FARMERS SURVEY TO ASSESS OF YIELD LOSS DUE TO INSECT PESTS IN MAIZE AND THEIR MANAGEMENT STRATEGIES ADOPTED BY FARMERS OF BAITADI DISTRICT OF NEPAL

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ABSTRACT

The loss due to insect-pests is one of the major constraints in crop cultivation. In order to assess the losses due to insect pests, a survey was conducted in Dashrath Chand municipality and Surnaya Rural Municipality of Baitadi district under Prime Minister Agriculture Modernization Project (PMAMP), Maize Zone, Baitadi. A total of 100 household heads were selected among the farmers of maize pocket areas of the Prime Minister Agriculture Modernization Project for interview using a semi-structured questionnaire. The descriptive and comparative analysis was done for the field survey data using Microsoft Excel (MS Excel), and ranking the problems using the Wilcoxon signed rank test using statistical tools Statistical Packages for the Social Sciences (SPSS). Additionally, indexing was used to rank the major insect pests found in the maize field. Results showed that the major problematic insects found in the maize field were fall armyworm (Spodoptera frugiperda), cutworm (Agrotis spp.), maize stem borer (Chilo partellus) and white grub (Phyllophaga spp.) respectively, as ranked by the farmers according to losses caused by them. The indexing identified fall armyworm infestation as the most crucial problem with an index value of 0.85 (I=0.85). Interestingly, the maximum loss was found 37.5% (local variety) and the minimum loss 8.33% (hybrid variety). Farmers responded that the average loss caused by the insect in local and improved varieties was 25.19% and 18.38%, respectively. Thus, it can be concluded that comparatively the local varieties are more affected by insect pests than the improved varieties. All the surveyed farmers were found to be practicing both the physical and cultural methods. However, some farmers (10%) were also found to be using biological method of insect control. None of the farmers in the selected areas were found to be using chemical pesticides. So this research is focused on identifying damage and various management practices that can be adopted to solve the yield loss caused by insect pests.

Keywords: *farmers survey, Fall armyworm, local and improved variety, pest control, pesticides*

INTRODUCTION

Maize (*Zea mays L.*), is one of the important cereal crop not only for Nepal but also for several other countries (Kandel, 2021; Yadav et al., 2016). Maize serves as a staple food for millions of people and its versatility makes it an essential source of nutrition, animal feed and industrial products (Murdia et al., 2016). It ranks second in terms of area and production with the total area of 985,565 ha and production of 3,106,397 Mt that accounts for 7.60% of the agricultural gross domestic production of Nepal (MoALD, 2022). This crop can be utilized as a food, feed, seed, and fodder in the different areas of Nepal (Lamichhane et al., 2015). In the fiscal year 2021/22, Far Western province ranks least among all seven provinces in terms of maize area (47,613 ha), production (135,933 mt) and productivity (2.85 mt/ha). However, the production of maize has increased by 11.02% than the last year in Far Western province (MoALD, 2022). Among the various districts of Far Western province, Baitadi district has been declared as the Maize Super Zone, ranks first in terms of area and production with the total area of 10864 ha and production of 32078 mt. But, the area of cultivation of maize in Baitadi district has decreased by 1.51% than the last year (MoALD, 2022).

The major reason behind decrease in area of cultivation of maize is possibly due to adverse climatic conditions, lack of irrigation water during the spring season, insect pest and diseases, overuse of chemical fertilizer and lack of storage facilities (Song et al., 2020). Among the major limiting factors, insect pests play significant role in decrease in maize yield (Shiferaw et al., 2011). As reported by Pathak et al. (1994), the average maize yield loss caused by insect pests of maize is estimated to be 31.5% in Asia and 21% in North and Central America. The major insects that attack the maize are *Phyllophaga spp, Spodoptera frugiperda, Achaea janata, Agrotis spp., Cicadella viridis, Chilo partellus , Mythimna separata, Mythimna unipuncta , Chinavia hilaris, Gryllus spp., Gryllotalpa spp., Sitotroga cerealella, Sitophilus zeamais, Oryzaephilus surinamensis, Tribolium castaneum, Rhyzopertha dominica,* etc. (Kumar et al., 2001). Keeping in mind the importance of maize and the heavy yield loss caused by insects, this study aimed to find the status of loss due to insect-pest in maize, major loss causing insect-pest ranked by their severity, pest management practices adopted by the local farmers and other related aspects. Despite having immense importance such research has not been conducted in detail in the selected sites and hence it is expected to help all the stakeholders working in this field to come up with appropriate strategies to combat with this problem.

