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RESEARCH ARTICLE

Impact of village level education and training on adoption of control strategies, their sustainability and reduction in crop losses

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Abstract

The present study was conducted to assess the impact of village level education and training on adoption of control strategies, their sustainability and reduction in crop losses in Kapurthala and Jalandhar districts of Punjab, India. Three villages selected in each district were categorized as (i) Maintenance area (ii) Neglected area, and (iii) Survey area. In maintenance area, proper education and training was imparted to farmers along with free distribution of rodenticide baits. Similar activities were done in neglected area but rodenticide baits were not distributed among the farmers. The survey area was kept as reference area where neither education was provided nor were the rodenticide baits distributed. KAP survey of farmers before imparting education in Rabi season (wheat crop period) revealed that the rodent control practices being used by the farmers were quite similar across villages. Farmers were often found adopting incorrect methods of poison bait preparation and application. Survey of farmers during subsequent Kharif season (rice crop period) revealed the sustainability of knowledge already imparted during wheat crop period. Impact assessment revealed higher reduction in rodent infestation, damage and yield loss due to rodents in maintenance and neglected villages compared to survey areas indicating timely education and training of farmers to be the important key factors responsible for the success of a rodent control programme.

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Introduction

Agriculture is a major component of Indian economy. More than 60% of Indian population lives in rural areas and depends upon agriculture for livelihood. An important constraint to crop production is significant yield loss caused by pests and diseases both at pre- and post-harvest stages. Rodents have been identified as major destructive pests causing severe damage to food crops in the field as well as in storage (Parshad, 1999).

Rodents cause 5-10% loss of food grains annually during production, processing, storage and transport (Singleton and Petch, 1994; Singleton et al., 1999; Singleton, 2003; Hussain et al., 2006; Fayenuwo et al., 2007; Palis et al., 2007; Meerburg and Kijlstra, 2008). They have been reported to cause a loss of 6-8% in paddy, 10-12% in wheat and 20-25% in sugarcane in India at pre-harvest stage (Chattopadhyay et al., 2010; Singla and Babbar, 2010 and 2012; Singla and Parshad, 2010).

Rodents are also a reservoir of more than 60 human and animal diseases that are transmitted directly from rat bites, bites of rat fleas and lice or indirectly by eating or touching food or water contaminated with rodent urine and feaces (Singla et al., 2008a,b and 2013; Pai et al., 2005; Meerburg et al., 2009). Farmers in developing countries have to manage rodents in order to reduce damage and to increase yield with ultimate goals of improving food security and increasing income (Brown et al., 2008, Singla et al., 2012). They use a wide variety of management practices to limit damage by rodents to their

crops and these include a range of physical, chemical and biological methods (Singleton et al., 1999; Tuan et al., 2003).

The major problems in the implementation of rodent control technologies are the lack of interest, motivation and awareness of the economic damages caused, discouragement due to frequent failure of rodent control operations as a result of adoption of incorrect control procedures, inadequate extension programmes for transfer of technologies and small land holdings of farmers which make rodent control campaigns difficult to organize over large areas (Prashad and Ahmad, 1996; Malhi, 1998; Fiedler and Fall, 1994; Singla et al., 2012). Most of farmers consider rodents as unmanageable pests and often neglect their control (Poeche et al., 1986; Stuart et al., 2011). In many cases, the rodent control efforts by farmers have not given satisfactory results (Singleton and Petch, 1994). The socioeconomic conditions and culture of farmers are thought to influence the success of pest management practices (Singla and Parshad, 1999). Information therefore needs to be collected on farmer beliefs, perceptions and practices associated with pest management (Heong and Escalada, 1999). This study reports information on farmers' knowledge, attitude and practices used for rodent pest management gathered through farmer surveys conducted in villages of districts Jalandhar and Kapurthala of Punjab, India; impact of education and training in terms of reduction in rodent damage and yield loss along with sustainability.

Materials and Methods

Present study was conducted in adopted villages of two districts namely, Jalandhar (2011-12) and Kapurthala (2012-13) in Punjab, India.

