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Review Article

PLANT PROTECTION SERVICES IN NEPAL: A DISCOURSE AND ASSESSMENT

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ABSTRACT

Agricultural production has been challenged by various biotic and abiotic factors in Nepal. Losses incurred by different insect pests and diseases are remarkable. As a counter measure, Government of Nepal has implemented various activities through extension, research and academic institutions. Integrated Pest Management (IPM) has been the central approach of plant protection in Nepal. It was initiated in 1997 with an aim to reduce the excessive and injudicious use of chemical pesticides to enhance the crop production, paying due attention on gender mainstreaming, and social inclusion. Besides, plant clinic program is gaining popularity in Nepal to provide plant health extension advisory services. Being a signatory country of Rotterdam Convention and Stockholm Convention, Nepal has imposed ban on sixteen different types of chemical pesticides including persistent organic pollutants (POPs). Botanicals and bio-pesticides are also used in agriculture to manage pests and diseases of crops in Nepal. So far, different 2275 pesticides have been registered by Pesticide Management and Registration Division (PMRD). National Plant Quarantine Program has been regulating the risks of entry, establishment and spread of harmful pest and plant diseases. Until now, quarantine pest of 18 commodities are identified. Strong research back up and coordination among the working partners are realized at wider level. This article assesses the status of the plant protection services and find way forward for strategic implementation of the plant protection services in Nepal.

Key words: IPM, pesticides, plant quarantine

INTRODUCTION

Nepal is an agrarian country. Agriculture is the backbone of Nepalese economy where 60 percent people depends on agriculture for their livelihoods (CBS, 2016). Most of the farmers are in subsistence condition, although efforts for commercialization have also been initiated in the country. Plant protection is an important discipline in the agriculture which deals with the concepts and approaches of pest management. Department of Agriculture (DoA), has been providing extension and agricultural advisory services to the farmers in the

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field of plant protection since it's establishment in 2014 B.S. by setting up organization at all hierarchy from central to local level. In the beginning, plant protection services were more dependent on application of chemical pesticides. With the development of ecological agriculture, there has been a paradigm shift in the tactics of pest management. To assess the gap and provide recommendation for way forward to the services, it is necessary to review the works of plant protection institutions. The aim of this article is to review the past works and depict the present scenario of plant protection services in Nepal. The findings will provide input to re-think and re-design the plant protection programs in future to promote sustainable agriculture in Nepal.

METHODOLOGY

This article is prepared based on the literature review and using secondary information from various sources. The qualitative and quantitative data and facts mentioned in this article are drawn from published journals, books, periodicals, proceedings and internet. This article is going to assess to integrated pest management program until 2016, pesticide management and plant clinics until 2017 and post -harvest activities of 2014.

RESULTS AND DISCUSSION

Plant Protection Services in Nepal

Plant protection is the science and practice of managing pests, diseases and weeds which damage to crops, and other plants. Plant protection is the key activities that need to be considered to protect the crops from the attack of insect pest and diseases throughout the crop life cycle including pre-and postharvest stages. In addition to growing of crops to derive the livelihoods, Nepalese farmers have been adopting other agricultural occupation such as sericulture, apiculture, and mushroom farming. Plant Protection is that discipline which has been helping to perform these activities. Plant protection services are provided through various governmental and autonomous institutions including Department of Agriculture (DoA), Nepal Agriculture Research Council (NARC) and academic institutions like Tribhuwan University (TU), Agriculture and Forestry University (AFU), Himalayan College of Agriculture Science and Technology (HICAST) and Council for Technical Education and Vocational Training (CTEVT). Under DoA, there are various offices to provide plant protection services at central, regional and district level. Plant Protection Directorate, Postharvest Management Directorate, National Plant Quarantine Program and Pesticide Management and Registration Division are central level plant protection organization. Five Regional Plant Protection Laboratories, Regional Plant Quarantine Offices and Plant Quarantine Check posts have been instituted in each development regions and one District Agriculture Development Offices (DADO) in each of the 75 districts of Nepal with a plant protection officer to look after the plant protection services at grass root level.

