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Review Article

INTEGRATED PEST MANAGEMENT EFFORTS FOR ECO-FRIENDLY AGRICULTURAL PRODUCTION IN NEPAL: A PERSPECTIVE

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ABSTRACT

World-wide, Integrated Pest Management (IPM) has been considered one of the eco-friendly and powerful tools to manage crop pests. In Nepal, it has been adopted for more than two decades with its highest success in various crops. As dissemination and up-scaling tools to this approach, Farmers Field School (FFS) is being launched in numerous farming communities. The basic notion of initiation of this program was to mitigate and combat the negative consequence created by chemical pesticides while controlling insect pests in crops. In Nepal, it started in 1997 through a FAO Technical Cooperation Project (TCP). This article summarizes IPM activities ever since TCP to Second Phase of IPM Program (2008-2013) launched by the Government of Nepal with the support of Norwegian government. Until, 2012/013, altogether 3772 FFSs were conducted by PPD and FAO initiatives and 99751 farmers graduated in IPM Program, while 1175 farmers trained as IPM FFS Facilitators. More than 5000 farmers groups benefited from yearlong IPM FFS. Medium level agricultural technicians, government Officers from different disciplines and 25 participants from Council for Vocational Education and Training Centre (CTEVT) were trained as IPM Master Facilitators. IPM policy and participatory system of IPM product certification system were drafted however; they could not be finalized during the project period. Support for Master Degree studies and Bachelor degree mini-thesis were provided to students of various Agriculture Education Institution. Curricula developed for yearlong IPM FFS in different crops were adopted by CTEVT and other Institute in their academic programs. In the the later phase of project, emphasis was towards the institutionalization of the outcomes into regular program of the Government with a modified approach of bio pesticide production, plant clinics and networking. The program ignited and stressed largely on the socio-technical empowerment to the farmers and technicians. Initiation on the marketing of IPM products was also one of the outputs. This should be linked with increasing use of bio pesticides to the healthy food production so that environmentally damaging chemical pesticides may be reduced from the country.

Key words: IPM, FFS, crop pests, pesticides

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INTRODUCTION

In recent decades, the plant protection scenario in most parts of the developed and developing countries have undergone dramatic changes. The protection of crops by combating the negative effects of pests on crop production is of major importance for food security especially in a developing country like Nepal. Integrated Pest Management (IPM) is one of the farmers' centred approaches which ensure optimum production in an economic and sustainable means with the full consideration for healthy environment. The main reason of for encouraging IPM to Nepalese farmers is to contribute for the wider adoption of crop intensification for higher production and income as the contribution of agriculture sector in GDP has been declining from 75% in 1950s and 1960s to 38% at present. IPM was introduced in Nepal in 1997, with the support from FAO and implemented by using farmer field school (FFS) approach since 1998 as project mode and national program mode. The basic philosophy of its initiation in Nepal was to promote judicious use of the chemical pesticides by the farm families. FFS consists of combination of strategies which had already demonstrated its rural development potential in rice and vegetables cultivation systems in Asia. Using IPM FFS farmers were able to successfully manage the common problems of pests and reduce pesticide use in rice from 75 percent to nearly no uses at all. GC (2013) described the genesis of IPM farmer field school and its impact in Nepal. This paper presents a birds eye view of IPM program in Nepal and it's 20 years achievements from the perspective of supporting in developing further working strategies of adopting IPM approaches and tactices for eco-friendly agricultural production. In this paper, information gathered from review of literatures including annual reports of Plant Protection Directorate (PPD) and IPM projects, publications from NGOs involved in IPM activities and from personal communication

TRANSECT OF IPM IN NEPAL

The Department of Agriculture (DoA) is the major actors of the first kick-start of FFS through Plant Protection Directorate (PPD) in Nepal. From TCP to until the First Phase of IPM (2004-2007), IPM program in Nepal was viewed primarily in project mode because of their operational modality. After realization it as an impetus for the social empowerment and successful crop protection tools, Norwegian Government funded for the First Phase of IPM somehow in different modality. However, on both the times, the major emphasis was laid on capacity building of the farmers and medium level technicians, officers of the Government working through IPM training. Realizing the need for better internalization and institutionalization of the outcomes into the regular program of the Government, Second Phase of IPM Program (2008-2013) was launched by the Government of Nepal with the support of Norwaygian government. In the second phase, two components, namely FAO Nepal and PPD as Government counterparts were involved. Twelve districts were undertaken as intensive IPM districts under FAO component whereas five districts in PPD component.