Categorization of villages

Three villages were selected from each district during Rabi (wheat crop period) and Kharif (paddy crop period) seasons and categorized as (i) maintenance area (village Kotbadal Khan in Jalandhar and Sarai Jatan in Kapurthala) (ii) neglected area (village Dalla in Jalandhar and Kolianwala in Kapurthala), and (iii) survey area (village Bandala in Jalandhar and Barindpur in Kapurthala). Land holdings of farmers in selected villages ranged from 1 to 24ha. Farmers of these villages grow crops like paddy, wheat, sugarcane, pulses and fodders with rice-wheat as major cropping system.

In maintenance areas, rodenticide baits were got prepared on the spot and distributed free of cost along with proper education regarding various rodent control technologies. Similar activities were done in neglected areas but rodenticide baits were not distributed among farmers. The survey areas were kept as reference areas where neither education was provided nor were the rodenticide baits distributed. Leaflets in local language (Punjabi) containing information on recommended methods of rodenticide bait preparation and time of application along with precautions to be taken were also distributed among farmers in both maintenance and neglected areas.

KAP survey

The opinion survey of farmers (30-50 in each village), was conducted in all the three villages (during the months of February and August in Rabi and Kharif seasons, respectively) before providing education and training by distributing a well-structured KAP survey questionnaire. Farmers had assembled at a common place in each selected village. Through questionnaire, information was gathered regarding the knowledge of farmers about different rodent management practices (during wheat and paddy crop seasons), their attitude towards control of rodents and rodent control practices being used by them.

Education and field demonstration

Education-cum-field demonstrations were organized with the help of Co-operative societies and Progressive farmers of villages and nearby Krishi Vigyan Kendras of Punjab Agricultural University, Ludhiana, India. Education about types of rodent species inhabiting crop fields, damages caused, their behaviour and various rodent control techniques was provided to farmers during the month of February in Rabi season and during the month of August in Kharif season in maintenance and neglected villages. These periods coincided with the grain filling stage of the crops which is the most suitable time for rodenticide baiting. Field demonstrations were given on rodenticide bait preparation and application at farmer's fields. During May-June and October-November, when there was little crop cover in the fields, farmers were advised to do burrow baiting by placing paper boats, each containing 10g of rodenticide bait about 6 inches deep inside each live burrow (the burrow closed with soil a day before treatment in the evening and found re-opened on the next day). During August and February, farmers were advised to place 10g of rodenticide bait on a piece of paper at 40 bait points in a 10 x 10m grid in fields of 0.4 ha each. In paddy crop, farmers were advised to keep the rodenticide bait on pieces of paper near bunds. Farmers were educated to do

rodenticide baiting thrice in sugarcane fields, first in July, second in October-November with two rodenticide baitings each (2% zinc phosphide bait followed by 0.005% bromadiolone bait at the interval of 15 days) at 1kg/ha and third in December-January with single baiting of 0.005% bromadiolone at 2kg/ha.

Farmers were asked to adopt prophylactic control measures at recommended timings prior to when economic damage is inflicted and to use recommended dose of rodenticide in the preparation of poison baits. Farmers were advised to integrate other methods like habitat manipulation (removal of weeds and grasses, reconstruction of bunds), conservation of natural predators of rats (like snakes, cats, owls etc.), mechanical methods (trapping and killing of rats during irrigation or flooding of fields) with chemical control. They were motivated to adopt all the rodent control strategies at community level.

Cereal based rodenticide baits i.e. 0.005% bromadialone and 2% zinc phosphide were prepared on the spot in front of farmers of maintenance areas and distributed free of cost in the months of February during Rabi season and August during Kharif season on the basis of their land holdings which were then applied by all the farmers in their fields on the same day. Farmers were also encouraged to do pre-baiting before using zinc phosphide, reduce repeated use of zinc phosphide bait and alternatively use bromadiolone. In addition, farmers were also requested to collect unconsumed poison bait and dead rats and mice to bury them deep inside the soil so as to avoid secondary poisoning.

Impact assessment and sustainability

For recording the sustainability of education and training imparted in maintenance and neglected areas during Rabi season, KAP survey was done again during coming Kharif season. To assess the impact of education and training on success of rodent control programme, seven fields of about 0.4 ha area of wheat and paddy crops during Rabi and Kharif seasons, respectively were selected in each village. Consumption of plain bait (cracked wheat, powdered sugar and groundnut oil in ratio 96: 2: 2) and number of live rodent burrows as pre- and post- treatment census were recorded before and after application of rodenticide baits. Rodent damage (percent cut tillers) in wheat and rice crops was assessed at pre-harvest stage by taking five samples of $1m^2$ per field of 0.4 ha in two diagonal lines to cover center as well as all the four geographical sides of a field. In each sample, number of healthy tillers and tillers cut by rodents were counted. Yield loss (kg/ha) was calculated as per the methods described by Singla and Babbar (2010).

