



FARMERS' PERCEPTION ON POTATO PESTS AND YIELD LOSS ASSESSMENT BY RED ANT AND WHITE GRUB ON POTATO IN RAMECHHAP, NEPAL

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Abstract

Survey was conducted to assess the knowledge and practices of potato growing farmers' on the details of potato pests in Gokulganga Rural Municipality of the Ramechhap district. Fifty farmers' were randomly selected and interviewed using structured open-ended questionnaire for collecting the information. Similarly, field yield loss by red ant and white grub on Cardinal and Rosita variety was assessed from one meter square area of thirty fields of the survey site. Survey revealed red ant followed by white grub were the major pest of potato. The average percentage yield loss by the red ant and white grub was 17.3% and 10.5%, respectively. It was also found that, Rosita variety was better in terms of yield than Cardinal. The percentage yield loss on Cardinal and Rosita variety was 15.59% and 6.11% by red ant and 2.01% and 4.16% by white grub, respectively. There is not significant difference in yield loss by red ant and white grub in between Cardinal and Rosita variety. The correlation between white grub population and percentage yield loss is moderately positive in both Cardinal (0.448) and Rosita (0.246) variety whereas correlation between red ant population and percentage yield loss is negative in Cardinal (-0.15) and less positive in Rosita (0.023) variety. Farmers' knowledge and practices on potato pest management and field loss information can be useful to design integrated pest management strategy for potato pest management.

Key words: Integrated pest management, Potato, Potato pests, Productivity, Yield loss

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Introduction

Potato (*Solanum tuberosum* L., Solanaceae) is the fourth major crop of the world after rice, wheat, and maize that are grown to satisfy the food demand and to improve the living standard of the farmer (FAO, 2012). It is one of the important cash crop to address food insecurity and reduces poverty among smallholder farmers' in the developing countries like Nepal (Timsina et al., 2011). Its cultivation is popular among farmers' due to its wider adaptability, high yield potential, and high demand which contributes about 6.57% and 2.17% in AGDP and GDP, respectively (Barjacharaya & Sapkota, 2017). According to FAO estimates, in 2019, over 423 million metric tons of potatoes were produced worldwide. In the year 2018/19, the productivity of the Ramechhap district (14.02 mt./ha.) was less than the national productivity (16.05 mt./ha.) (MoALD, 2078).

Pests are the major yield-reducing factor of potato in the world which accounts for 16% of losses, and reductions in tuber yield and quality can be between 30% and 70% for various insect pests (Alyokhin et al., 2013). Among different insect pests of potato, red ant is one of the most important soil pest all around the world whose population build-up is favoured by high temperatures and dry weather (Kishore et al., 1990) and once the colony is established it is difficult to eradicate (Alyokhin et al., 2013). Red ant mainly damages the potato stems and tubers by chewing holes and in case of severe attack plants become wilt in direct sunlight and will eventually dry up (Trivedi & Rajagopal, 1999). The pest makes a hole on the surface of tuber which reduced tuber yield as well as market quality and the tuber damage is more in medium-sized tuber compared to the large and small-sized tuber (Gulab et al., 2002). In India and Bangladesh, 35 to 90% damage of potato tubers by this pest was reported (Mishra et al., 1993). In West Bengal, red ant causes potato yield reduction up to 35-40% (Konar et al., 2005). The insect is reported causing 70-90% damage at harvest to potatoes in farmers' fields in Bihar (Ram et al., 1993). Red ant has long been known as an important pest of potato from mid-hill to high-hill of Nepal (GC et al., 1997) and causes serious damage to potato, radish, carrot, cauliflower, cabbage, and many solanaceous and cruciferous vegetables in Nepal (Joshi, 1998). Previous studies conducted in the various parts of Nepal showed that it caused 15 to 82% of tuber damage on potato fields (Bhandari, 2011; Joshi, 1998). White grubs are the polyphagous pest that feeds on cereals, vegetables, cotton, tobacco and potato including turf, meadows, lawns, ornamental plants, pastures, plantation crops, and forest trees (Guppy & Harcourt, 2012). Young grubs feed on mother tuber, roots and tuber of developing potato plants, making shallow, and circular holes which reduces market quality (Gupta & Gavkare, 2014). The damage to potato tuber has been reported to vary from 8.5 to 75% especially in the hilly region of India (Chandel et al., 2015). The damage caused by scarab larvae is estimated to reduce the crop yield by about 40-80% and found to be the dominant from mid-hill to high-hill of Nepal (Khanal et al., 2012).

