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KNOWLEDGE-BASED INTEGRATED SUSTAINABLE AGRICULTURE AND NUTRITION (KISAN) PROJECT

PESTICIDE EVALUATION REPORT & SAFER USE ACTION PLAN (PERSUAP)
MARCH 11, 2014

CONTRACT NUMBER AID-367-C-13-00004

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CONTRACT NUMBER AID-367-C-13-00004

APPROVAL OF THE RECOMMENDED ENVIRONMENTAL ACTION

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ACRONYMS

Ai	Active ingredient
Agrovet	Pesticide retail dealer
BDS-MAPS	Business Development Services – Medicinal and Aromatic Plants Project
BEO	Bureau Environmental Officer
BHC	Benzene hexachloride organo-chlorine insecticide
Btk	Microbial insecticide based on a bacterium *Bacillus thuringiensis* var. *kurstaki*
CEAPRED	Center for Environmental and Agricultural Policy Research, Extension, and Development
CIMMYT	International agricultural research center of wheat and maize (Mexico)
DDT	Organo-chlorine insecticide
DOPP	Department of Plant Protection
FAO	UN Food and Agriculture Organization
EC	Emulsifiable concentrate, a liquid formulation of pesticide
EIG	Education for Income Generation
EMMP	Environmental Mitigation and Monitoring Plan
FFS	Farmer field school
FTF	Feed the Future
FYM	Farm yard manure
G	Granular pesticide formulation
GDP	Gross domestic product
GLC	Gas liquid chromatograph
GON	Government of Nepal
GTZ	German Technical Cooperation Program (Gesellschaft für Technische Zusammenarbeit)
GUP	General use pesticide
Ha	Hectare
IEE	Initial environmental evaluation

IPM	Integrated pest management
IPM IL	IPM Innovation laboratory
Kg	Kilogram
KISAN	Knowledge-based Integrated Sustainable Agriculture and Nutrition
m	Meter
M	Million
MOAD	Ministry of Agricultural Development
MOE	Ministry of the Environment
MPC	Marketing and Planning Committees
MRL	Maximum residue limit
MSDS	Material Safety Data Sheets
NARC	Nepal Agricultural Research Council
NARO	Nepal Agricultural Research Organization
NDPIC	Nepal Drug and Poison Information Center
NEAT	Nepal Economic Agriculture and Trade
NFRP	Nepal Flood Recovery Project
NGO	Non-governmental organization
NPV	Nuclear Polyhedrosis virus
PA	Protective area
PERSUAP	Pesticide Evaluation Report and Safer Use Action Plan
Ppm	Parts per million (1 ppm = 1 mg/kg)
POPs	Persistent organic pollutants
PPE	Personal protective equipment and clothing
Ropani	Nepali measurement of field area equivalent to 1/8 of an acre
Rs	Nepal Rupee
RUP	Restricted use pesticide
SC	Soluble concentrate formulation

SG	Soluble granular formulation
SIMI	Smallholder Irrigation Market Initiative
SL	Soluble liquid concentrate
T	Metric tons
USAID	United States Agency for International Development
US EPA	United States Environmental Protection Agency
VDC	Village Development Center
WHO	World Health Organization
WP	Wettable Powder formulation

EXECUTIVE SUMMARY

Winrock International received a contract from the United States Agency for International Development in Nepal (USAID/Nepal) for the Knowledge-based Integrated Sustainable Agriculture and Nutrition (KISAN) Project. This project is part of the Feed the Future (FTF) Initiative and is the flagship food security project of USAID/Nepal. The Project's overall goal is to sustainably reduce poverty and hunger in Nepal by achieving inclusive growth in the agriculture sector, increasing the incomes of farm families, and improving nutritional status, especially of women and children. As part of the project, Winrock conducted a Pesticide Evaluation Report and Safer Use Action Plan.

In preparation for this project, USAID conducted an initial environmental examination for the KISAN project in April of 2012, which was approved by the Bureau Environmental Officer (BEO). This document reviews the project activities and, based on the proposed interventions, recommends determinations for each output and major activity. Activities were either a categorical exclusion (CE), which means there is no environmental impact or a negative determination with conditions (NDC). Some of the NDC activities include establishing water systems, fish ponds, demonstration gardens, drip irrigation, latrines, collection centers, post-harvest storage facilities, and community-based seed production. In addition, training activities to enhance famers' knowledge on various topics like high-yielding and nutrient-rich crops, optimal fertilizer use, integrated pest management (IPM), organic cultivation, composting, and livestock production practices were also assigned NDC.