Plant Protection Directorate

Plant Protection Directorate has been functioning at the central level which is an umbrella organization to perform the plant protection activities throughout the country. In Nepal, 30-35% losses in crop production are caused by insect pest, diseases and weeds (PPD, 2012). To reduce such losses and promote sustainable agriculture, Plant Protection Directorate (PPD, 2014a) aims at: (i) Eco-friendly management of crop pest through implementation of Integrated Pest Management (IPM) program that to achieve the national objectives of agriculture intensification and diversification; (ii) Safe use and management of pesticides through effective enforcement of Pesticide Act 1991 and Regulation 1993; (iii) Promotion of agricultural trades by strengthening external and internal quarantine to prevent the introduction of pest as provisioned in Plant Protection Act, 2007 harmonizing with international organizations' guidelines; (iv) Prepare pest map in district, regional and central level through survey and surveillance; (v) Provide assistance and counseling to GoN to formulate of policies of plant protection.

Policies

Plant Protection Directorate has given top most priority to the concept of IPM for ecological pest management and implementation of Integrated Pest Management through Farmer's Field School (IPM-FFS); regulate the export and import of agricultural commodities by imposing Plant Protection Act, 2007 and Regulation, 2010 to prevent introduction of quarantine pest; appropriate management of pesticides as provisioned in the Pesticide Act,1991 and Regulation 1993; and delegation of responsibility to Regional Plant Protection Laboratories (RPPLs) for monitoring and backstopping of district programs are the main policies adopted by PPD.

IPM Program in Nepal

After a brown planthopper (BPH) outbreak in 1997, Nepal organized its first IPM program for rice (Pokhrel and Saha, 2008). So, IPM was officially introduced in Nepal in 1997 through technical cooperation of project of FAO (TCP/FAO) for the first time with farmer field approach (Adhikari and Adhikari, 2017). Later on, TCP entered into the community IPM when Nepal became the member of ICP (Inter country program) for community IPM in 1998. In the beginning, FAO provided technical and financial supports and implemented the program at the farmer level jointly with Plant Protection Directorate. Over the time, this program was taken up by PPD. After termination of Community IPM, there were two phases in the program. The financial support for first phase (2003-2007) and for second phase (2008-2013) was received through Norwegian Government. Government of Norway provided a grant of US$ 1,284, 444 for the first phase and US $ 5,000,000 for the second phase. To intensification and institutionalization of the program:, PPD took the lead in execution of the project and where FAO-Nepal provided backstopping support and conducted activities in 12 intensive IPM districts which were Dadeldhura, Kailali, Surkhet,

Jumla, Kaplivastu, Syangja, Mustang, Bara, Kavre, Ilam and Jhapa. In the meantime, without support from FAO; PPD had managed 5 additional IPM intensive districts in Morang, Parsa, Dhading, Chitwan, Tanahu, and Bardiya to create platform for replication of modules developed under the intensification and institutionalization components. National Integrated Pest Management Program (NIPMP) in Nepal has been designed in 2008 to support reduction of poverty, ensure food security and environment protection in a sustainable way. The specific objectives of NIPMP were: (i) to contribute to institutionalize a sustainable national IPM program in Nepal by strengthening the capacity of the PPD and strengthening the capacity of technicians and leader farmers through the national, regional and district level training; (ii) to empower them to increase production and productivity efficiently, while protecting the environment. Its strategy was to implement and gradually up-scale participatory IPM using the Farmers Field School approach as a national program and covering seventy five districts of Nepal in integrated agricultural development with primary focus on rural poor where IPM will increase economic benefits, farmer empowerment and better marketing of safer commodities leading to a transparent mode of agricultural transactions that safeguards human health and environment in response to governments national commitments to global biodiversity and environment protection and World Trade Organization (WTO) related issues (PPD, 2014b).

Impacts of IPM Program in Nepal

IPM is one of the important activities of PPD. Since 1997, PPD has been implementing the IPM-FFS with the assistance of various donors.