Application of botanicals like Banmara and Ketuki can decrease the yield loss up to 25% (Pathak, 2014) and application of Dursban 20EC @ 5ml/ltr of water and Sevin 85WP @ 3ml/ltr of water around the root zone starting from 45 days after sowing of potato tuber give the lowest infestation (Saikia, 2017). This research aims to assess the major pests of potato, farmers' understanding about the pests, and yield loss status under farmers' field condition.

Materials and methods

Selection of Study area

This research was carried on May 2020 in Gokulganga Rural Municipality of Ramechhap district, located at longitude (27.482648 N, 86.138576 E) to (27.6459 N, 86.3164 E) and the altitude ranges from 1186 to 2223 masl (Figure 1). The climate of Ramechhap varies largely from Tropical to Temperate. According to Climate Data (2020), the Köppen-Geiger climate classification of Ramechhap district is temperate climate with dry winter and hot summer. The average annual temperature is 17.4 °C with variation in temperature being 12°C while average annual precipitation is 1315mm with 323 mm variation. The soil texture of the research sites were sandy loam to loam which is suitable for potato cultivation. Maize was the previous crop grown in all selected thirty fields.

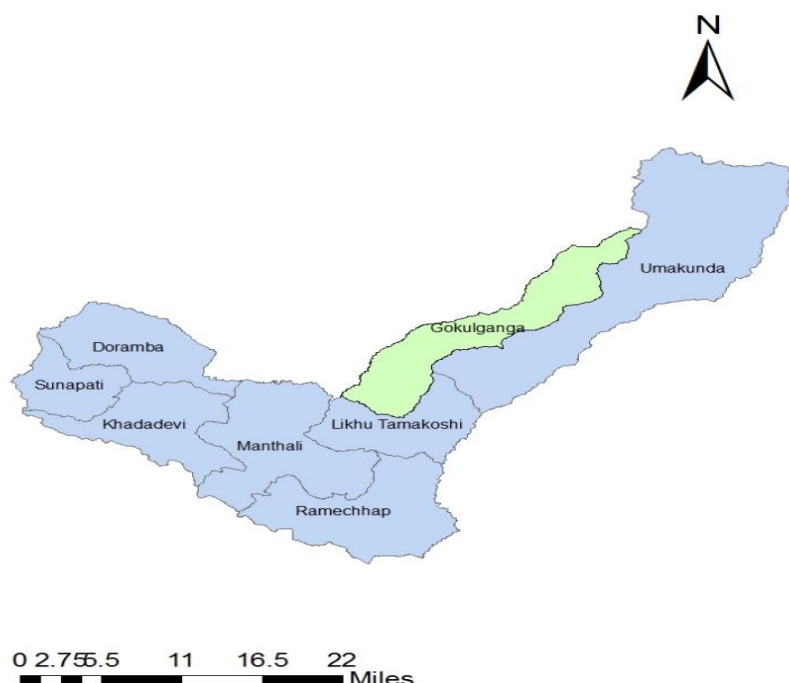


Figure 1: Map of Ramechhap district showing Gokulganga Rural Municipality.

The study consisted of two major parts:

- i) Farmers' survey
- ii) Yield loss assessment by red ant and white grub in potato crop.

Farmers' survey

A total of fifty farmers' from Gokulganga Rural Municipality representing 10% of total registered potato growers in PM-AMP, potato zone, Ramechhap were selected through a random sampling technique. Pre-structured open-ended questionnaire was used for the field data collection. Questionnaire was primarily focused on major insect pests' problem of potato, farmers' perception regarding the problem of red ant & white grub, nature of damage, percentage yield loss, and its management aspects (see annex 1 for the details).