Despite the wider acceptance of IPM in the developed agriculture, it is still at infant stage in Nepal in practical sense. Ever since of its establishment, IPM program in Nepal has been viewed and understood in the project mode and still there is a long hangover among stakeholders that "IPM is a project". Similarly, most of the practitioners feel it as "a method rather than an approach". Because of these understanding and its operational modality, its progress has been realized rather sluggish in terms of internalization and institutionalization. Sometimes, some people argue it is rather a Directorate focused program or FAO project. The feeling might have been mis-leaded in the ground of its technical necessity as implementation is possible only with the well trained IPM facilitators. In another words, it is heavily dependent on IPM trained manpower which is different than the conventional and general type of trained personnel. In fact, implementation of this program requires not only well trained manpower in the field but also requires spacious land for practical classes. Based on the acquisition of the knowledge, one can implement the program. In order to conduct this program, capacity building were carried out for the Master trainer in the farmer's level, medium level technicians (JT/JTAs) and officer level are carried out in different time. Extension of IPM has been geared up through FFS and is considered as the heart of this program, which basically requires well set up of practical classes and almost difficult to conduct in a fixed set up theoretical environment.

Until now the greater thrusts have been found laid on capacity building of the farmers and technicians, yet it has to demonstrate its impact on reduction on the haphazard use of chemical pesticides and improvement in the environment along with the increasing crop yields in the long run. Another reasons of sluggish impact of IPM program could be due to its role in the cross cutting issues as its intervention requires as a supportive role. At the same time, IPM program has been largely suffered with the lack of alternatives measures to chemical pesticides. Open and very porous geographical locations with neighboring country has affected for the effective implementation of the program in some aspect. The practical adoption of alternatives to chemical methods while controlling pest insect may be difficult to apply on farms than simple chemical control techniques. It is still difficult in case of Nepal as the country has no chemical pesticides manufacturing industries in one hand and purchasing of such compounds from abroad needs lot of resources in another hand. At the same time, majority of the farmers are illiterate, therefore, community level education approach, the FFS is highly imperative. More than 90% of the farmers in terai and mountain regions could not read or understand the language written on the pesticide labels, and that unacceptable levels of pesticide residues have been detected on food grains, fresh vegetables and animal milk that justify the need of IPM FFS in Nepal.

FIRST PHASE OF NATIONAL IPM PROGRAM

Over the entire phase, field activities were implemented in collaboration with District Agricultural Development Offices (DADO). In addition, the NIPMP worked together with other institutions such as, Institute of Agriculture and Animal Science (IAAS), Rampur,

Chitwan, Plant Protection Society of Nepal and World Education. In order to streamline the program at national level, regional level and at the district level, there had been provision for the National Steering Committee, National IPM Program Co-ordination Committee, regional level coordination committee and district coordination committee by including different stakeholders from the related institutions. The implementation modality adopted in this phase is presented in figure 1.

The total budget of the I Phase of IPM program was $1,300,147 for four years, however, it was spent only 66% by the end of 2007 therefore, the program was continued for one more year with the remaining funds .Most of the expenditures were utilized for training (65%), which exceeded its original budget by $185,000. On the other hand, only 13% of the planned budget was utilized for contracted services. Considering that training was given high priority and almost negligible was spent on permanent professional (5%) and general service staff (7%, including casual labor). The major portion of the budget appears utilized for the training of the facilitators at various levels with little funding for program monitoring and evaluation.