METHODOLOGY

Site selection and Sampling

The study was conducted at Baitadi district located in Sudurpaschim province of Nepal. Within the various local bodies, Dashrath chand Municipality and Surnaya Rural Municipality of Baitadi district, which are under Prime Minister Agriculture Modernization Project (PMAMP), Maize Zone where agriculture has been considered as the primary source of economy, were purposively selected for this research. The data was collected from the 100 farmers who was the beneficiaries of PMAMP Maize Zone, Baitadi. Total 50 households from Dashrath chand Municipality (25 from Gurukhola-1 and 25 from, Gowalek-9) and 50 households from Surnaya Rural Municipality (25 from Chillepaniand Gwani-2 and 25 from Bikuli-4) were selected. The sample size was determined by using Cochran Formula (Cochran, 1977), that gave the sample size of about 100 households. The formula for calculating the initial sample size for the estimation of indicators of proportions that ensures adequate precision is given by:

$$n = \frac{z^2 p(1-p)}{e^2}$$

$$n = \frac{1.96^2\, 0.5(1-0.5)}{0.1^2}$$

$$n = 96.04 \sim 97$$

Where
Z = 1.96 (Z-score for 95% confidence level)
e = (Margin of error) = 0.1
p = (Estimated proportion) = 0.5

Data Collection

Quantitative and qualitative data were collected by using semi-structured questionnaire in a household survey. The survey was used to collect information on household personal and demographic characteristics (household head's age, house head's education level, household head's gender, family size, etc.), major insect-pests appearing in the maize, their nature, pest losses and management practices.The production data was collected twice when insect attacked significantly and did not attack significantly (keeping all other factors affecting production as constant).

Data analysis

Quantitative data associated with the production loss due to insect was analyzed by using descriptive and comparative method in MS Excel. The Wilcoxon signed ranks test was done to test whether the loss due to insect in maize is significant or not. It is a method used to compare two sets of related data or one set of data to a standard (Woolson, 2007). Descriptive statistics such as means, percentages and standard deviation was used to analyze the data. Index scoring method was used to rank the insect. Indexing/Scaling technique was applied to construct an index for prioritizing the insects as per farmers' perception using MS-Excel. Miah (1993) stated that the scaling techniques provide the direction and extremity attitude of the household heads towards any proposition. On the basis of responded frequencies, weighted indexes were calculated for the analysis of farmer's perception on the major insect problem. Farmer's perception to the different insects was ranked by using four-point scales (Neupane, 2019). The formula used to determine the index for intensity of various insect problems is:

$$\text{Iprob} = \sum \frac{sifi}{N}$$

Where,

Iprob = I = index value for intensity of problem ($0 < I < 1$)

s_i = scale value at i^{th} intensity/severity

f_i= frequency of the i^{th} severity

N= total number of the respondents

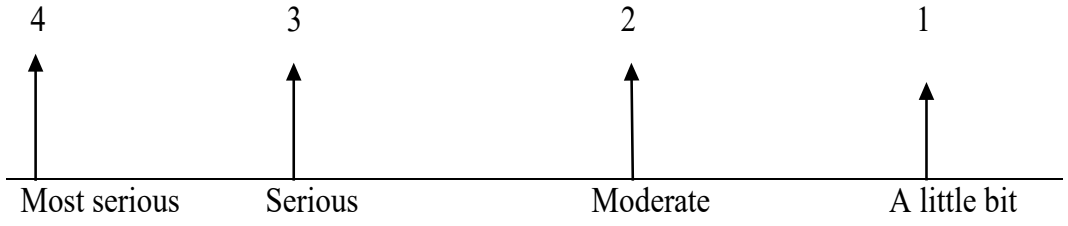

Figure 1: Scale of rating

RESULTS AND DISSCUSSION

Socio-economic and demographic characteristics

The minimum age of the household head was 21 and maximum was 80 years, with an average of the 43 this shown that household head as not too old and not too young