Yield loss assessment

A field-based experiment was conducted to assess the loss by red ant and white grub in potato crop of Gokulganga Rural Municipality. Thirty potato fields located in various sites were selected for field loss assessment. Two common potato varieties such as Cardinal and Rosita were selected either from the same or different fields. One meter square in each field was demarcated and potatoes ready to harvest were harvested.

The numbers potato plant were counted, and the tubers were harvested from that demarcated meter square area with the help of hoe. Then the total tubers were counted and weighted. Red ant and white grub damaged tuber were separated, counted and weighted by weighing balance. Single tuber damaged by both insect were counted and weighted in both categories. Tubers damaged (categorical damage) by both insects were ranked as high (more than 75% damage), medium (25-75% damage), low (less than 25% damage) and no damage separately. All the selected locations were ranked by giving different marks i.e. 1 (more than 75% damaged tubers out of total tubers), 3 (50-75% damaged tubers out of total tubers), 5 (25-50% damaged tubers out of total tuber) and 7 (less than 25% damaged tubers out of total tubers). Finally, all the insects found in the field during the potato harvest were counted.

Data analysis

The entry of data collected from the survey and field-based experiment was done in MS-excel. The analysis of survey data was done in MS- Excel.

Preferential ranking of potato pests was done by indexing

$$I_{imp} = \sum (S_i \times F_i / N)$$

Where, I_{imp} = Index of importance

S_i = Scale value

N = No. of respondents

F_i = Frequency of importance given by respondents

The data of field-based experiments were normalized by square root transformation and data were analysed in Minitab software. Percentage yield loss was calculated by the formula given by Dash et al., (2013)

$$\text{Percentage yield loss} = \frac{\text{Insect damaged tubers wt.}}{\text{Total tubers wt.}} \times 100 \%$$

Two sample t-test of SQRT data was done to compare the mean percentage yield loss by red ant and white grub on Cardinal and Rosita variety at 95% of confidence level.

Results and discussion

Farmers' perception on potato pests and their management

Farmer ranked red ant as the major insect followed by white grub, aphid, cutworm, PTM, leaf miner and wireworm (Table 1). Timisina et al., (2013) stated red ant and white grub are the major insects of potato in Nepal. Survey revealed 52% of farmers' observed red ant & white grub during both earthing up and harvesting whereas 48% of farmers' observed only during harvesting. The tuber damage by red ant and white grub was 82% and 80%, respectively. In addition, damage to both tuber and root due to the red ant and white grub were 18% and 20%, respectively. Initially, first instar grubs feed on mother tuber & roots of developing potato plants, but after tuber formation, the older second instar and third instar grubs feed heavily on the underground potato tubers by making large, shallow, and circular holes into them causing greater economic loss (G.C., 2006).

Table 1: Farmers' ranking of major insects of potato on the study site.

Insects	Score							Weightage	Index	Rank
	1	0.857	0.714	0.571	0.428	0.285	0.142			
Red ant	43	7	0	0	0	0	0	48.99	0.97	I
White grub	7	43	0	0	0	0	0	43.85	0.87	II
Aphid	0	0	30	17	3	0	0	32.41	0.64	III
Cutworm	0	0	12	18	18	2	0	27.12	0.54	IV
PTM	0	0	8	15	23	4	0	25.26	0.5	V
Leaf miner	0	0	0	0	3	28	19	11.96	0.23	VI
Wireworm	0	0	0	0	3	16	31	10.24	0.2	VII

According to farmers' knowledge, the average percentage yield loss by red ant and white grub on potato was 17.3% and 10.5%, respectively. In the study site, 42% of the respondents responded the intensity of pest infestation has increased than the previous year and 18% and 40% of respondents responded decreased than the previous year and remains constant, respectively. 36% of the farmers' manages potato pests by physical methods whereas 64% farmers' do not manage pests that are observed in the field (Table 2). Moreover, the percentage of farmers' acquainted with integrated pest management methods, involvement in

training related to IPM and use of any IPM methods in their potato field was found zero. They haven't used any Bio-pesticides for the control of red ant and white grub. The non-acquaintance of the farmer towards IPM is due to not involvement in training related to IPM. Farmer don't use chemical pesticides. The reason behind no use of chemical pesticides might be unavailability of pesticides in the research area. Also, they were aware about the negative impacts of chemical pesticides. Similarly, no use of biological methods and cultural methods is due to unaware of it.

