40.0	36.7	10.3	18.2	26.3				
	Not sure/No opinion	10.0	0.0	0.0	0.0	2.5				

Table 3. Proportion (%) of farmers' perceptions and beliefs towards rodent pests and their management in the Pothwar, Pakistan

Statements	Responses	Villages				Total	Chi Square	df	P-value
		Ahmedabad	Makhial	Usmanzada adra	Kisran				
Rodent control is needed	Yes	96.7	100.0	100.0	95.8	98.1	1.4	6	0.86
	No	3.3	0.0	0.0	4.2	1.9			
	Not sure/No opinion	0.0	0.0	0.0	0.0	0.0			
Crop production is affected due to rodents	Yes	63.3	96.7	90.0	87.5	84.4	67.7	6	0.00
	No	13.3	3.3	3.3	12.5	8.1			
	Not sure/No opinion	23.3	0.0	6.7	0.0	7.5			
Rodents are sources of disease	Yes	63.3	76.7	93.3	95.8	82.3	42	6	0.00
	No	3.3	23.3	3.3	4.2	8.5			
	Not sure/No opinion	33.3	0.0	3.3	0.0	9.2			
Collective efforts can decrease rodents losses	Yes	16.7	33.3	43.3	58.3	37.9	98	6	0.00
	No	60.0	66.7	56.7	41.7	56.3			
	Not sure/No opinion	23.3	0.0	0.0	0.0	5.8			
All farmers cooperate in rodent management	Yes	75.9	78.6	93.3	87.0	83.7	21.8	6	0.00
	No	13.8	7.1	0.0	8.7	7.4			
	Not sure/No opinion	10.3	14.3	6.7	4.3	8.9			
Help or training provided by government/private sector	Yes	10.0	23.3	16.7	33.3	20.8	29.8	6	0.00
	No	83.3	76.7	83.3	62.5	76.5			
	Not sure/No opinion	6.7	0.0	0.0	4.2	2.7			

Table 4. Principal component analysis with restriction to two components (varimax rotation with kaiser normalization)

Items	Component	
	1	2
C-2 Low quality seed	0.781	0.162
C-6 Cost of labour	0.624	0.097
C-4 Water shortage	0.616	-0.129
C-5 Rainfall problems	0.611	0.094
P-3 Production effected	0.576	0.223
C-3 High prices of fertilizer	0.532	0.101
P-5 Collective effort by farmers can decrease loss due to rodents	0.523	0.244
C-1 Less fertile soil	0.515	-0.03
P-2 Rodent control possible	0.405	0.651
P-7 Help or training	0.211	0.501
C-7 Rodent problem	0.197	0.586
P-6 All farmers cooperate in rodent management	0.062	0.58
P-4 Diseases spread	-0.012	0.779
P-1 Rodent control needed	-0.2	0.387
Eigenvalues	3.7	1.7
% of Variance	26.7	12.5
Cumulative %	26.7	39.2