For Outcome 1 farmers receive improved and increased agriculture inputs, the IEE suggested that "activities may include use of improved pest management and improved fertilizers" and was determined NDC with a PERSUAP requirement. The document explained that KISAN would improve farmers' access to fertilizers, vaccines, and improved pest management. Based on the IEE, Winrock developed an Environmental Monitoring and Management Plan (EMMP). This PERSUAP was developed in response to both the IEE and the EMMP.

This report assesses and evaluates the pesticide use and regulations and identifies key risks that farmers face. The action plan suggests a number of chemicals that can be safely used by the KISAN Project to help promote farmers' productivity. All 19 chemicals recommended by this report are registered with United States Environmental Protection Agency (US EPA) http://www.epa.gov/pesticides/PPISdata/ (also see http://npirspublic.ceris.purdue.edu/ppis/ for a user friendly way to search for EPA approved pesticides) for unrestricted same or similar use as mandated by 22 CFR 216.3(b)(1)(i), the Government of Nepal (GON), and the World Health Organization (WHO). In addition, chemicals were chosen based on their efficacy, overall safety to the environment and consumers, and safety to the farmers applying them. Pesticides not included were too toxic for farmers who do not wear sufficient protective clothing and other equipment to protect them from exposure. The next criteria for selection was those registered with the US EPA and registered with GON. KISAN will not approve any pesticides of a rating of one or two on the 1-4 toxicity scale. Nepal is a signatory to the Stockholm Convention, which bans the most persistent organic pollutants (http://chm.pops.int/TheConvention/ThePOPs/tabid/673/Default.aspx); Basel Convention, which protects vulnerable countries from unwanted hazardous waste imports (http://www.basel.int/Home/tabid/2202/mctl/ViewDetails/EventModID/8295/EventID/443/xmid/8052/Default.aspx); Rotterdam Convention, which requires prior informed consent for disposal of outdated, obsolete chemicals (http://www.pic.int/); and follows the UN FAO Pesticide Code of Conduct.

The PERSUAP expert assessed a total of 45 pesticides permitted for use on crops and livestock to control insect and mite pests and plant pathogens, which are listed in Annexes IV-VII. Of those assessed, this PERSUAP recommends a total of 19 pesticides be approved and permitted in KISAN. These are approved by the US EPA for unrestricted use or similar uses. These pesticides are approved by the GON and include fungicides, insecticides, bio-fungicides, bactericides, bio-insecticides, and bio-nematicides (see Table 1 – note some chemicals are used to prevent pests and nematodes and are listed more than once).

Table 1. Pesticides recommended to be permitted under KISAN

Fungicides	Insecticides	Bio-Fungicides	Bactericides	Bio-Insecticides	Bio-Nematicides
Crops					
Metalaxyl + Mancozeb	Acetamiprid	Azadirachtin	Copper oxychloride 50% WP formulation	Azadirachtin (Neem oil extract)	Azadirachtin (Neem cake)
Carbendazim	Chlorantraniliprole	Pseudomonas fluorescens	Steptomycin sulphate	Beauveria bassiana	Pseudomonas fluorescens
Sulpher	Buprofezin	*Trichoderma sp*	*Tetracycline hydrochloride*	*Metarhizium anisopliae*	
Mancozeb	Thiamethoxam				
	Sulphur				
	Imidacloprid				
Livestock					
	Cypermethrin 5% EC				
	Malathion EC				

The expert also assessed the overall of pesticide use situation and found some of the key issues around using pesticides safely are:

- Weak pesticide regulatory and enforcement system;
- Farmers lack knowledge on the characteristics and use of pesticides; and
- Lack of trained manpower to implement improved IPM.

This report's Safer Use Action Plan suggests that KISAN encourage farmers to minimize pesticide use in the context of an Integrated Pest Management (IPM) program so that farmers use good agricultural practices and limit toxic chemicals. In addition, KISAN should improve farmers' knowledge of the hazards of pesticides, and encourage their safe and effective usage by using the guidelines provided herein. KISAN should draw from the USAID-funded IPM Innovations Lab, and previous training materials developed for USAID Programs on IPM. When needed, KISAN should only promote the safest and recommended pesticides, use the FAO Material Safety Data Sheets for reference, and emphasize the need for protective clothing, appropriate equipment, and safe disposal of pesticides when they are being used.

Though it is beyond the scope of KISAN, USAID could improve pesticide management in Nepal by encouraging the Ministry of Agricultural Development (MOAD) to remove the most toxic pesticides from the list of registered pesticides. This is happening in India as it deregisters the most unsafe agriculture chemicals.

If there are projects or other resources, USAID and KISAN could consider the suggestions on how MOAD can improve the training of its staff to provide better services and improved institutional backing to implement enhanced IPM programs in Nepal.