Table 2: Insect pest management practices followed by farmers'.

Insect management practices	Frequency	Percentage
Chemical method	0	0
Physical method	18	36
Biological method	0	0
Cultural method	0	0
No management	32	64
Total	50	100

Yield loss assessment

The study revealed that, in one meter square area, total plants number, tubers number, and average tubers no. per plant were found greater in Rosita variety ie.12, 101, 10 than Cardinal variety ie.11, 85, and 9. Moreover, total tubers weight (kg), average tubers weight per plant (kg), and average single tuber weight (kg) were also found greater in Rosita variety ie.2.594, 0.232, 0.027 than Cardinal variety i.e. 1.097, 0.118, and 0.012, respectively. The productivity of Cardinal variety is greater than Rosita variety (MOALD, 2078) but the low productivity of Cardinal might be due to greater loss by red ant in the later stage of plant.

The average percentage yield loss by red ant on Cardinal and Rosita variety was 15.59% and 6.11% respectively whereas the percentage yield loss by white grub was 2.01% and 4.16% respectively (Figure 2). Konar et al. (2005) reported 35-40% potato yield loss by red ant in west Bengal while Bhandari (2011) reported on an average 15-80% potato yield loss by white grub in Nepal which is greater than the calculated value. The lower percentage yield loss might be due to killing of insects physically found during earthingup by the farmers. Joshi (1998) reported the percentage yield loss due to red ant in local varieties like sabet local (15.5-36.2%), chisapani rato (22.4 - 39%), and Khumbule (38.5 - 55%) were least damaged as compared to improved varieties Kufri Jyoti (43.8 - 61.8%), Desiree (36.9 - 77%) and Cardinal (54.8 - 70.6%) that were moderately to highly damaged by red ant. Sharma et al., (2019) also reported that local varieties has least damage than improved varieties.

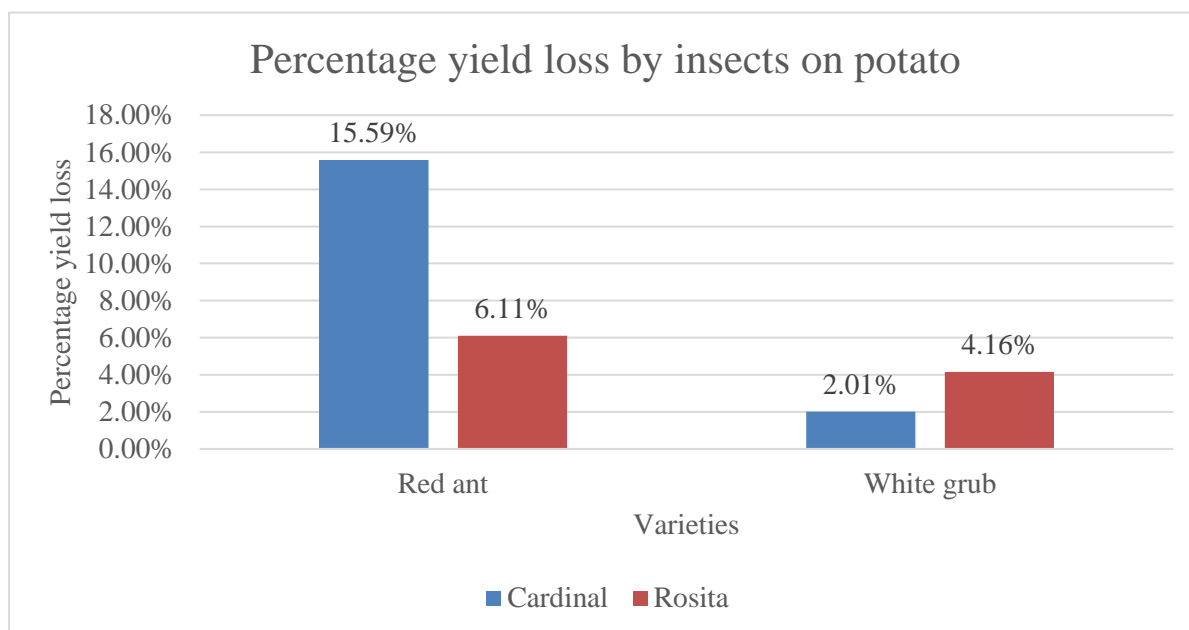


Figure 2: Percentage yield loss by red ant and white grub on Cardinal and Rosita variety.