(Table 1). In CBS (2021), we found that the minimum age of household head is less than 14 while maximum is more than 70.

Table 1. Gender and age of household head

Parameters	Average	Minimum	Maximum	S.D.
Age	43	21	80	13.44

In the study area, 70% of the household head were male while only 30% of them were female (Table 2). This shows that the area is male dominated. As reported by CBS (2021), 40.76% of the household heads were female while the rest are male in the study site. Regarding ethnicity, the Chhetri ethnic group was found to be the dominant with the Brahmin following closely as shown in the table. It is noteworthy that the dominance of the Chhetri ethnic group in our study area mirrored its dominance at the national level. Nationally, Chhetri is the largest ethnic group, constituting 16.45% of Nepal's total population, (CBS 2021). All the people in the site were found to be Hindu. In case of Nepal also, 81.19 % of total population are following Hindu religion (CBS, 2021). In the experimental site, around 85% of the people were involved in agriculture while the rest is occupied by teaching and business. This shows that the dependency is very high on agriculture. CBS (2021) also reported that 65.13% of total population rely on agriculture. Table shows that most of the people of the study area are educated, most of them have done secondary level of education (47%) and only around 31% have primary education or below. Also, there are only a few household heads (around 18%) who had completed university level education (bachelors or above).

Table 2. Ethnicity, occupation and education of household head

Parameters	Categories	Percentage (%)
Gender	Male	70
	Female	30
Ethnicity	Brahmin	33
	Chhetri	67
Occupation	Agriculture	85
	Teaching	10
	Business	5
Education	Primary	31
	Secondary	47
	Bachelor	18

From the survey, minimum number of people in a family was 2 and maximum was 14 with an average of 6 people (Table 3). It reveals that large number of people are living in the joint family while only few are living in nuclear family. As per CBS (2021), the average number of members in family in Baitadi district was 4.84. The Table 3 shows the average land holding of the farmers was 0.58 hectare and land used for maize cultivation was 0.483 hectare. As per CBS (2021), average land holding of farmers is found to be 0.539 hectare.

Table 3. Family size and total land used for maize cultivation

Parameters	Minimum	Maximum	Average	S.D.
Family members	2	14	6	2.42
Family members involved in maize farming	2	12	5	1.83
Total land holding (ha)			0.58	11.38
Land used for maize cultivation (ha)			0.48	6.80

In the study site, Rampur composite variety was the most dominated variety with the total coverage of 63% of the farmers, followed by Manakamana 3 (25%) and Arun 4 (12%) as shown in Table 4. The local variety (Local seto) was found to be cultivated by all farmers (100%) in a separate plot. In a study by Gairhe et al. (2021) Rampur composite and Manakamana 3 are the major grown varieties in the hilly areas of Nepal.

Table 4. Maize variety cultivated by Farmer

Variety	Percentage (%)
Rampur composite	63
Manakamana 3	25
Arun 4	12

The household heads were asked about major insects and their ranking on the basis of loss that are lowering the production of maize. Fall armyworm was the major insect pest causing loss with the index value 0.855 followed by cutworm (0.700), maize stem borer (0.535) and white grub (0.410) (Table 5). Fall armyworms have the potential to cause up to 80% yield in maize (Ghimire, 2020).