To mitigate some of the greater issues of pesticide use in Nepal, USAID should, through leadership of the Mission Environmental Officer (MEO), form a stakeholders' committee to work with the GON Pesticide Technical Committee to not reregister the most toxic pesticides, reduce the smuggling of pesticides into the country, improve the labels to be more useful to Nepali farmers, require local testing of new pesticides, encourage pesticide inspectors to be more vigilant, and increase fines for infractions. The GON should also be encouraged to improve institutional capacity in pesticide residue capabilities especially of vegetables, to equip and train staff to run its bio-control laboratories, to conduct more research to develop crop monitoring protocols and decision thresholds for pesticide usage, and to encourage the development and registration of more bio-rational pesticides.

1. BACKGROUND AND PROJECT DESCRIPTION

For a small country, Nepal has tremendous geographic diversity. It rises from less than 100 meters in elevation in the tropical Terai along the northern rim of the Gangetic Plain, to over 7,000 meters beyond the perpetual snow line. In addition to the varied climate, the average annual precipitation varies from as little as 160 millimeters north of the Himalayas to as much as 5.5 meters on windward slopes. Along a south-to-north transect, Nepal can be divided into three east-west belts: Terai, Hill, and Mountain Regions. In the other direction, Nepal is divided into three major river systems, from east to west: Koshi, Gandaki/Narayani, and Karnali (including the Mahakali/Sarda along the western border), all tributaries of the Ganges.

Agriculture plays an important role in Nepal's national economy with over 75% of the adult rural population (total population is 26.5 million[1]) involved in agriculture, comprising one-third of the gross domestic product (GDP) (Joshi et. al, 2012). A number of GON publications, including the recently published Agriculture Development Strategy (ADS), call for commercialization of agriculture to accelerate economic growth and poverty reduction in Nepal. There is potential for Nepal to earn foreign exchange by selling agricultural products to neighboring and more densely populated India. However, commercialization entails high-input, high-value commodities-based intensification of agriculture, which often leads to increased use of pesticides. Inappropriate and/or excess use of chemical pesticides can have hazardous impact on people, livestock, and the environment. Therefore, it is important that effective and ecologically sound crop protection programs combine various alternative pest control measures, including mechanical, biological, and plant genetic resistance and cultural methods, and should be implemented to minimize harmful effects of toxic pesticides. Following integrated pest management (IPM) practices, the safest chemical pesticides should be used only as a last resort. This requires promotion of appropriate crop protection technology and IPM strategies, and increased awareness of government extension personnel, pesticides dealers, pesticide applicators, farmers, and consumers.

A long list of pesticides is currently approved by the Directorate of Plant Protection (DOPP) of the Department of Agriculture in Nepal. Due to lack of enforcement legislation, there has been misuse of pesticides. For example, there is no mechanism for consumer safety as no government agency monitors fresh produce in the marketplace for pesticide residues. The expiration dates of pesticides and the quality of imported as well as locally produced chemicals sometimes go unchecked. There have been some pesticides imported from India which are of doubtful quality. In the past, the bulk of pesticides were marketed by the Agricultural Inputs Corporation. Currently private dealers, called Agrovets, sell most of the pesticides to farmers and the public. Since Nepal has an open border with India, it is very difficult to estimate the exact quantity of pesticides imported into the country.

Agrovets also import pesticide application equipment, mostly sprayers (hand compression and knapsack type) from India. Vegetable production has become very popular in many parts of the country, especially near the highway corridors. Farmers started frequently treating high-value vegetable crops with

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[1] Source: http://www.ifpri.org/sites/default/files/publications/Agriculture_seed_and_innovation_in_Nepal.pd

pesticides. In many places, farmers apply pesticides in a routine manner without considering the waiting period required for the pesticide to breakdown, residue on the treated produce, human health, or the environment as a whole. Panchkhal VDC, near Kathmandu, is a very popular area for growing different vegetable crops, which are sold at high prices in urban markets. Many people who are concerned about the abuse of pesticides are hesitant to consume the crops (especially vegetables) grown in Panchkhal area. Since there is very limited facility for pesticide residue analysis in the country, it is difficult to judge the amount of pesticide residue present in the fresh produce, soil, and water around farmlands.