Results and Discussion

KAP analysis

Survey of farmers for KAP analysis before imparting education revealed that pre-existing knowledge of farmers, their general attitude towards rodent pests and the management practices being used by them were quite similar across all the villages selected in Jalandhar and Kapurthala districts (Tables 1and 2). During the study, it was observed that all the farmers considered rodents to be the important pests, responsible for causing low to high damage to their crops, thus reducing their crop yield.

Knowledge

All the farmers of two districts were aware about the advantages of rodent control and most of the farmers knew the importance of applying rodent control operations collectively at village level, but they were not doing so. In all the villages (maintenance, neglected and survey villages) of district Jalandhar (Table 1), 80-90% farmers were found aware of the fact that rodents cause more damage to crops left in the fields after harvesting and 84-94% farmers thought that rodent control operations during crop period should be carried out before grain filling stage as after that period rodents do not readily accept the poison bait. Farmers did not have any knowledge about bromadiolone as a rodenticide. Only 20-50% farmers knew that pre-baiting before zinc phosphide is must and only 2-37.5% knew that zinc phosphide baiting should not be repeated again and again at short intervals. Only up to 44% farmers knew the fact that collection of dead rats and remaining poison bait reduces chances of secondary toxicity.

The farmers of all the villages (maintenance, neglected and survey villages) of district Kapurthala (Table 2) had a different approach. Most of the farmers (80-88%) were aware of the fact that rodents cause more damage to crops left in the fields after harvesting and 55-76% farmers thought that rodent control operations during crop period should be carried out before grain filling stage. In district Kapurthala also the farmers did not have any knowledge about bromadiolone as a rodenticide. Only 35-43% farmers knew that pre-baiting before zinc phosphide is must and only 13-17% knew that zinc phosphide baiting should not be repeated again and again at short intervals. In district Kapurthala, up to 90% farmers knew the fact that collection of dead rats and remaining poison bait reduces chances of secondary toxicity, but none was found doing so practically.

Attitude

All the farmers of the both the districts used to procure zinc phosphide from the market and most of the farmers relied on labour for application of rodenticide baits in their fields. Most of the farmers of the two districts were also of the view that rats should be killed after trapping. All the farmers of district Jalandhar (Table 1) were of the view that rodent control should be carried out but, only 10-16% of the farmers were of the view that rodent control before start of damage (before grain filling stage) is wastage of time and labour. 50-84% farmers were of the view that conducting pre-baiting before zinc phosphide treatment is a mere wastage of time. Most of the farmers were of the view that after rodent control programme, rodent population rebuilds up and hence control measures have to be applied again and again.

In district Kapurthala (Table 2), 64.7-100% farmers were of the view that rodent control should be carried out but, only 24-40% of the farmers were of the view that rodent control before start of damage is wastage of time and labour. 57-65% farmers were of the view that conducting pre-baiting before zinc phosphide treatment is a mere wastage of time. Only 10-15% farmers of district Kapurthala were of the view that rodent population rebuilds up after a successful rodent control programme.

Practices

All the farmers of the two districts used only zinc phosphide bait to control rodents. Farmers used to apply poison baits either by grid baiting, burrow baiting, by placing bait near rodent burrows or by all the three methods. In district Jalandhar Table 1), 66-72% farmers were using cracked wheat or any other cereal (like rice, maize, bajra etc.) in the preparation of poison bait, whereas 28-34% farmers were also using sweets and fruits as bait material. Only 4-18% farmers were using recommended dose of zinc phosphide in preparation of bait and only 16-50% farmers were doing pre-baiting before zinc phosphide treatment. Up to 10% farmers used to apply poison baits collectively at village level and up to 7% farmers used to collect dead rats and remaining poison baits to avoid secondary toxicity. Only 2-10% farmers used to reconstruct permanent bunds to destroy rodent burrows. Most of the farmers of district Jalandhar were removing weeds and grasses from their fields to reduce rodent infestation and were not killing natural predators of rodents (like dogs, cats, owls etc.) whereas, 53-80% farmers were also treating wasteland areas.