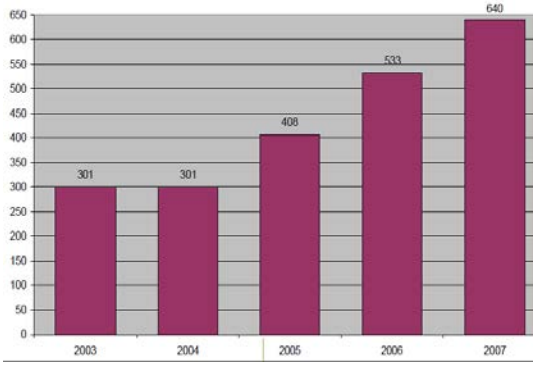

Fig. 1: Increased in number of Farmer Facilitators
Source: PPD, 2014b

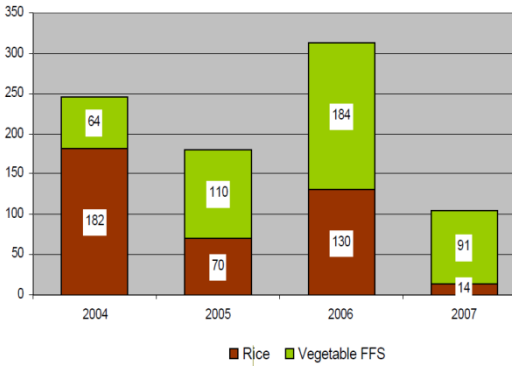

Fig. 2: Annual number of IPM FFS
Source: PPD, 2014b

Initially, it was started to control the infestation of Brown Plant Hopper in the rice field of Chitwan district. So far, more than 10000 IPM-FFS have been conducted in the rice and vegetable crops. IPM-FFS was conducted in potato, coffee, tea and zinger crops and postharvest loss reduction. The IPM-FFS have many good many impacts in the agriculture, economic and social system of Nepal. Studies had been carried to assess the impacts of

IPM. Following are some key achievements after the implementation of first phase of IPM program during 2003-2007 in Nepal (PPD, 2014b).

National Integrated Pest Management Program has a strategy to upscale the IPM Program and covering in all districts of Nepal so it has started to train the farmer facilitators. According to Figure 1, in 2003, the numbers of farmer facilitators were 301 and it reached 640 in 2007. The numbers of Farmer Facilitators were increased by 2.12 folds. While analyzing the Figure 2, it can be generalized that in the initial year of the project, IPM was more focused on paddy. Later, it was gradually focusing on vegetable crops. In 2007, 6.5 folds more IPM program were implemented in vegetable crops than paddy. There were also increment in the number of technical facilitators both officers and non-officers. Moreover, other governmental and non-governmental organizations are also focusing IPM for safe vegetables production and supported to capacitate human resources (technical and farmer's facilitators).The situation of pesticide use in IPM trained farmers had been changed. It shows that there has been a very noticeable change in the attitude of farmers to pesticide application. 57% of the farmers have been applying botanicals (Neem, Mustard cake), bio-pesticides and Bipbin (molting hormone). It is cleared that majority of the farmers have adopted IPM knowledge through the approach of Farmer Field School.

IPM FFS program is sensitive to the gender issue and social inclusion. Women's participation in the Nepalese agriculture is 80% but they have not had access to the productive resources (USAID, 2013). They lack to the firsthand information and need to depend upon their household head. This is one of the predisposition factors of not involving women into the decision-making process. FFS approach of IPM is very aware about the gender mainstreaming. *Dalit and Janajati* are deprived castes and they have not had full access on the national resources and services. Government of Nepal would like to ensure their participation and getting benefits from the development programs. The IPM program has a good impact on *Dalit and Janajatias* they have had a meaningful participation in the program.

Traditionally women farmers have fewer access of opportunities to resources than men in Nepal (ADB, 1999). FFS has offered more opportunities to women through agricultural training that were used to fewer in other programs, discovering new options, new possibilities and eventually making better informed decisions in farming. Consequently, increased women's participation in FFS has positive effect on food security of their families, and the increase in knowledge and social capital women obtained through their participation in FFS leads to an increase in agency and capabilities (Westendorp, 2015).