Building on the previously trained facilitators, one of the major objectives of the Program was to strengthen the capacity of PPD and other institutions to implement IPM activities. During the course of the project, the number of trained IPM-FFS facilitators was almost doubled from 440 in 2004 to 859 in 2007.

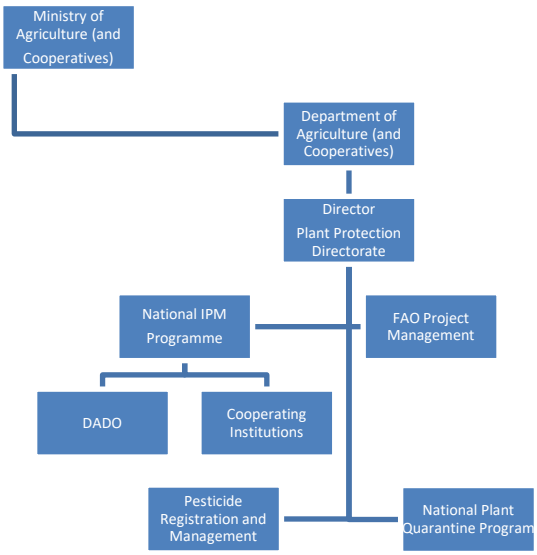

Fig. 1 : Implementation modality of I Phase of IPM program in Nepal

In particular, training of officer and non-officer IPM facilitators towards the capacity building activities were implemented during the project period. Training of Facilitators (ToF) is a field-

based, season-long residential learning experience involving up to 30 future facilitators at a time. During the course, participants improve their technical expertise in IPM; develop participatory, non-formal adult education training skills; and enhance their management and experimental capabilities. The curriculum consisted of ecosystem analysis; crop development and management; decision-making; participatory educational process; organization and planning; gender sensitivity; and group dynamics. After graduation, participants are expected to implement FFS independently.

The program appeared to be highly appreciated by the local communities. While going through the number of activities and geographical spread of the program, it is found that the first phase mostly confined in the central regions and in the training parts, which in fact is not impressive and inclusive. The quality of the trainings, facilitators and the modality they adopted were found satisfactory, however, in the initial phase, it is interesting to note that, none of the IPM FFS have been found locally funded. Similarly, there was no separate IPM unit in the first phase with full-time staff and the cooperation with other institutions was limited. During that period, the links between the National IPM Program and the National Pesticide Policy appeared weak. Incorporation of IPM activities into core (regular) IPM program at the regional and district level as well as collaborative works with national agricultural research system was found weak. The curriculum was also narrowly focused mainly with the process rather wider coverage on the food safety and network with marketing institutions was lacking.

SECOND PHASE OF NATIONAL IPM PROGRAM

The National IPM Program Phase II is a continuation of the earlier phases, which emerged due to the need for institutionalization into the regular program of the Government of Nepal. The second phase (25 October 2008 - 26 October 2013) was implemented with technical backstopping of FAO-Nepal and overall implementation and coordination of PPD. The main purpose of the program was to institutionalize and scale up IPM program for the commercialization as well as sustainable agriculture in the selected districts of Nepal. As described in GC 2013, this program covered terai, mid-hills and mountains districts under five development regions, where Ministry of Agriculture and Co-operatives is the executing agency. Unlike earlier phases, the operation modality as well as funding modality is different in this phase. Looking into the objectives of the program, Plant Protection Directorate (PPD) has great challenge to institutionalize the past outcomes of IPM so far achieved and implement the program as per the desires and aspiration of the farmers, technicians, policy makers and donors. The second phase of the program has given increasing thrusts on the production and utilization of IPM products; therefore, the program has given ample thrusts on aspect by formulating IPM policy and IPM standards and marketing networks. It is found that the implementing agency i.e. PPD has included many different stakeholders in launching its program from research, extension, development and private partners as per the need basis. However, there is inadequate functional relation exists among research, teaching and extension counterparts. At the same time, ambiguities are

seen in case of applying single norms in the country because most of the INGOs and NGOs are applying their own norms. There were lack of clarity among the working partners engaging in IPM program. Broadly, it has implemented its program with two modality i. e. through Intensive IPM model and a general district model.