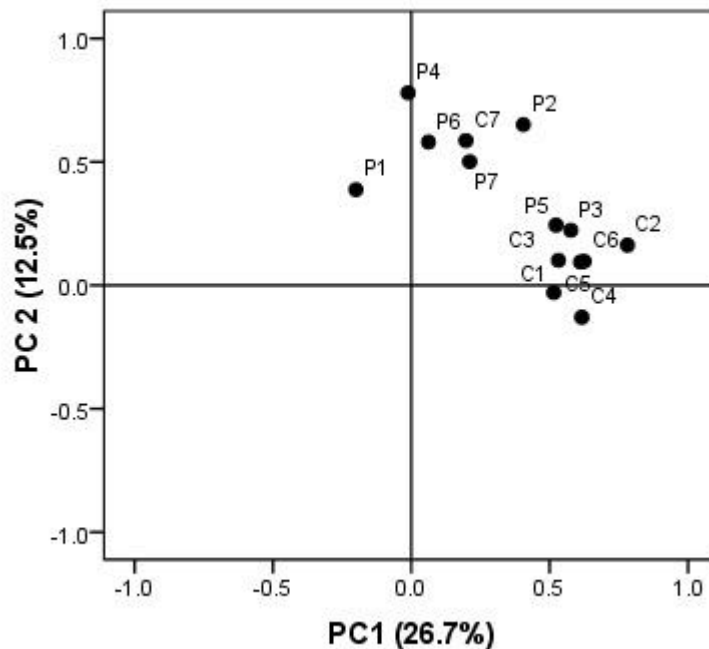


Figure 3. Principal component analysis bi-plot for the first two components

Discussion

Farmers were well aware of the different constraints in the crop production. The majority of farmers considered rodents as an important constraint in the agricultural system of Pothwar, Pakistan. This is consistent with the previous survey in Khyber Pakhtunkhwa (KPK) province of Pakistan [29] and other parts of the world [9, 20, 28, 30], where rodents were considered as the most important pest in agricultural crops. Farmers consider booting stage in crop as an important growth phase, when rodents can be controlled more efficiently. This is consistent with previous surveys in other parts of Southeast Asia, where farmers consider booting as an important phase in rice crop to control rodents [11, 21, 27].

In Pothwar, farmers identified the harvest stage as the most critical crop stage, when rodent population is high and rodents cause serious damages. The extent of rodent damage and the most affected crop stage can vary with the cropping system of a particular area [31]. Farmers' perception about the rodent abundance and the most affected stage can be confirmed by further studies on the major ecological aspects of rodents in the Pothwar. Easy access to abundant food resources could be the possible reasons for the increase in abundance at the harvest stage. Furthermore, in most of the Asian countries, harvesting is done manually and it is generally a time taking process. This results in high exposure of crops to the pests and hence cause significant losses, particularly at the harvest stage [32].

For controlling rodents, farmers preferred rodenticides as compared to other methods. However, farmers have no background knowledge about the type of rodenticides and their correct use. Similarly, poisoning has been reported as a common control method in the Philippines [20]. In an other study, [6] reported that often rodent management fails due to lack of knowledge about the proper

timing and quantity of rodenticides to be applied. Also, most of the rodenticides are not environmentally friendly, and are harmful to other non-pest species [33] and may also have hazardous effects on human health [34]. Hence, it is suggested that improper use of rodenticides should be avoided and farmers should be trained in alternative control strategies, particularly ecologically-based management practices [27]. Ecologically-based rodent management (EBRM) has been successfully implemented in some of the developing countries, including Indonesia [9] and Vietnam [34], resulting in the reduction of 50% and 75% rodenticides use. According to [35], EBRM works successfully only if the management plan is species specific and area or habitat specific. Hence, an understanding of the population dynamics of the major rodent pest species present in Pothwar, combined with the farmers' perceptions and beliefs about rodent pests can help to develop appropriate ecologically based management strategies for the area.

Although most of the farmers believed that with cooperative efforts they can manage rodents more effectively and decrease losses in their field crops and storage, yet most of them were controlling rodents individually. Previous studies have suggested that for the implementation of successful management plans, farmers should be encouraged to work together at the community level [20, 28]. Farmer's attitude towards rodent management practices is very important for successful implementation of any management plan and rodent infestation and crop damages can be reduced if the farmers are given proper training and education [36]. Similarly, [29] reported that the Farmers Field School (FFS) is an effective strategy to minimize pre- and post- harvest losses due to various pests. Their study showed that the farmers were most concerned with the rodent problem, because rat burrows were causing

loss of irrigation water. Through FFS, farmers were able to minimize losses due to rodents. Our results indicated that farmers were not satisfied with the role of government sector or other private agencies in providing assistance towards rodent management practices. Hence, farmers' training is highly recommended in the area to minimize crop losses due to rodents.

Conclusion

In conclusion, rodents were considered as a major pest causing pre- and post- harvest crop losses in rural areas of Pothwar, Pakistan. Farmers considered harvest stage as the most critical stage to rodent damage. Farmers practiced rodent management individually and lacked proper training on different control strategies. Use of rodenticides as an effective method of rodent control raises environmental concerns. Hence, farmers should be trained with alternative control strategies to minimize their reliance on rodenticides. Based on the present situation, ecologically-based management strategies with a better understanding of the biology of major pest species are recommended.

Authors' contributions

Conceived and designed the experiments: S Khanam & M Mushtaq, Performed the experiments: S Khanam, Analyzed the data: S Khanam, Contributed materials/ analysis/ tools: M Mushtaq & S Khanam, Wrote the paper: S Khanam & M Mushtaq.

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