There have been few socio-economic studies to document the use of pesticides in agriculture. A study conducted by Shrestha and Neupane (2002) in the Jhiku Khola Watershed area in Kavre Palanchowk district next to Kathmandu (representative of the Middle Hills Region) details the use of pesticides and provides a reference to pesticide use in commercial agriculture. The Shrestha and Neupane study exemplifies how some farmers overuse pesticide and illustrate the dangers farmers face as pesticides become available when there is little knowledge and a weak regulatory environment. It was not possible to conduct a more current study in the KISAN project area. However, project staff noted that based on their field experience, farmers in the Mid-Western region in 2013 use less pesticides compared to the farmers mentioned in the Shrestha and Neupane (2002) study.

Shrestha and Neupane also found that 97% of farmers used pesticides on their crops as well as stored grain, and determined the frequency of pesticide usage on common horticultural crops. Potato crops received a mean of eight to12 insecticide applications (dichlorvos, dimethoate, fenvalerate, methyl parathion), and nine applications of fungicides (mancozeb and a mixture of metalaxyl plus mancozeb) primarily against the late blight. Chili and capsicum averaged five to 11 insecticide applications (dichlorvos, dimethoate, fenvalerate) and eight fungicide applications (mancozeb), respectively. Beans were sprayed five times with insecticides (dimethoate) and five times with fungicide (mancozeb). Mustard was sprayed twice with insecticide (fenvalerate) and twice with fungicide (mancozeb). Data was also collected on the decision process for pesticide application to various crops by the farmers. Farmers usually considered the presence of pests, damage symptoms, or both. Some farmers applied chemicals on a calendar schedule. In the case of rice, 31% of the households considered the presence of pests, 36% considered damage symptoms, and 3% considered both as guidelines to pesticide usage. In the case of potato, 88% of the households sprayed upon seeing symptoms of damage. Potato late blight is caused by a fungus which cannot be seen by the naked eye so farmers must rely on damage symptoms.

Given the toxicity of pesticides, experts define a waiting period as the period between the last application of pesticide on a crop and the date it can be safely harvested and consumed. Generally during this period, the pesticide residue on or in the treated crop has dissipated and has fallen below the maximum tolerance residue levels for human and animal consumption. The current problem in developing countries, including Nepal, is that farmers usually do not maintain (or know) the recommended waiting period prescribed for each pesticide. This has resulted in people consuming agricultural products containing illegal levels of pesticide residues and may suffer from various chronic medical problems as a result. Based on interviews of government workers in key institutions related to pesticide studies, it is likely that the vegetable growers do not maintain the recommended waiting periods for the various pesticides; therefore vegetables sold in the market pose health risks for the public.

About 20% of farmers have been found treating harvested grains directly with pesticide to protect them from storage pests. Farmers applied the extremely toxic aluminum phosphide (Celphos tablets), which in other countries can only be used by licensed applicators. They also used malathion (dust), and dichlorvos (Nuvan EC). The latter two insecticides are not recommended by DOPP for direct use in grains in storage. Sometimes farmers and livestock consume these treated seeds in times of food shortage at great risk to their health.

In the Jhiku Khola study, farmer interaction with agriculture extension workers appeared to be minimal. Some 24% of respondents in the study (Shrestha & Neupane, 2002) took agricultural advice from the local extension agent, while 65% either decided on their own or relied on an Agrovet shopkeeper. Only 8% of the respondents changed their choice of pesticides on the same crop following a training advising against use of such chemicals. The study found that farmers' knowledge of pesticides (such as their types, method of dilution and application, residue problems, expiry dates, precautionary measures, etc.) was low. Only 32% to 41% of males and 8% to 23% of females had any knowledge about this, and none had mastered it sufficiently. Only 12 farmers used other pest control practices in Jhiku Khola who reported using botanicals such as neem, mugwort Artemisia vulgaris, chili, garlic, tobacco, and wood ash. Cow urine, soap, and light-traps were also used. Cow urine alone (diluted with water) or in combination with crude water extracts of the above botanicals (especially their leaves, fruits, and bulbs) are applied on the plant foliage. Farmers believed that this treatment protects the crops from pest damage.

In Nepal, pesticides are applied using very simple manual applicators such as sprayers and dusters. The hand compression (usually nine-liter capacity) and the knapsack sprayer (16-liter capacity) are commonly used. If the farmer does not own a sprayer, locally-made whisk brooms are dipped into a bucket and used to fling the spray onto the crop. In the absence of a duster, pesticide dust is spread over plants and soil surface dangerously by hand. In this case, the pesticide solution will constantly be splashing, inevitably spilling on the body. Both men and women are involved in pesticide application. In rare cases, even children are involved. The study by Shrestha and Neupane (2002) found that 46% of men and 25% of women were engaged in pesticide application; and 57% to 91% of households had sprayers. Farmers who did not own sprayers rented them from neighbors at Rs. 23 to 40 per day. Of those who sprayed, 6% to 28% felt some health symptoms such as headache, nausea, and trembling. Sixty-seven to 85% of the respondents were aware of pesticide hazards to general public health and the environment. A majority of users (85% to 90%) washed their hands with soap, but very few (5% to19%) used gloves, boots, or mouth and nose cover such as a handkerchief. No farmer used goggles, a facemask, or wore waterproof clothing while spraying.