The FAO supported twelve intensive IPM Districts include, Illam, Jhapa, Bara, Kavre, Syangja, Mustang, Kapilbastu, Banke, Surkhet, Kailali, Dadeldhura and Jumla. PPD has also has been running intensive IPM program in five other districts as an additional districts. The main logic of replicating it is to up-scale the better learning and outcome from the FAO supported IPM districts. The PPD supported intensive IPM districts includes, Morang, Dhading, Chitwan, Tanahun and Bardiya. Implementation of IPM activities in earlier case has been found since 2009, whereas in later case since the late of 2010.

The program thrust and strategies of the secong phase of NIPM were: (i) Mainstreaming and gradual internalization of IPM Program in DoA/PPD regular program; (ii) Scaling up the program within the existing and new districts; (iii) Institutionalization of IPM Program, networking and strengthening in of IPM groups/Association/Cooperatives; (iv) Capacity enhancement of farmers and technicians to address organized production, self certification and marketing of healthy crop products; (v) Linkages with Research Institutions and Participatory Field Research; (vi) Collaboration/coordination with teaching institutions universities and I/NGOs other likeminded institutions; (vii) Strengthening of Institutions and Laboratories; (viii) Human Resource Development; (ix) Development of crop specific IPM modules – GAP (IPM Standard), Postharvest handling and marketing. Cluster based approach to empower the farmers; (x) Sustainability of the program.Table 2 summarizes the selected areas and focus on the crops.

Table 2. Focused crops of Intensive IPM Districts

Focused Crop	Intensive IPM Districts
Ginger	Illam
Tea	Illam; Jhapa
Vegetable	Bara, Kavre, Kapilvastu, Syangja, Banke, Surkhet, Kailali and Dadeldhura
Citrus	Kavre and Syangja
Apple	Mustang and Jumla

RESULTS AND DISCUSSION

Common pest of some important crops in IPM District

Ilam and Jhapa are primarily tea growing districts. Despite of the long history of their cultivation in the districts, there are dozens of problem. Among them the damage caused by insect pests is regarded as primary one. Common pest that attract tea are caterpillar (*Latoia*sp, *Gracilariatheivora*), leaf roller (*Gracilariatheivora*, *Stringlinaglareola*, *Hamonacoffearia*), tea mosquito (*Heolipeltisfebriculosa*), aphids (*Toxopetraaurantii*,

Empoascaflavescens), Jassids (*Halopeltis* spp.), flush worm (*Lasperesiabipunctata*) and other pests.

Nearly all kinds of insect pests and diseases are common in all the IPM districts; however, magnitude of the severity differs in place and crops. Most common are Lepidopteran, Coleopteran, Dipteran, Homopteran, Hemipteran etc. The borer pest insect (*Helicoverpaarmigera)* cut worm (*Spodopteraexigua),* fruit fly (*Bactroceracucurbitae, B. dorsalis),* thrips, bugs, borers, aphids, termites, caterpillars, rollers, mosquitoes, worms etc are common insect pest and that involve in different stage of the crops. Their losses differ in severity. Similar to insect pests, different types of diseases like fungal, bacterial, viral, nematodes are also common which involve in damaging of the different crops. They sometimes attract and damage hectares of the crop field.

Pesticide application situation in IPM districts

Nearly all types of pesticides that are available in Nepalese markets are being used in these districts, however it has been found with reduced dose, frequency and time. This can be taken as impact of the program too. In all the program side, the reduction of pesticide is progressing as compared to non-program area. Before launching the program the farmers used to use, chemical pesticides beyond level of prescribed dose but now this tendencies have abandoned. One important thing that every farmer raised in all the program side is lack of alternative compounds over chemical pesticides is being apparent. Because of this, the farmers are practicing less and less with alternative means.