In district Kapurthala (Table 2), 42-54% farmers were using cracked wheat or any other cereal in the preparation of poison bait, whereas 46-58% farmers were also using sweets and fruits as bait material. Only 18-50% farmers were using recommended dose of zinc phosphide in preparation of bait and only 35-43% farmers were doing pre-baiting before zinc phosphide treatment. In villages of district Kapurthala, most of the farmers were applying poison baits collectively at village level, collecting dead rats and remaining poison baits to avoid secondary toxicity and removing weeds and grasses to reduce rodent infestation. Only 10-20% farmers were treating wasteland areas, 20-41% farmers were reconstructing permanent bunds to destroy rodent burrows and 20-15% farmers were not killing natural predators of rodents.

Impact assessment

KAP survey of farmers of both maintenance and neglected areas in districts Jalandhar and Kapurthala during Kharif season, after imparting education in Rabi season revealed up to 60% increase in knowledge of farmers regarding rodents, damages caused by them and methods of their management. All the farmers started knowing about the advantages of second generation anticoagulant, bromadiolone and started using it along with the use of zinc phosphide.

Adoption of rodent control practices and sustainability

There was found an overall change in attitude of farmers regarding conduction of prophylactic control before grain filling stage, pre-baiting before using zinc phosphide and decreased dependence on labour for poison baiting. There was a decrease in percentage of farmers which thought that rodent population increases after their control. In district Jalandhar (Table 1), the percentage of farmers who thought that pre-baiting before using zinc phosphide is wastage of time, decreased by 30 and 27% in maintenance and neglected villages, respectively, whereas in district Kapurthala (Table 2), percentage of farmers with this thought decreased by 40 and 30% in maintenance and neglected villages, respectively. As the farmers were educated that zinc phosphide should not be used repeatedly, so percentage of farmers using bromadiolone as alternative increased by 32 and 15% among farmers of maintenance and neglected villages of district Jalandhar and by 30 and 20% among farmers of maintenance and neglected villages of district Kapurthala. However, in survey villages of both the districts, farmers used zinc phosphide bait only. There was also an increase in percentage of farmers of maintenance villages of both districts considering that all the rodent control operations should be carried out collectively at village level. In West Java, integrated rat

management, coordinated at the community level, provided a large benefit for farmers with small land holdings, and reduced reliance on rodenticides (Singleton et al., 2005).

Cracked wheat is best material for preparing cereal based rodenticide bait. In maintenance villages of both districts, there was 8-23% increase in farmers who used cracked wheat or other cereals and 8-18% decrease in farmers who used sweets and fruits as baiting materials, thus increasing the efficacy of poison baits. In maintenance and neglected villages of district Kapurthala, there was 31-35% increase in farmers, who used grid method of bait application in crop fields. In Jalandhar district, farmers were mainly using grid method but in maintenance village, there was increase in percentage of farmers who did baiting near burrows. Interestingly, in maintenance and neglected villages of district Kapurthala, there was 57 and 30% increase in farmers who used recommended dose of zinc phosphide (25g/1kg bait material), whereas in maintenance and neglected villages of district Jalandhar, there was 96 and 62% increase in farmers who used recommended dose of zinc phosphide during bait application. In maintenance villages of districts Kapurthala and Jalandhar, there was 15-21% increase in farmers who started application of poison bait in wastelands along with their crop fields after getting education (Tables 1and 2). Rodenticides are widely used by financially poor farmers in Southeast Asia, but often inappropriately (Sudarmaji et al., 2003), resulting in genetic resistance, behavioral avoidance, non-target poisoning and environmental risks (Cowan et al., 2003, Jackson and Van Aarde 2003).

There was 8-49% increase in farmers who started collecting dead rats and remaining poison bait in maintenance villages of both districts (Jalandhar and Kapurthala) being higher per cent in Jalandhar to reduce secondary toxicity effects (Tables 1 and 2). Mostly the rats make their burrows in permanent bunds surrounding crop fields, so their regular reconstruction is necessary. There was 22-59% increase in farmers in maintenance villages of both the districts, who reconstructed permanent bunds around their crop fields.