The study found farmers to be highly risk averse and over-applied pesticides to horticultural crops. Other reasons for high use of pesticides included their low costs and very low share in the total cost of production of crops (8%). Based on these surveys and interviews with key informants, farmers have little knowledge on safe use of pesticides, and pesticide regulations have not been enforced rigorously. To improve this situation, farmers' awareness needs to be raised regarding pesticides and other alternatives should be identified. Farmers need to be encouraged to practice IPM and an enabling environment to enforce regulations passed by the government. Since 2002, it seems that general awareness about safe use of pesticides has improved.

1.1 FEED THE FUTURE

USAID's Feed the Future Program (FTF) has the overarching goal of sustainably reducing global poverty and hunger. A further goal is to help the vulnerable become more resilient to food shortages. FTF supports country-driven approaches that incorporate the wishes of national partners for determining research objectives.

1.2 KISAN

The United States Agency for International Development in Nepal (USAID/Nepal) awarded Winrock International a contract on February 14, 2013 for the Knowledge-based Integrated Sustainable Agriculture and Nutrition (KISAN) Project. This project is a part of the Global Presidential Initiative, Feed the Future, and is the flagship food security project of USAID/Nepal. The Project's overall goal is to sustainably reduce poverty and hunger in Nepal by achieving inclusive growth in the agriculture sector, increasing the incomes of farm families, and improving nutritional status, especially of women and children. The project is implemented in collaboration with five Nepali organizations as subcontractors: Antenna Foundation Nepal (AFN); Center for Environmental and Agricultural Policy, Research, Extension and Development (CEAPRED); Development Project Service Center (DEPROSC); Nepal Water for Health (NEWAH); and Nutrition Promotion and Consultancy Services (NPCS). KISAN will work in 20 districts in the Western, Mid-Western, and Far-Western Development Regions. This multifaceted project will integrate agriculture and nutrition in order to increase agricultural production and incomes, and improve the nutritional status of women and children under the age of five. This project builds on several other USAID/Nepal successful interventions such as the Smallholder Irrigation Market Initiative, the Education for Income Generation Project, the Flood Recovery Project, and Nepal Economic, Agriculture, and Trade Project (NEAT).

With the exception of NEAT, none of the USAID projects promoted pesticide use and did not have PERSUAPS. Based on an informal assessment of other non-USAID-funded agriculture projects, none are promoting or conducting training in pesticide use.

KISAN has seven expected outputs:

<u>Outcome 1</u> Farmers receive improved and increased agricultural inputs. Interventions address low productivity in Nepal due to poor access to quality inputs such as seeds, fertilizers, and pesticides as well as limited technical knowledge on how to use them and limited access to credit to purchase them. Farmers will receive better inputs and the knowledge to use them correctly, including improved integrated pest management (IPM).

Outcome 2 Improved capability of agriculture extension workers, service providers, and farmers. Knowledge will focus around higher yielding varieties, optimal fertilizer use, IPM, organic cultivation, composting, and linking crop production to livestock production.

Outcome 3 Improved and sustainable agriculture production and post-harvest technologies and practices adapted at the farm level. This will include introducing good agriculture practices, including IPM.

Outcome 4 Improved market efficiency. The project will strengthen farmer's ability to sell the agriculture products.

Outcome 5 Increase capacity of GON and local organizations. Interventions will include providing trainings and other support to the GON and local organizations.

Outcome 6 Improved knowledge and behavior on nutrition, hygiene, and sanitation practices. This will include promoting nutritious vegetables through kitchen gardens.

Outcome 7 Improved access to water and sanitation facilities.

USAID conducted an initial environmental examination for the KISAN Project in April of 2012. Activities were either a categorical exclusion (CE), which means there is no environmental impact, or a negative determination with conditions (NDC).

For Outcome 1 farmers receive improved and increased agriculture inputs, the IEE suggested that "activities may include use of improved pest management and improved fertilizers" and was determined NDC with a PERSUAP requirement. The document explained that KISAN would improve farmers' access to fertilizers, vaccines, and improved pest management. Based on the IEE, Winrock developed an Environmental Monitoring and Management Plan (EMMP). This PERSUAP was developed in response to both the IEE and the EMMP. This document will guide Winrock staff and partners on which chemicals the project can promote and the necessary training and precautions that staff and farmers must take.