Pesticide use situation in tea showed that different types of pesticide are used in tea for controlling varieties of pest insect. Endosulfan an organochloride pesticide abundantly used for controlling varieties of pests. Similarly, use of organophosphate includes quinalphos, ethion, malathion, monochrotophus, propanofus, acefate, dichlorovous, chloropyriphos as a common pesticide in tea field to control large verities pest. Also, other synthetic insecticides such as alfamethrine, cypermethrine and pyrethroid ester insecticides like fenpropathrin are also used in tea. Herbicides such as gramoxone, oxyflurene, glyphosphate and 2, 4 D were generallyfound to use to control dicot, broad leafs and grass bushes. Banned pesticides items area abundantly used in tea in eastern Nepal.

Similarly, use of pesticide scenario in vegetable shows, Endosulfan is a common most organochlorine pesticide used in vegetables to control pest. Beside that quinalphos, ethion, malathion, monochrotophus, propannofus, acefate, dichlorvous, methyl parathion are heavily used. Beside them, alfamethryene, cypermethryene, pyrethroid, fenpropathrin are also used. Gramoxone, oxyflurene, 2,4-D are used for herbicide. Systemic as well as non-systemic fungicides and pesticides are commonly used in these items.

Quite a more area, farmer uses cocktail of pesticides by mixing more than one group and compounds. Not only a single pesticide type, a mixture of more than 5 pesticides including

highly infectious pesticides are used in vegetable farms mostly of Bara, Banke and Kavrepalanchowk. Insects/pest resisted with one type of pesticide therefore, more than one pesticide mixture is needed to control the damage. Peoples of IPM non-coverage are still use large amount of pesticides. However, from the implementation of IPM, application of pesticide has been gradually reducing at least in the farmland of IPM members as they started to know consequence of pesticides in human health. Also they started knowing origin of growth defects whether from insect pest attract or from deficiency of the nutrients.

Maximum Residue Limit (MRL) in some crops

Pesticide residue in vegetables, exportable commodities pulses and cereals became not limited only the political and geographical boundary of only one country but became an interest of global peoples. Short as well as long term deadly lethal activities of pesticides determines by the level of residue exist in such items. Pesticides and heavy metals are stored in fat/oil glands and other energy storage sites in body. According to EPA, when it crosses the MRL, it would cause carcinogenic effect that is lethal to human. These chemicals are also reported to have birth defective effects. Some chemicals even have carcinogenic effects. Therefore, uncontrolled application of these deadly chemicals with or without its prior knowledge would cause human health hazards.

Sample of different vegetables and tea from different districts for different pesticides are detected. Detected pesticides that are 2- 4 D, 4-bromo-2-Chlorophenol, Abamectin, Acephate, Acetamiprid, Aldrin, Atrazine, Azoxystrobin, BHC, Bifenthrin, Bitertanol, Buprofezin, Butachlor, Captafol, Captan, Carbaryl, Carbendazim, Carbofuran, Carbon-di-sulfide, Carbosulfan, Cartaphydrochride, Chlordane (sis and trans), Chlorfenvinphos, Chloropyrifos, Chlorothalonil, Clothianidin, Cyfluthrin, Cymoxanil, Cypermethrin, DDT, Deltamethrin, Diafenthiuron, Dialdrin, Diazinon, Dichlorovos, Dicofol, Difenoconazole, Diflubenzuron, Dimethoate (Including Omethoate), Dimethomorph, Dinocarp, Emamectin Benzoate, Endosulfan, Endrin, Ethion, Ethofenprox (etofenprox), Etrimphos, Famoxadone, Fenamidone, Fenarimol, Fenchlorvus, Fenitrothion, Fenpyroximate, Fenvularate, Fipronil, Flufenoxuron, Flusilazole, Heptachlor, Hexaconazol, Imidacloprid, Indoxacarb, Iprobenphos, Iprodione, Iprovalicarb, Lambda-Cyhalothrin, Lindane, Malathion, Mencozeb, Metalaxyl&Metalaxyl-M, Methamidophos, Methomyl, Monocrotophos, Myclobutanil, Omethoate (Dimethoate), Oxydemeton-methyl, Oxyfluorfen, Parathion, Penconazole, Permithrin, Phorate, Phosphamidon, Profenofos, Propargite, Pyraclostrobin, Quinalphos, Smiazine, Spinosad (Sum of Spiosad A+B), Tebuconazole, Thiamethoxam, Thiodocarb, Thiophanate-methyl, Triademorph, Triadimefon, Triadimenol, Triazophos.