In maintenance villages of both the districts, there was 12-18% increase of farmers after education, who started removing weeds and grasses which serve as alternate food for rats and also provide them shelter for living. Using rodenticides is not a sufficient method to control rodents, we also have to adopt various other approaches to control them. We must do something to conserve their natural enemies. There was 18-76% increase in farmers of maintenance and neglected villages of both districts, who started protecting natural enemies of rodents to reduce rodent population and thus increase crop yield.

There was found sustainability in knowledge and attitude of farmers regarding rodent pest management and adoption of different rodent control practices after imparting education in both maintenance and neglected villages of districts Jalandhar and Kapurthala.

Affect on reduction in rodent infestation, damage and yield loss

In wheat crop, a significant ($p \leq 0.05$) reduction in consumption of bait from 63.1% before treatment to 14.1% after treatment was observed in maintenance village in district Jalandhar indicating reduction in rodent infestation due to control measures applied (Table 3). Post treatment bait consumption in maintenance village was also significantly ($p \leq 0.05$) low compared to that observed in neglected and survey villages in district Jalandhar (Table 3). Similarly, there was a significant ($p \leq 0.05$) reduction in number of live burrows of *Bandicota bengalesis* after treatment in maintenance and neglected villages and that of burrows of *Mus booduga* in maintenance village as compared to survey village in district Jalandhar (Table 3). Significant ($p \leq 0.05$) reduction in number of live burrows of *B. bengalensis* after treatment in maintenance village as compared to survey village was also observed in district Kapurthala (Table 4). Cut tillers (%) and yield loss (kg/ha) after treatment were found reduced significantly ($p \leq 0.05$) in maintenance and neglected villages in district Jalandhar (Table 3) and in maintenance village in district Kapurthala (Table 4) compared to survey village thus indicating that timely education and training of farmers on rodent control are the important key factors responsible for the success of a rodent control programme.

In rice crop, there was observed a significant ($p \leq 0.05$) reduction in bait consumption after treatment compared to consumption before treatment in maintenance (43.9 to 24%) and neglected (22.1 to 14.3%) villages of district Jalandhar and neglected (45.9 to 17.9%) village of district Kapurthala (Tables 5 and 6). Crop in maintenance village of Kapurthala was harvested a day before the collection of left over bait, so consumption could not be recorded. A significant ($p \leq 0.05$) reduction was observed in number of live burrows of *B. bengalensis* after treatment in maintenance and neglected villages of district Jalandhar (Table 5) and in live burrows of both *B. bengalensis* and *M. booduga* in neglected village of district Kapurthala (Table 6) compared to survey village. Cut tillers (%) and yield loss (kg/ha) after treatment were found reduced significantly ($p \leq 0.05$) in maintenance and neglected villages compared to survey village in district Jalandhar (Table 5). No rodent damage and yield loss was observed in neglected village of district

Kapurthala (Table 6). This may be due to management of weeds in addition to rodenticide treatment carried out by the farmers from whose field data was taken from neglected village. Singleton et al. (2005) reported 1.9 times more tiller damage in control village (13%) as compared to that in treated villages (6.8%).

Our study has established a fact that the respondents have knowledge on rodent control practices and have positive tendency of controlling them by doing poison baiting. Similar tendency among rural farmers was also reported earlier in Bangladesh and India (Rogers and Shoemaker, 1971; Posamentoer, 1994; Reddy and Rao, 2000). There is a positive indication of approach towards management of rodents as farmers purchase rodenticides themselves from pesticide outlets. These results indicate requirement of human resource development to reduce rodent damage through awareness, campaign and by giving lectures for improving the efficiency in rodent management by integrating different control techniques instead of depending solely on poison baiting methods.

Rodent control is a very complex and intricate problem in crop fields. Different training programmes regarding rodent pest management are required to create interest and motivation among farmers to combat rats. Rodent population can be managed if farmers work together as a community (Brown and Khamphoukeo, 2010) at village level and different control measures are applied at right time of crop growing stage. Therefore it is important to demonstrate the effectiveness of different rodent control strategies to farmers at village, block and district level.