KISAN is one of USAID's Feed the Future initiatives implemented in Nepal. For example, USAID has funded several research projects including the Integrated Pest Management Innovation Lab (IPM IL), the Livestock IL, the Horticulture IL as well as the Cereal Systems Initiative, South Asia (CSISA) project that work to address food security issues in Nepal. KISAN staff have met and made linkages with the staff of each of these projects and are gathering information during frequent meetings in Kathmandu and in the field. KISAN plans to scale up the promising findings of these research-oriented projects. The IPM IL, most relevant to the PERSUAP, has developed alternative pest control technologies to replace synthetic pesticides – KISAN will train farmers on these technologies. Staff from the IPM IL has developed field-tested recommendations that are consolidated as packages for tomato, peppers, eggplants, cucurbits, and crucifers crops. Appendix 11 provides an example of IPM IL fact sheet that lays out the practices for the tomato crop. In addition, KISAN will build on other USAID-funded projects which developed and promoted IPM such as the NEAT, EIG, and SIMI projects. Appendix III shows quick reference guides and training manuals that KISAN will use to train change agents and staff. As appropriate, KISAN will provide feedback to the IL programs on challenges and successes. In addition to the IL projects suite, KISAN will work closely and share materials with the USAID-funded Suahaara Project and Agriculture Food Security Project (AFSP).

1.3 DEVELOPING THE PERSUAP

The consultant, Dr. James Litsinger, was mobilized on June 17, 2013 and prepared for the consultancy at Winrock's home office before leaving for Nepal on June 21, 2013. The consultant met the KISAN staff in the Winrock office in Sanepa, Lalitpur. Uttam Dhakal, Capacity Building and Training Manager, assisted throughout the assignment in Nepal, identifying key stakeholders and accompanying the consultant to various government institutions, non-government agencies, and private firms that supply pesticides and IPM products. See Appendix 1 for the list of institutions and persons contacted. The consultant visited Nepalgunj on June 30, 2013, then overnight to Birendranagar in Surkhet District on July 2, 2013 before returning to Nepalgunj. Dr Litsinger conducted a seminar on IPM at the KISAN office on July 3, 2013. The consultant returned to Kathmandu on July 4, 2013 where he gave a debriefing at the KISAN office on July 8, 2013. The consultant departed Nepal for the US on July 11, 2013 and completed the report on July 15, 2013.

2. PESTICIDE MANAGEMENT

2.1. PESTICIDE IMPORTATION AND USAGE

A short review of the history of pesticide use in Nepal shows how recently the country has undertaken pesticide regulation compared with its neighbors. Chemical pesticides have been imported into Nepal since the 1950s (Sharma et al. 2012). The first pesticides introduced in 1952 were Paris green (arsenic-based), Benzene hexachloride organo-chlorine insecticide (BHC), and nicotine sulfate imported from the United States. The organo-chlorine insecticides were introduced in the 1950s; organo-phosphates in the 1960s; carbamates in the 1970s; and synthetic pyrethroids in the 1980s. As pesticides come in many concentrations, reports express pesticide quantities in terms of 100% which is termed 'active ingredient' or 'ai'. For example if we speak of 100 tons of 50% concentration it translates to 50 tons active ingredient.

There has been a phenomenal increase in the use of pesticides since the 1980s. The percentage of vegetable farmers using pesticides rose from 7% in 1991 to 16% in 2001. The percentage of maize growers using pesticides rose from a base value of 0.9% in 1981 to 2.8% in 1991 and 4.2% in 2001 (Sharma et. al, 2012). There were regional differences in pesticide usage: in 2001, only 6% of farmers used pesticides in the Far-Western Development Region whereas 32% of farmers in the Central Development Region used pesticides.

Recently, nationwide imports of pesticides in 2010 totaled 211 tons active ingredient (ai) (with gross sales value of $3.05M), up from 0.56 tons ai in 1997; the breakdown in 1997 was 59% insecticides, 28% fungicides, 12% herbicides, and 1% rodenticide. Currently, 29% are insecticides, 61% fungicides, 7% herbicides, and 2% others. Studies (Sharma et al. 2012) suggest that in 2009 most pesticides were applied to rice, potato, and vegetables crops.

There has been a general upward trend in the use of pesticides since 1998. The tremendous increase in 2007 was from high importation of fungicides. Herbicides have fluctuated between 1.9% and 84% of the pesticides, and rodenticides fluctuated between 0.7% and 10.7%. Use of fungicides was more abundant than insecticides in 2003 and 2006.