Pesticide residues detected vegetable are Okra from Bara and Kailali, Tea from Ilam, Bean from Bara and Jhapa, Bitter gourd from Kailali and Banke, Tomato from Kavre and Potato from Dadeldhura. Most of the results have found below detection quantity (BDQ). Among them some of the results have been found as in Table 4.

Vegetable	District	Name of pesticide					
		Cypermethrin	DDT	Endosulfan	Heptachlor	Mencozeb	Phorate
Okara	Bara	0.001	0.002	0.008	0.002	0.001	0.005
	Kailali	0.002	BDQ	0.01	BDQ	BDQ	0.003
Tea	Ilam	0.05	BDQ	0.01	BDQ	0.06	0.003
Bean	Bara	0.06	0.001	0.02	0.001	0.04	0.006
	Jhapa	0.001	0.003	BDQ	BDQ	BDQ	0.001
Bitter gourd	Kailai	0.001	0.001	BDQ	BDQ	BDQ	0.003
	Banke	0.01	0.001	0.02	BDQ	0.07	0.002
Kavre	Totamo	0.1	BDQ	0.005	0.003	0.1	BDQ
Potato	Dadeldhura	BDQ	BDQ	BDQ	BDQ	BDQ	BDQ

BDQ: Below detection quantity

Pesticide use scenario before and after the IPM Program

Table 4. Summarizes the different types of pesticide use scenario in different crops

Crops	Before IPM Program			After IPM Program		Remarks
	Type of Pesticides	Quantity	Frequency	Type of Pesticides	Quantity	
Rice	Insecticide, Fungicide	2000 gm or ml/ha	3	Insecticide, Fungicide, Bio-pesticides	1600 gm or ml/ha	Use of animal urine
Bitter gourd	Insecticide, Fungicide	300 gm or ml/ha	4	Insecticide, Fungicide, Bio-pesticides	190 gm or ml/ha	Use of Foliar fertilizer
Potato/pea	Fungicide	2160 gm or ml/ha	3	Fungicide, Bio-pesticides	1440 gm or ml/ha	Servo
Cauliflower	Insecticide, Fungicide	2000 gm or ml/ha		Insecticide, Fungicide, Bio-pesticides	1600 gm or ml/ha	Use of Foliar fertilizer
Cabbage	Insecticide, Fungicide	2000 gm or ml/ha	1	Insecticide, Fungicide, Bio-pesticides	1560 gm or ml/ha	Use of Foliar fertilizer
Tomato	Insecticide, Fungicide	3890 gm or ml/ha	4	Insecticide, Fungicide, Bio-pesticides	3100gm or ml/ha	Use of Foliar fertilizer
Cucumber	Insecticide, Fungicide	1500 gm or ml/ha	3	Insecticide, Fungicide, Bio-pesticides	700 gm or ml/ha	Pheromone Trap in intensive use

ACHIEVEMENTS

The achievements and milestones of IPM interventions since 1997 can be summarized as follows:

1. IPM may play a crucial role in knowledge uplifting process in grass root level with the utilization of local resources. Technical knowledge at farmer's level in cropping system improvement, gap and irrigation management, crop rotation and integrated cropping would play a vital role in pest reduction.
2. As part of the institutionalization, IPM Unit has been established under the PPD with the deployment of staff from the regular program of the Government.
3. Until now, altogether 3772 FFS are conducted by PPD and FAO initiatives in Nepal. Altogether 99751 farmers are graduated from this program. A total of 1175 Farmers have been prepared as IPM Master Facilitators. More than 5000 farmers groups benefited from yearlong IPM FFS and 10153 farmers trained through 390 season long FFS. 120 IPM Groups registered at different DADO of Intensive IPM Pilot districts.
4. In addition to the social and knowledge empowerment of the farmers and their groups, enrichment of IPM knowledge through training as Master Facilitators 444 medium level agricultural technicians, 217 Officers from different disciplinary fields, 25 from CTEVT have been trained.
5. IPM Farmers in the pilot districts increasingly adopting IPM technologies and is producing healthy IPM products in an organized way. They are now seeking marketing and premium price of these products because of their logics of no or low use of chemical pesticides.
6. Pesticide Act and Regulations are at the stage of finalization. Similarly, IPM policy has been drafted and yet to be finalized. Participatory system of IPM product certification established, lower IPM GAP has not been finalized yet. It is expected that, this policy will guide for the further activities of IPM and facilitate mainly in policy level.
7. IPM projects has also trained 58 Officers as IPM Master Facilitators of Government official and the faculty members of teaching institute, IAAS, Rampur, Chitwan, Himalayan College of Agricultural Science and Technology (HICAST) and Council for Vocational Education and Training Centre (CTEVT) in the joint supports of EU-Food Facility and PPD. Only in this phase, altogether 266 farmers, 217 JT/JTAs are also receiving IPM Master Facilitators training in different places and are expected that they would fulfill the voids of training requirement in the country.
8. This program also has trained 8 Plant Protection Officers (PPO) in full scholarship to pursue their Master Degree in IAAS Rampur. Similarly, 2 Plant Protection Officers (PPOs) received partial scholarship for master degree for doing thesis research in IAAS, Rampur and 2 fresh Graduate students in HICAST for their mini-thesis work.
9. Curriculum for cropping cycle based yearlong FFS designed and IPM FFS conducted in

different crops (rice, vegetables, potato, tea, ginger and citrus). This has been found highly useful and being adopted by CTEVT in their teaching program. Curriculum of IPM FFS designed and building up in the National level Institutes such as IAAS, Rampur, HICAST, and CTEVT.

10. Bio Rearing Training (Officer Level) conducted with the technical support of Institute of Agriculture and Animal Science (IAAS), National Maize Research Program (NMRP) and National Grain Legume Research Program (NGLRP). Training was organized to develop the knowledge and skill of Plant Protection Officers working in Regional Plant protection Laboratories and District Agriculture Development Offices with aiming of developing their capacity to work in their respective districts. Special Training on Plant Disease Management and Bio-control conducted involving with the experts from AIT, Thailand.
11. Several study materials on IPM and plant protection published and found highly useful to the farmers, medium level technicians as well as to the officer level staffs. During the reporting period, Plant Protection Directorate has prepared booklet, pamphlet, poster and leaflet on the disease, insect and pesticide related information. Following major publications of the Directorate and are being circulated to the farming communities, DADOs and concerned stakeholders. These includes, as books like Biological control of white grubs, Plant Clinic and its operational modality, Biopesticides for insect pests and disease control, Insect pests of apple and their integrated control , Integrated Pest Management of vegetable and fruits , and as leaflets like Club root management in cauliflower, Major Scarab beetles of Nepal and their biological control, Wheat rust and its control measure, Major diseases of citrus and their control measure, Mango banded caterpillar and its control measure, Mango hopper and its management.
12. A novel approach of controlling insect pests using bio pesticide has been successfully achieved by the program by producing two novel products such as insect pathogenic fungus based, *Metarhizium anisopliae* and *Trichoderma.* This task has been successfully conducted by the joint venture of public-private partnership approach. At the same time, functional role of Regional Plant Protection Laboratories (RPPLs) and Central Plant Protection Laboratory has been enhanced by streamlining their tasks. Under this scheme, each RPPL are designated to produce at least with one biocontrol agent. Production of these novel means will finally be linked with private organization where *Trichoderma* (a fungus based bio product) and Nuclear Polyhederosis Virus (NPV, a virus based bio product) have been continued by Far and Mid Western Development Regions respectively. Similarly, the useful natural enemies are being multiplied in RPPL Pokhara, where as the botanical, Bojho *(Acoruscalamus)* has been producing in Birat Nagar. Central Plant Protection Laboratory in HariharBhawan has been involved in producing EPNS, Insect Parasitic Nematodes (the Heterorhabditis) and fungus (*Metarhizium anisopliae)* based bio pesticides. With these roles the Laboratories are heavily found engaged in biocontrol activities and are expected to fuel the needy job