Table 1- KAP analysis of farmers during wheat and rice crop periods in villages of district Jalandhar during 2011-2012

Sr. No.	Parameters	Percentage of farmers					
		Maintenance village		Neglected village		Survey village	
		Rabi	Kharif	Rabi	Kharif	Rabi	Kharif
Knowledge							
1.	Rodents are important pests causing low to high damage	100	100	100	100	100	100
2.	Rats cause damage to crops left in fields after harvesting	90	100	86	88	80	80
3.	Rodent control during crop period to be carried out before grain filling stage	94	100	84	86	85	85
4.	Pre-baiting before zinc phosphide treatment is must	50	80	16	43	20	20
5.	Zinc phosphide treatment can not be repeated again and again	37.5	84	02	43	10	10
6.	Bromadiolone as alternative to zinc phosphide	0	100	0	100	0	0
7.	Rodent control to be conducted at village level	86	100	74.5	65	90	90
8.	Dead rats and remaining poison bait to be collected to avoid secondary toxicity	44	100	30	94	0	0
Attitude							
9.	Rodent control should be carried out	100	100	100	100	100	100
10.	Rodent control before start of damage is wastage of time and labour	10	06	16	14	15	15
11.	Pre-baiting before zinc phosphide treatment is a mere wastage of time	50	20	84	57	80	80
12.	Rodent population increases after control measures	94	25	78	15	90	90

13.	Relying on labour for application of rodenticide baits	100	85	100	95	100	100
14.	Procurement of rodenticides from market	100	100	100	100	100	100
15.	Rats should be killed after trapping	53	100	96	100	100	100
Practices							
16.	Using only zinc phosphide bait to control rodents	100	68	100	85	100	100
17.	Using bromadiolone bait to control rodents	0	32	0	15	0	0
18.	Using cracked wheat/other cereals as bait material	66	74	70	64	72	72
19.	Using sweets and fruits as bait material	34	26	30	36	28	28
20.	Doing pre-baiting before using zinc phosphide	50	80	16	43	20	20
21.	Using recommended dose of zinc phosphide	04	100	18	80	10	10
22.	Bait application by						
	a) Grid baiting	46	47	61	65	35	35
	b) Near burrows	28	43	06	07	30	30
	c) Burrow baiting	14	0	04	14	30	30
	d) All the above	12	10	29	14	05	05
23.	Applying poison bait in wastelands	53	74	63	80	80	80
24.	Applying poison baits collectively	04	10	10	15	0	0
25.	Collecting dead rats and remaining poison bait	04	53	07	20	0	0
26.	Reconstructing permanent bunds	10	32	02	10	10	10
27.	Removing weeds and grasses	88	100	97	100	95	95
28.	Do not kill natural enemies of rodents	66	90	67	85	80	80

Table 2- KAP analysis of farmers during wheat and rice crop periods in villages of district Kapurthala during 2012-2013

Sr. No.	Parameters	Percentage of farmers					
		Maintenance village		Neglected village		Survey village	
		Rabi	Kharif	Rabi	Kharif	Rabi	Kharif
Knowledge							
1.	Rodents are important pests causing low to high damage	100	100	100	100	100	100
2.	Rats cause damage to crops left in fields after harvesting	82	94	88	77	80	80
3.	Rodent control during crop period to be carried out before grain filling stage	76	85	66	76	55	60
4.	Pre-baiting before zinc phosphide treatment is must	35	75	43	73	40	40
5.	Zinc phosphide treatment can not be repeated again and again	17	68.7	13	27	10	10

6.	Bromadiolone as alternative to zinc phosphide	0	100	0	100	0	0
7.	Rodent control to be conducted at village level	82	100	65	73	90	90
8.	Dead rats and remaining poison bait to be collected to avoid secondary toxicity	90	100	90	94	0	0
Attitude							
9.	Rodent control should be carried out	64.7	88	78	82	100	100
10.	Rodent control before start of damage is wastage of time and labour	24	15	34	24	40	40
11.	Pre-baiting before zinc phosphide treatment is a mere wastage of time	65	25	57	27	60	60
12.	Rodent population increases after control measures	12	0	15	10	10	10
13.	Relying on labour for application of rodenticide baits	100	70	95	85	94	90
14.	Procurement of rodenticides from market	100	100	100	100	100	100
15.	Rats should be killed after trapping	100	100	100	100	100	100
Practices							
16.	Using only zinc phosphide bait to control rodents	100	70	100	80	100	100
17.	Using bromadiolone bait to control rodents	0	30	0	20	0	0
18.	Using cracked wheat/other cereals as bait material	52	75	54	50	42	40
19.	Using sweets and fruits as bait material	48	25	46	50	58	60
20.	Doing pre-baiting before using zinc phosphide	35	75	43	73	40	40
21.	Using recommended dose of zinc phosphide	18	75	50	80	50	50
22.	Bait application by						
	a) Grid baiting	29	60	05	40	05	05
	b) Near burrows	65	40	65	50	60	50
	c) Burrow baiting	06	0	15	10	05	35
	d) All the above	0	0	15	0	30	10
23.	Applying poison bait in wastelands	10	25	20	20	20	20
24.	Applying poison baits collectively	90	93	95	100	100	100
25.	Collecting dead rats and remaining poison bait	80	88	80	100	100	100
26.	Reconstructing permanent bunds	41	100	20	80	30	40
27.	Removing weeds and grasses	82	90	85	90	85	85
28.	Do not kill natural enemies of rodents	24	100	25	100	20	20