By March 2013, there were 1,098 brands of pesticides registered, see: ppdnepal.gov.np/.../Registered_Pesticides_List_2068_in_Nepal.pdf. Of the registered brands of pesticides, 33% were insecticides, 48% were fungicides, 16% were herbicides, 0.5% were bio-pesticides, and 2.5% were acaricides, bactericides, and rodenticides. In Asia, the price and wages of rural labor have increased to the point where herbicides are now cheaper than hiring local labor. Last year, according to the Pesticide Registrar, Nepali farmers utilized 345 metric tons of pesticides. After 2007, there was a significant leap in pesticide use, probably due to increased application on high-value vegetable production which has replaced low-earning cereal crops in the hill region (Figure 1). While it has been noted that farmers used much more pesticide on vegetables and cash crops than on subsistence cereal crops, field experience indicates that farmers in the Mid-Western region in 2013 use less pesticides compared to those near the commercial pockets around Kathmandu.

Figure 1. Annual Importation of Pesticides into Nepal

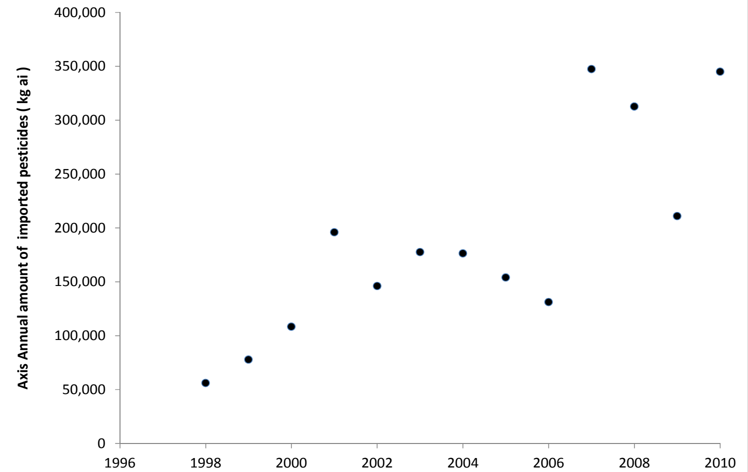

Figure 1. Annual Importation of Pesticides into Nepal from 1998-2010.

Therefore, there has been an explosion of brand names increasing from 650 in 2010 to 1,098 in 2013, an increase of 69% (based on Sharma et al., 2012). One reason for the numerous brands of pesticides is that the Pesticide Registration Office does not require that field trials be carried out in Nepal to verify if the pesticides are effective. Companies just have to show evidence that their product is licensed in India; therefore, data from India is sufficient. This is normal for a small country with little capacity to conduct the trials, but Nepal is a larger country and should have such a capacity. It is also an opportunity to generate income from fees charged from the trials. Most of the brand names are insecticides. The patents of the most popular insecticides have expired. China has entered into the world market recently, greatly expanding the number of brands.

Table 2. Number of Pesticides by Type, Nepal 2010

Type	Common Name	Brand Name
Insecticide	49	391
Fungicide	35	170
Herbicide	14	63
Rodenticide	2	7
Bio-pesticide	6	15
Bactericide	1	4
Total	107	650

Source: http://www.moad.gov.np/journal/article_11.PDF

2.2 USE OF HAZARDOUS PESTICIDES

The US EPA categorizes pesticides into four levels based on toxicity.

- Class I is the most toxic (less than five grams is fatal to humans).
- Class II is moderately toxic (five to 30 grams is toxic).
- Class III is slightly toxic (greater than 30 grams is toxic).
- Class IV is practically non-toxic.

WHO has a similar classification system but subdivides Class I into Ia and Ib, with Ia being the most toxic. In Nepal, the toxicity of each pesticide is color coded on the pesticide label: red is Class I; yellow is Class II; blue is Class III; and green is Class IV. Most farmers, however, are unaware of the implications of the color coding.

Fourteen of the pesticides most harmful to people and the environment, namely chlordane, DDT, dieldrin, endrin, aldrin, heptachlor, mirex, toxaphene, lindane, BHC, phosphamidon, methyl-parathion, monocroptophos, and organo-mercury fungicides, were banned when Nepal signed the Stockholm Convention in 2001. Recently, endosulfan was also deregistered in Nepal.

In 2009, the most popular insecticides on vegetables were in Toxicity Class I (phorate, monocrotophos, methyl-parathion) with the exception of endosulfan which was in a Toxicity Class II but is highly toxic to fish. Thus, Nepal is gradually moving towards less toxic pesticides as the government is actively preventing registration of the more dangerous pesticides.