Table 5. Ranking of major insects

Insect	1	2	3	4	Index value	Rank
Fall armyworm	56	30	14	0	0.855	I
Cutworm	30	35	20	15	0.700	II
Maize stem borer	14	21	30	35	0.535	III
White grub	0	14	36	50	0.410	IV

Table 6 shows the descriptive and comparative analysis of loss in local and improved maize varieties due to insects. The maximum loss was found in local variety (37.5%) and the minimum loss was found in improved variety (8.33%). It was found that the average loss in local variety was 25.06% and in improved variety was 18.37%. In average, losses in local varieties were 26.69% which was higher than that of improved varieties. In case of the maize crop, the pest's attack alone has been reported to cause yield losses of 24–75% (Sharma & Gautam, 1970).

Table 6. Loss in maize production due to insect

Variety	Minimum loss %	Maximum loss %	Average loss %	S.D.
Local	11.76	37.5	25.06	5.60
Improved	8.33	28.57	18.37	4.96

To know the effect of insect attack on local maize variety production, Dependent variable Wilcoxon signed ranks test was used. A Wilcoxon signed rank test revealed that the production of local variety of maize when there is insect attack (Md=0.53, n=100) was significantly lower as compared to production when there was no insect attack (Md=0.75, n=100), z= -8.594, at $p<0.001$ significance level as shown in Table 7. There was a significance difference in production when insect damages the maize and when no damage. Similarly, in the improved variety of maize, the production of maize when there is insect attack (Md=0.71, n=100) was significantly lower as compared to production when there was no insect attack (Md=0.90, n=100), z=-8.161, at $p<0.001$ significance level as shown in Table 7. Thus, there is a significant difference in production in maize in case of insect attack and no attack.

Table 7. Wilcoxon signed ranks test result

For local Variety						
Variables	Mean	S.D.	MD Mean	Rank	Z	Significance (2-tailed)
Production without insect attack	1.05	0.94	0.75	27.00	-8.594[b]	<0.001
Production with insect attack	0.76	0.62	0.53	50.74	-	
For improved variety						
Production without insect attack	1.28	0.99	0.90	51.17	-8.161[b]	<0.001
Production with insect attack	0.05	0.82	0.71	50.48	-	

Management practices adopted by the farmers to control insect pests

From the survey, farmers generally adopted physical, cultural and sometimes biological methods. Chemical method of management practice is not used commonly as it is not a cost effective method as compared to the physical, cultural and biological method. Physical methods of insect control such as the field sanitation, crop debris destruction, hand picking (if observed), cultural methods such as intercropping, mixed cropping, use of different planting methods, water management, fertilizer management, crop rotation, planting time, synchronous and asynchronous planting over a given area, trap crop, tillage, weeding, and growth differing duration of the crop were common in reducing the number of maize insects. Intercropping also a useful tool to reduce yield loss and pest or disease populations (Trenbath, 1993). Intercropping leguminous crops with maize offers maize a better level of protection than monoculture maize (Hailu, 2018). Jholmol a plant-based biopesticide are also common in farmers field, Spinosad, a synthetic insecticide were common in survey sites and commonly farmers use this particular pesticide to control the pest during autumn season (Ahmed, 2002).

CONCLUSION

Fall armyworm *(Spodoptera frugiperda),* cutworm *(Agrotis spp.)*, maize stem borer *(Chilo partellus)* and white grub (*Phyllophaga spp.)* are the major insects causing significant loss in the maize production in the study area. Among them, fall armyworm is the major insect causing maximum damage with the highest index value (I=0.855) while cutworm ranks second with the index value of 0.700. Maize stem borer and white grubs holds third and fourth rank with the index value of 0.535 and 0.410, respectively. From the descriptive and comparative analysis the maximum loss was found in the local variety (37.5%) and the minimum loss was recorded in the improved variety (8.33%).

Comparatively the local varieties are found more affected by insect pests than the improved varieties. The average loss caused by the insect in local and improved varieties was found to be 25.19% and 18.38%, respectively. Wilcoxon signed rank test revealed significant difference in production in maize when insect attack and when insect does not attack. The production of both local and improved variety of maize is reduced by the insect attack while crops without attacks have relatively high productivity. To overcome the losses due to insects, physical, cultural and biological methods are practiced widely. Almost none of the farmers were found using chemical pesticides due to its high cost and less cost effectiveness.