towards the reduction of chemical pesticides. During this phase an official website of the PPD updated (www.ppdnepal.gov.np) and brochure of the IPM program published with an expectation that the program can be extended at a wider level.

13. Directorate has given increasing emphasis of the wider scaling up of the programs through audio- visual aids such as documentary of the IPM Farmers Field School and pertinent activities. It has prepared hoarding boards, audio-video CDs on bio pesticides and its usefulness, audio video CD on IPM FFS and Master Facilitator Training. It is also found that, the program has given ample emphasis on the institutionalization of the outcomes into its regular program. It has given increasing importance on the reduction of the haphazard and injudicious use of chemical pesticides in agricultural fields. In order to give the appropriate messages that, "chemical pesticides are poison and not as medicine", it had prepared and set up hoarding boards in farming sites, production and distribution sites like big market center in Kalimati, Kathmandu and other places. Considering the education level of the farmers and suitability of the program, timely broadcasting of the messages was done through Ujyalo-90 Network, which has wider coverage in the country. In addition to this FM Radio, broadcasting of these CDs and programs has been done through National Televisions (NTV and ABC) and couple of other FMs and Government Krishi Radio on frequent basis. PPD made joint MoU with them and broadcasted the message over the period of time.
14. Plant Protection Directorate has engaged for conducting IPM program for more than a decade. While implementing IPM program PPD has based it on the IPM principles i.e. the production of healthy crop, judicious use of chemical pesticides as well as the use of bio pesticides. Awareness program to discourage un-necessary use of chemical pesticides in farming community had been successfully done. To this effect, understanding of biotic and abiotic problem through the means of plant clinic approach was found dire need. Work on the plant wise program and PPD was initiated since 2012 and different modules of plant doctors (from first and fourth module) was conducted where number of agricultural officers were received training. In these trainings, not only plant protectionists were trained but the officials working in other disciplines were also trained. PPD soon institutionalize this aspect and made provision of the budget through regular program. Some clinics (mainly on need based mobile type) were conducted in collaboration of Regional Plant Protection Laboratories (RPPLs) and District Agriculture Development Offices (DADOs) and farming communities. Through the program, it appears that, this program would take lead role in the frame of IPM. PPD also developed the norms for plant clinic and institutionalized within the Government system. Some hand books on plant doctor training (module I and module II) were also prepared along with occasional publications in this field. Very positive impacts had been received from such program in terms changing the trained of farmers, treating the plant illness, changing the "*do how*" not only "*know how*" of the farming communities. Plant clinical approach seems one of the important components or strategies within IPM

where *"do nothing strategies"* may well able to reduce the un-necessary penetration of the chemicals in our land, food items and health system.

The efforts of IPM program are observed very relevant to biodiversity conservation as it emphasizes for the conservation of natural enemies and stress for healthy environment to all the living beings. IPM program in future will be highly relevant components in contributing one health system, which has been buzzing word in these days.

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