Two sample t-test of SQRT data was done to compare the mean between the Percentage yield loss by the red ant and white grub on Cardinal and Rosita variety at 95% confidence level. The P-value obtained in 2-sample t-test of yield by red ant on Cardinal and Rosita is 0.889 which is greater than 0.05 (significance level), which shows no significant difference between the yield loss in both varieties by the red ant (Table 3). Similarly, the P-value obtained in 2-sample t-test of yield loss by white grub in Cardinal and Rosita variety is 0.070 which shows that no significant difference between the yield loss in both varieties by the white grub (Table 4).

Table 3: 2-Sample t-test of yield loss by red ant on Cardinal and Rosita variety.

Sample	N	Mean	St. Dev.	SEM
Red ant in Cardinal	15	1.94	2.97	0.77
Red ant in Rosita	15	1.28	1.6	0.41
df	28			
T-value	0.14			
P-value (0.05)	0.889 ^{ns}			

*ns=non-significant at 5% level of significance

Table 4: 2-Sample t-test of yield loss by white grub on Cardinal and Rosita variety.

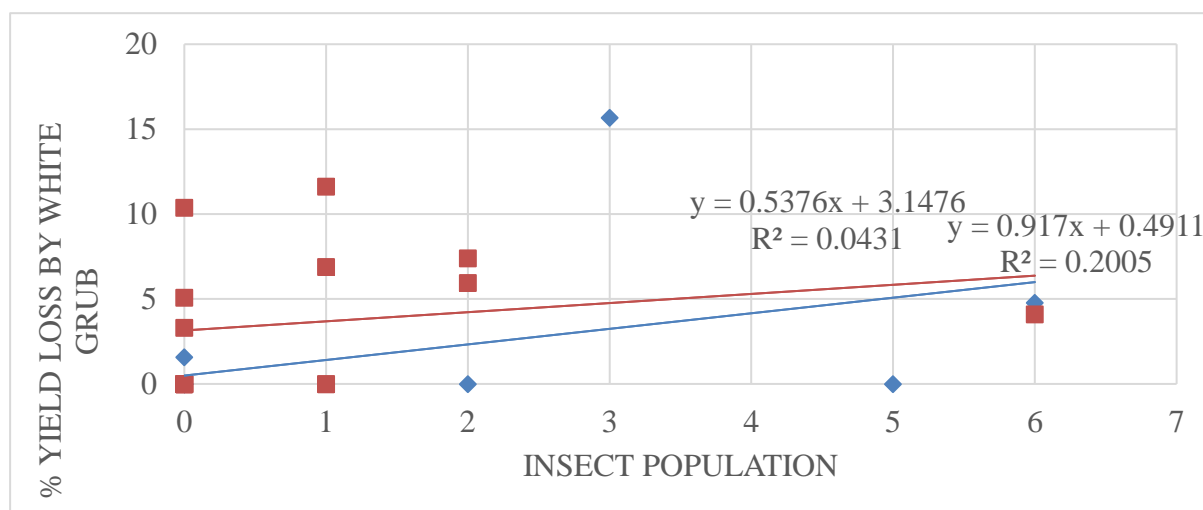
Sample	N	Mean	St. Dev.	SEM
White grub in Cardinal	15	0.49	1.15	0.3
White grub in Rosita	15	1.37	1.38	0.36
df	28			
T-value	-1.89			
P-value (0.05)	0.07 ^{ns}			

*ns=non-significant at 5% level of significance

The percentage of damage caused by Red ant and white grub is classified into four categories viz. less than 25%, 25-50%, 50-75%, and more than 75%. Among them, all fifteen locations have less than 25% damage by white grub in both Cardinal and Rosita variety. Whereas Red ant damage in Rosita variety in all fifteen locations is less than 25% but in Cardinal variety, Thirteen locations have less than 25% and one location has 25-50% & remaining one has more than 75% damage.