National Integrated Pest Management Phase-II in Nepal was a continuation of the earlier first phase. The second phase had imparted positive impacts in the agriculture system of Nepalese farmers that include reduction of pesticide application and fertilizer management. There are no use of WHO class Ia pesticides at all, no application of banned pesticides, FFS farmers were reducing the area under WHO class Ib pesticides considerably, area under

pesticide application reduced by 78.76%, cost of pesticide was reduced by 96.60%, a notable increase in in-country migration and decrease in seasonal migration to India of FFS category had been noticeably found in the districts of Arghakhachi, Surkhet, Sarlahi and Bara (FAO, 2014). In terms of fertilizers use, decrease in nitrogen application and increase in use of FYM in rice, vegetables and cole-crop in FFS households, use of improved rice seeds found increased mainly in the FFS type of households in Surkhet, Sarlahi and Bara districts and similar finding was seen in case of use of improved seeds in tomato and potato were main achievements of IPM FFS in Nepal.

Plant Clinic

Plant health advisory services have a significant role in the agricultural development of country. Plant clinic is one of the extension approaches that deliver field level diagnostic services to farmers. In Nepal, Plant Clinic approach is in operation since 2008 with support from Centre for Agriculture and Bioscience International (CABI). The contribution of plant clinic was reflected by the capacity development of agricultural advisory personnel, development of extension materials, promoting integrated pest management measures, networking plant doctors, and clinic data management in plant health system of Nepal (Adhikari *et al*., 2017). There are two types of plant clinics running in Nepal namely regular plant clinic and mobile plant clinic. Regular plant clinics provide regular service with certain time interval such as every month to the farmers in particular location, whereas mobile plant clinics are run at different locations as per need. Plant clinics have been operated by DADO supported by CABI led Plantwise program of PPD and also by other governmental and non-governmental organizations. The number of plant clinics established were 123 (including regular, mobile and official), among them 104 were active plant clinics those submitted the clinic's data regularly; total queries recorded in the plant clinic were 5869, and 40 plantwise fact sheets and 30 pest management decision guides (PMDGs) were published as agricultural extension materials by the plantwise plant clinic program (POMS, 2018). A workshop was conducted in Nepal to make possible synergistic linkup between plant clinic and IPM FFS (Pandit, 2016) and several FFS facilitators had been provided trainings on plant clinic modules. Plant clinic is one of the important measures for the promotion of environmentally safe approaches for the reduction of crop loss caused by pests and diseases in Nepal. It has been dealing with all the farmers, crops and their problems; and farmers have easy access to it because plant clinics have been conducted in their nearby location. Plant health problems have been identified in the clinics and recommendation is prescribed by plant doctors to combat the pests and diseases of crops. It aims to reduce crop losses to improve the food security of poor rural population groups (SDC, 2016). Moreover, plant clinics help farmers to reduce crop losses and increase the productivity and incomes through plant protection advisory services. By this way, it helps to improve livelihood of smallholder farmers and increase global food security.

Pesticide Registration and Management Division

Pesticide Registration and Management Division (PRMD) was established in 1994 A.D. with objective to regulate the import, export, formulation, distribution and professional application of pesticides through Pesticide Act, 1991 and Pesticide Regulation, 1993. It has been functioning under the Plant Protection Directorate. Mission of PRMD are : (i) to carry out the activities related to the import, export, formulation, distribution and professional application of pesticides; (ii) to formulate national policy on pesticide, regulate the quality of pesticides and coordinate between the public and private sector.

Pesticides Imported and Formulated in 2016/17

In Nepal, pesticides have been imported mainly from India, China and other countries. Pesticides formulation plants have been established and they do commercial formulation of pesticides by importing active ingredients of the pesticides. In the fiscal year of 2016/17, the total amount of money expended to 1857964.60 kg (635712.92 Kg a. i.) of pesticides was NRs 747785916.60 (Table 1).