REFERENCES

Ahmed, S., Saleem, M. A., & Rauf, I. (2002). Field efficacy of some bioinsecticides against Maize and Jowar stem borer, *Chilo partellus* (Pyralidae: Lepidoptera). *International Journal of Agricultural Biology*, *4*(3), 332-334.

CBS. (2022). *National Statistics Preliminary Report*. Central Bureau of Statistics, National Planning Commission, Government of Nepal, Kathmandu, Nepal.

Cochran W. G. (1997). *Sampling technique (3rd Ed.)*. John Wiley and Sons.

Gairhe S., Timsina, K. P., Ghimire, Y. N., Lamichhane, L., Subedi, S., & Shrestha, J. (2021). Production and distribution system of maize seed in Nepal. *Heliyon 7*(4), 1-12.

Hailu G., N. Saliou, K. R. Zeyaur, N. Ochatum, S. Subramanian. (2018). Maize–legume intercropping and push–pull for management of fall armyworm, stemborers, and striga in Uganda. *Agronomy Journal*, *110*(6), 2513-2522.

Kandel, B.P. (2021). Status, prospect and problems of hybrid maize (*Zea mays* L.) in Nepal: a brief review. *Genet Resour Crop Evol, 68*, 1-10. https://doi.org/10.1007/s10722-020-01032-0

Kumar J., N. P. Kashyap & S. D. Sharma. (2001). Pests of maize and their management in Himachal Pradesh – A review. *Agriculture Review*, *22*(1): 47-51.

Lamichhane J., K. P. Timsina, D. B. Ranabhat and S. Adhikari. (2015). Technology adoption analysis of improved maize technology in western hills of Nepal. *Journal of Maize Research and Development*, *1*, 146-152.

MoALD. (2023). *Statistical Information in Nepalese Agriculture* 2078/79 (2021/22). Ministry of Agriculture and Livestock Development, Government of Nepal, Kathmandu, Nepal.

Murdia L. K., R. Wadhwani, N. Wadhawan, P. Bajpai and S. Shekhawat. (2016). Maize utilization in India: An overview. *American Journal of Food and Nutrition*, *4*(6), 169-176.

Neupane A. K. (2019). Value chain analysis of ginger in Panchthar district. *International Journal of Agricultural Invention*, *4*(2), 148-151.

Pathak M. D. & Z. R. Khan. (1994). *Insect pests of rice*. International Rice Research Institute, Manila, Philippines.

Sharma P. N., & P. Gautam. (2010). Assessment of yield loss in maize due to attack by the maize borer, *Chilo partellus* (Swinhoe). *Nepal Journal of Science and Technology*, 11, 25-30.

Shiferaw B., B. M. Prasanna, J. Hellin & M. Bänziger. (2011). Crops that feed the world 6. Past successes and future challenges to the role played by maize in global food security. *Food Security*, *3*, 307-327.

Song Y., H. W. Linderholm, Y. Luo, J. Xu. & G. Zhou. (2020). Climatic causes of maize production loss under global warming in northeast China. *Sustainability*, 12(18), 7829.

Trenbath B. R. (1993). Intercropping for the management of pests and diseases. *Field Crops Research*, *34*(3-4), 381-405.

Woolson R. F. (2007). Wilcoxon signed-rank test. Wiley Encyclopedia of Clinical Trials. https://doi.org/10.1002/9780471462422.eoct979

Yadav, O. P., Prasanna, B. M., Yadava, P., Jat, S. L., Kumar, D., Dhillon, B. S., & Sandhu, J. S. (2016). Doubling maize (Zea mays) production of India by 2025-challenges and opportunities. *The Indian Journal of Agricultural Sciences*, *86*(4), 427-34.