Table 3-Impact of education and training on rodent infestation, damage and yield loss in wheat crop in adopted villages of district Jalandhar

Village	Percent bait consumption		After treatment			
	Before treatment	After treatment	Live burrow count		Cut tillers (%)	Yield loss (kg/ha)
			Bandicota bengalensis	*Mus booduga*		
Maintenance	63.1±8.2[a]	14.1±1.2*[b]	5.1±1.0*	0.7±0.4*	0.18±0.1*	11.7±4.9*
Neglected	38.8±6.1	28.1±1.9	10.1±0.8*	4.9±0.6	0.20±0.1*	13.7±5.0*
Survey	-	33.1± 3.1	13.7±0.9	4.7±0.8	0.62±0.1	22.5±3.4

a,b Significant reduction in bait consumption after treatment in a row at $P \leq 0.05$
*Significant difference from survey village in a column after treatment at $P \leq 0.05$

Table 4-Impact of education and training on rodent infestation, damage and yield loss in wheat crop in adopted villages of district Kapurthala

Village	Percent bait consumption		After treatment			
	Before treatment	After treatment	Live burrow count		Cut tillers (%)	Yield loss (kg/ha)
			Bandicota bengalensis	*Mus booduga*		
Maintenance	31.04±6.3	25.21±2.8	3.00±0.9*	3.5±1.9	0.32±0.1*	35.29±10.2*
Survey	56.46±7.4	45.62±2.3	7.08±0.8	0.00±0.0	1.40±0.9	158.82±89.2

*Significant difference from survey village in a column after treatment at $P \leq 0.05$

Table 5-Impact of education and training on rodent infestation, damage and yield loss in rice crop in adopted villages of district Jalandhar

Village	Percent bait consumption		After treatment			
	Before treatment	After treatment	Live burrow count		Cut tillers (%)	Yield loss (kg/ha)
			Bandicota bengalensis	*Mus booduga*		
Maintenance	43.9±10.2[a]	24.0±11.5[b]	8.2±0.9*	7.0±1.3	0.3±0.0*	30.3±4.0*
Neglected	22.1±4.1[a]	14.3±3.4[b]	6.7±0.7*	7.0±0.5	0.3±0.0*	28.1±6.6*
Survey	36.4±10.3	45.0±3.4	15.2±2.6	7.5±1.1	1.5±0.1	162.0±0.6

a,b Significant reduction in bait consumption after treatment in a row at $P \leq 0.05$
*Significant difference from survey village in a column after treatment at $P \leq 0.05$

Table 6-Impact of education and training on rodent infestation, damage and yield loss in rice crop in adopted villages of district Kapurthala

Village	Percent bait consumption		After treatment			
	Before treatment	After treatment	Live burrow count		Cut tillers (%)	Yield loss (kg/ha)
			Bandicota bengalensis	*Mus booduga*		
Maintenance	31.4±3.7	harvested	6.7±0.7	13.0±1.4	0.7±0.1	65.9±16.4
Neglected	45.9±4.5 [a]	17.9±3.0* [b]	0.0±0.0 [*]	1.7±1.4 [*]	0.0±0.0 [*]	0.0±0.0 [*]
Survey	38.7±1.9	42.1±9.6	6.3±1.9	14.7±0.7	1.1±0.4	87.0±23.4

a,b Significant reduction in bait consumption after treatment in a row at $P \leq 0.05$
[*]Significant difference from survey village in a column after treatment at $P \leq 0.05$

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