Table 1. Pesticides consumption in Nepal 2016/17

SN	Pesticides	Total quantity kg (a.i. kg)		Total Amount (NRs)	Total Amount (USD)
1	Insecticide	1106606.30	(169360.00)	368713061.18	3388472.87
2	Fungicides	493325.95	(347707.22)	257005033.69	2361876.26
3	Bactericide	67.00	(6.70)	225549.60	2072.80
4	Herbicides	212159.60	(105445.44)	98400763.95	904303.02
5	Rodenticide	25357.50	(12077.31)	16866326.20	155001.54
6	Bio pesticide	20448.25	(1125.25)	6575182.02	60425.92
	Grant Total	**1857964.60**	**(635721.92)**	**747785916.6**	**6872152.41**

Source: PRMD (2018)

Insecticide was the main pesticides that has been imported and used in the agriculture sector then followed by fungicides and herbicides (Table 1). Bio-pesticides has been regarded as the safer to manage the pests although its import in Nepal was only limited to the 20448.25 kg with the worth NRs. 6575182.02.The Government of Nepal has banned 16 pesticides including POPs and extremely hazardous pesticides Chlordane, Lindane, Dieldrin, Endrin, Aldrin, Heptachlor, Mirex, Endosulfan, Toxafen, B.H.C, DDT, Phosphamidon, Methyl Parathion, Organo Mercury Chloride, Monocrotophos and Phorate. There are total 1561 pesticides have been registered among Ia is no at all. Among the registered pesticides, insecticides are the highest in number of 1405 trade names and 52 common names (Table 2).

Table 2. Summary of registered pesticides 2016/17

SN	Types of Pesticides	Trade Name	Common Name
1	Insecticides	1405	52
2	Acaricide	27	6
3	Fungicide	648	40
4	Bactericide	15	1
5	Herbicide	350	22
6	Rodenticide	33	2
7	Molluscide	2	1
8	Bio-pesticides	90	12
9	Herbal	6	3

Source: PRMD (2018)

Postharvest Management Directorate

Rural Save Grain Project was started in Nepal in 2036 B.S. Its main objective was to reduce the loss of cereal grains by rodents, birds and other store grain pests. The project was implemented for more than a decade. Later on, the project was renamed as Postharve st Loss Reduction Section which had been functioning under the Plant Protection Directorate. In the year 2004, this was upgraded as Post Harvest Management Directorate. The directorate started to work not only on cereal grains but also for postharvest loss reduction in fruit and vegetables. In coordination with Nepal Agriculture Research Council (NARC), Department of Food Technology and Quality Control (DFTQC) and other organizations, Postharvest Management Directorate has carried out some studies for postharvest loss reduction in fruits and vegetable crops. In the past different works were done like design of different storage structures to reduce loss in the storage, promoting fumigants and other local herbs for controlling stored grain pests, improvement in local storage structures, rodent control campaign etc. Recently, the directorate has focused in perishable crops like fruits and vegetables. The main outcome to remember are the testing of solar drier for drying different commodities, zero energy cold storage (mini) for household level, cellar store for citrus and apple, modeling for grading machine and handheld sizer for citrus fruits, harvesting tools for papaya, study of different packaging material for safe handling of perishables, vase life study and recommendation for different flowers etc. The directorate has researched about loss of commodities through various means of transportation and storage. Table 3 explains about the studies of postharvest loss in cereal grains. Similarly, Table 4 and 5 explain about the loss of fruits and vegetables during transportation and storing in varying structures.

Table 3. Postharvest loss of different cereal grains (%) in Nepal

Crop	Harvesting	Transportation	Threshing	Drying	Storing	Processing	Total
Paddy	1.63	0.52	2.19	1.57	6.31	4.40	16.62
Wheat	2.21	1.22	3.07	2.07	7.76	2.00	18.33
Maize	3.33	1.04	2.85	2.50	7.44	2.30	19.46

Source: Subedi (2014)

The data of Table 3 shows that cereal grains are lost the subsequent stages of postharvest. Maximum loss of wheat occurred by 7.76% at the stage of storing then followed by maize and rice. The total percentage of postharvest loss was higher in maize then followed by wheat and paddy. Table 5 reveals the loss of fruit and vegetable during transportation.