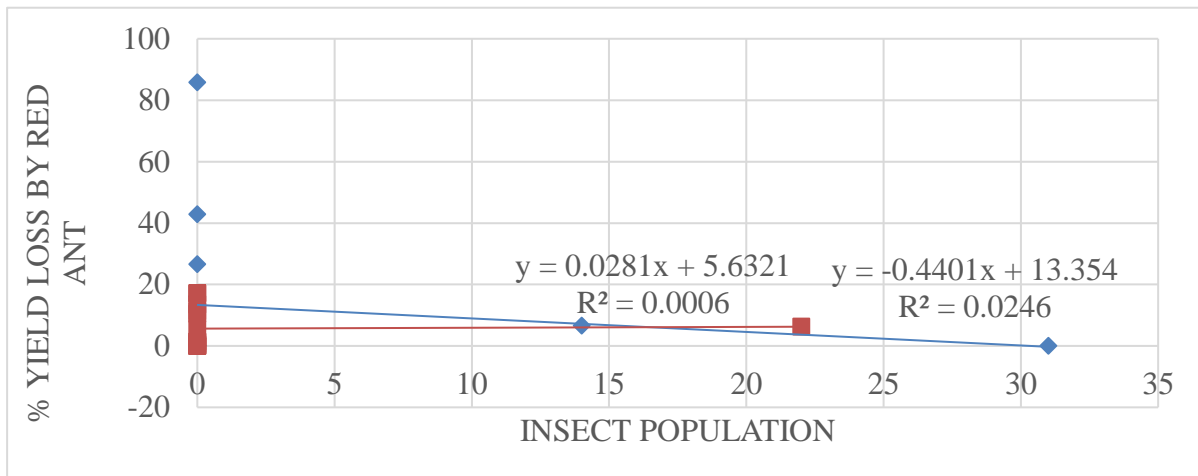
The mean white grub no. in Cardinal variety (2) was greater than Rosita (1). On an average one white grub adult was found in Rosita variety whereas no adult was found in Cardinal variety. No carabids and termites were found in both varieties. On an average one click beetle was found in Cardinal variety whereas no click beetle were found in Rosita variety. Moreover, on an average of two earthworms and one unidentified insects were also found in both varieties.

The correlation between the white grub population and percentage yield loss is moderately positive in both Cardinal (0.448) and Rosita (0.246) variety (Figure 3). However, the correlation between the red ant population and percentage yield loss is negative in Cardinal (-0.15) and less positive in Rosita (0.023) variety (Figure 4). Social insects red ant damages the tuber by aggregating in the single tuber or plant and the negative correlation between red ant population and percentage yield loss in cardinal variety is due to preference of large sized Rosita variety than Cardinal (Gulab et al., 2002).



*Blue line and red line indicates white grub population and % yield loss by white grub in Cardinal variety and Rosita variety respectively.

Figure 3: Correlation between white grub population and % yield loss by it on Cardinal and Rosita variety.



*Blue line and red line red ant population and % yield loss by red ant in Cardinal variety and Rosita variety

Figure 4: Correlation between red ant population and % yield loss by it on Cardinal and Rosita variety.

For the farmers' survey, 10 percent of farmers registered in PM-AMP, potato zone of Ramechhap district were selected, which is very low to represent all the potato growing farmers' of the Gokulganga Rural Municipality. Farmers' low level of education and no provision of record keeping are also the limitations of the study.

Conclusion

The calculated percentage yield loss by insects is very low than farmers perception which indicated farmers' low level of knowledge. The pest management methods adopted by farmers' is very low. Respondents revealed the infestation rate has been increased year by year. The percentage yield loss by red ant was found greater in Cardinal variety whereas it was found to be greater in Rosita variety by white grub. There is no significant difference in yield loss by the red ant and white grub in Cardinal and Rosita variety. The Production performance of local Rosita variety is satisfactory. So, future research on this variety must be conducted.