Table 4. Transportation loss of fruits and vegetables in Nepal

Crop	Percentage of Loss
Tomato	23-35
Cabbage	6-19
Cauliflower	4.48-18.75
Apple	26-35
Oranges	2.02-8.25
Mangoes	36.36

Source: Subedi (2014)

Table 5. Storage loss of fruits and vegetables in Nepal

Crop	Loss %	Type
Tomato	14-25	Zero Energy
Apple	10	Cold store
Apple	15-30	Underground pit
Carrot	6-14	Zero Energy
Oranges	22-23	Cellar Store

Source: Subedi (2014)

National Plant Quarantine Programme

National Plant Quarantine Programme (NPQP) is responsible for trade facilitation through phyto-sanitary risk management in the trans-border trade of agro-forest products and other related commodities. After getting membership of the Asia Pacific Plant Protection Commission (APPPC) in 1965, Nepal has promulgated plant protection act and regulation. Initially, Plant Quarantine Unit was established under the Plant Pathology Division of Nepal Agriculture Research Council which can be considered as the milestone in the history of plant quarantine in Nepal. Since then, many institutional re-structuring has occurred in this

organization and finally established as National Plant Quarantine Program in 2003. NPQP is an authorized government institution for regulating plant quarantine related activities in Nepal. It has been functioning under the Department of Agriculture and Plant Protection Directorate. Now, there are five regional plant quarantine offices in each development region, eight check posts and two sub-check posts in different customs points of India and China. Three check posts are in Nepal-China border; one check post is at Tribhuvan International Airport, Kathmandu; and all other are along the Indo-Nepal border. This institution has to regulate the activities on plant health dynamics to reduce the risk of entry, establishment and spread of notorious plant pests within the national territory in pursuant to Plant Protection Act 2007 and Plant Protection Regulation 2010 (NPQP, 2017).

Surveillance of regulated pests

Surveillance is one of key activities of plant quarantine and give the pest situation for crop production. For the purpose of surveillance, following activities have been done.

- NPQP has developed National Sanitary and Phtosanitary Measures (NSPM) to identify the regulated pests;
- 445 pests of 18 commodities are declared as Quarantine pests (QPs), and regulated in pursuant to Plant Protection Act (NPQP, 2015);
- Pest Risk Analysis (PRA) for other commodities are going on.
- Pest Identification Manuals of the quarantine pests of Apple, Banana, Citrus, Coffee, Zinger, Tea, Large Cardamom, and Garlic have been prepared and published.

NIRTTP (2015) mentioned about transaction in the quarantine Check Post in Birgunj which is the main border checkpoint for trade in goods subject to SPS measures. In 2013, Nepal had recorded exports and imports subject to SPS measures of about US$ 250 million and US$ 1.16 billion, respectively. One-quarter of these exports and more than half of these imports were cleared at Birgunj. Moreover, NIRTTP (2015) reported about lacking in the quarantine check post as in spite of high importance to maintain measures to ensure that food is safe for consumers and prevent the spread of pests or diseases among animals and plants; following things have in lacking the quarantine check post in Nepal.

- Competent laboratories and expert diagnosticians in the customs points;
- Post entry quarantine facilities;
- Holding yards for the consignments;
- Automated fumigation chambers;
- Quarantine pest reference library.

CONCLUSION

IPM programme was initiated in Nepal in 1997 with the assistance of FAO. After implementing IPM, one of the important impacts is reduction in pesticide application so area under pesticide is reduced by 79%. National IPM program helped to support the capacity

building of PPD and other national, regional and district level extension institutions. Other important reflections in the agriculture system are gender mainstreaming; increased social inclusion, reduction to the cost of pesticide by 96.60%; decrease in seasonal migration to India of FFS category had been noticeably found; decrease in nitrogen application and increase in use of farm yard manure in rice and vegetables; use of improved in rice; and use of improved seeds in tomato and potato. Pesticide Management and Registration Division have banned 16 pesticides. So far, 2576 pesticides have been registered by PMRD. Postharvest management Directorate has been working to reduce the loss of agricultural commodities. National Plant Quarantine Program has been regulating the activities to reduce the risk of entry, establishment and spread of plant diseases. So far, 500 pests of 19 commodities are declared as QPs, and regulated with pursuant to Plant Protection Act still it has competent laboratories and diagnosticians in the custom points. The service suffers from weak linkages with national agricultural research systems. Thus, there should be functional coordination among intra and inter organizations and stakeholders of plant protection sectors in Nepal. Moreover, research, extension and academic systems should have functionally linked for the strategic implementation of plant protection services in Nepal.

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