Conflict of interest

The author declare that there is no conflict of interest regarding the publication of this paper.

Authors' contribution statement

Santosh Khadka designed, executed the study and wrote the draft of the manuscript, Madhav Koirala and Susmita Tiwari helped during data recording, analysis and manuscript writing, and Sundar Tiwari finalized the draft of this manuscript.

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5.	Age	
6.	Primary occupation	1. Agriculture 2. Service 3. Abroad 4. Business 5. others
7.	Education status	1. Illiterate 2. literate If literate, i) Primary education up to class 5 ii. Higher-level up to class 12 iii. Bachelor level iv. Master level and university level v. PhD

B. Typical Agronomic practices adopted to grow potato on your farm

S.N	Details	Response
1.	Potato cultivated area	
2.	Variety	
3.	Date of plantation	
4.	Seed Rate	

5. Manure application and management

i. time of application: a. field preparation b. at the time of planting

ii. Amount:

iii. Manure improvement activity:

- a. Use of well-decomposed FYM
- b. Covering of FYM at the time of storage
- c. Composting

6. Do you use chemical fertilizer in the potato field? Yes No

If yes mention:

S. N.	Name of fertilizer	Time of application	Amount	Remarks
1.				
2.				
3.				

7. Soil tillage method adopted:

8. From where do you brought seed?

A. Own storage b. Agro vet c. Resource center d. Neighbor e. from government sector f. Others
:(Specify.....)

9. How do you plant potato tubers?

a. With cutting b. Without cutting

If with cutting: Why?

How do you cut?

If without cutting: Why?

10. Do you treat Cut tuber during planting? Yes No

If yes by which chemical do you treat?.....

11.	Type of field prepared for plantation	a. Flat why?..... c. Others: (Specify)	b. Ridge and furrow why?.....
12.	Mulching	Yes <input checked="" type="radio"/> If yes which type a. Rice straw c. Plant leaves	No <input type="radio"/> b. Thatch d. others.....
13.	Irrigation channel used	a. pipe b. canal	
14.	Irrigation frequency		
15.	Irrigation method adopted	a. Flooding b. sprinkle c. drip d. others	
15.	Previously grown crop on same field		

C. Pest situation

1. Major pest of potato

S.N.	Insects	Stage of plant	Nature of damage	% loss	Rank
1.					
2.					
3.					
4.					
5.					

3. Have you noticed any new pest in your field this year? Yes No

If yes, mention them

4. What is the intensity of pest Infestation?

a. Increased than previous year b. Decreased than previous year

c. Constant d. no idea

5. What type of pest management practices do you follow?

- a. No management b. chemical pesticides
- c. Biological d. Others: (specify:)

In the case of chemical pesticide mention them:

S.N.	Name of pesticide (Trade name)	Common name	Target pest	Dose	Application method	Interval	label	Impact
1.								
2.								
3.								
4.								

6. Do you think use of chemical pesticides is good or bad?

- a. If good, why?
- b. If Bad, why?

7.

7. Where do you store pesticide?

8. When (crop stage) you normally use pesticide to control red ant?

9. When (crop stage) you normally use pesticide to control white grub?

D. IPM Information

1. Do you know what IPM means? Yes No

If yes, IPM is.....

2. What are the common methods of IPM?

- a.
- b.
- c.

3. Have you received any training related to IPM? Yes No

If yes who conducted the training

4. Are you using any IPM method currently?

.....

5. What is the impact of IPM on your production?

6. Do you have any specific techniques to control white grub or red ant in your locality?

.....

7. Do you use any biopesticide to control them?

8. Do you store potato tuber for seed? Yes No

If yes, which method do you follow?

a. Rustic storage b. Own house by making pile c. Others: (Specify:)

9. Do you treat tuber during storage? Yes No

If yes, a. Chemical b. Biological

If chemical mention

S.N.	Name of chemical	Doses	Impact	Remarks

F. Production of potato

This year production:

Average production:

Selling price of potato:

 *Thank you for your valuable time and information.*