Of 107 different commercial pesticides assessed in 2010, 2% were Class I; 36% were Class II; 42% were Class III; and 2% were Class IV. The most common pesticides in 2009 were phorate and monocrotophos. Among vegetables, eggplant had the highest pesticide usage with 67% of farmers spraying eggplant crops more than eight times and 25% spraying four to six times per crop. The most frequently applied pesticide to eggplant was endosulfan (Class II). Eggplant was followed by cauliflower, bitter gourd, and potato for high pesticide usage. Tomato had five to six applications of endosulfan per crop to ward off Heliocoverpa fruit borer; mancozeb fungicide was used for late blight. After phorate monocrotophos, the most common pesticide was m-parathion. Phorate was the most common pesticide used on flowering cucurbits. Endosulfan, phorate, m-parathion, and monocrotophos are now banned in most countries. Persistent Organic Pollutants (POPs) were banned in April 2001, and quinalphos, ethion, monocrotophos, and phorate were prohibited on tea in May 2005 after Nepali tea was black-listed for pesticide residues by the European Union.

In 2012, the Pesticide Registrar began removing endosulfan, carbofuran, methomyl, and phorate by not allowing them to be re-registered due to high toxicity. There are inspectors who are responsible in their respective districts to regulate pesticides through acts and regulation. However, some inspectors allow pesticides to be used even if they are Class I products. In Nepalgunj, Department of Agriculture extension agents recommend application of carbofuran and phorate granules for maize borer and to protect against white grubs even though these chemicals are no longer on the pesticide registrar. Farmers still request banned chemicals which continue to be available. Though these are the most toxic, they remain in demand as farmers are keen for quick action to eliminate the insect pests. Less toxic pesticides take several hours to kill an insect. However, an Agrovet complained that because endosulfan is being banned in India, along with the most toxic red coded varieties, the current supply is drying. The most popular insecticide in an Agrovet shop in Birendranagar, Surkhet is Nuvan (dichlorovos), a Class I insecticide. The fact that India is banning the most toxic pesticides is expected to force Nepal to do the same. Agrovet shops will have no more supply, nor will the smugglers.

Banning a pesticide can be a lengthy process. The GON Pesticide Committee may decide to ban a particular pesticide but gives the banned product a grace period of one to two years before the ban is effective. Banning means that importation permits cannot list the banned pesticide. For example, endosulfan is banned, but it will not be banned from import permits until 2014. This is to allow the company to sell its remaining stock. After that, the importer cannot list it. The banned pesticide could then be smuggled into Nepal where it becomes the responsibility of the Pesticide Inspectors.

Consumption of pesticide is high in developed countries but pesticide poisoning cases are more common in developing countries due mainly to lack of knowledge. Additional reasons are because Nepalese farmers tend to choose more toxic pesticides, rarely use personal protective equipment (PPE), apply pesticides unnecessarily and frequently, have few alternatives to pesticides, and because the pesticide rules and regulations are not enforced

Current government recommendations and research also appear to be adding to the confusion. The Department of Agriculture within the Ministry of Agriculture produces an Agricultural Diary which lists the crop husbandry practices for the common crops in Nepal and is updated each year. Each extension agent is given a copy for their reference, and the current issue recommends phorate, carbofuran, demeton-S-methyl (Metasystox), and endosulfan. The first three are Toxicity Class I and, as mentioned, endosulfan is a Class II. The Pesticide Registrar said it will be banned in Nepal next year.

Moreover, a book produced by the Entomology Division of the Nepal MOAD in 2011 titled "Management of Economically Important Agricultural and Household Pests of Nepal," by Ram Babu Paneru and Yagy Prasad Giri, recommends many bio-pesticides but also some dangerously toxic varieties such as:

1. Endosulfan (Toxicity Class II) for tomato fruit borer, eggplant fruit and shoot borer, cutworms, and rice bug;
2. Dichlorvos (Toxicity Class I) for diamond back moth, fruit flies, whiteflies, and wooly apple aphid, and to be injected into banana pseudostems and stem borer holes in mango trees;
3. Carbofuran and phorate granules for rice stemborers, brown planthopper, white grubs, wooly apple aphid, brown citrus aphid, and citrus psyllid;
4. Aldicarb (Toxicity Class Ia) granules for wooly apple aphid, brown citrus aphid, scales, citrus psyllid; and
5. Disulfoton (Toxicity Class I) for wooly apple aphid.

These highly toxic products were recommended by the Entomology Division just two years ago.

It is clear that farmers prefer more powerful pesticides; some safe products such as Bacillus thuringiensis (Btk), a bacterium harmless to humans, have not been re-registered due to low sales. There have been some attempts to encourage the use of safer pesticides. The Registrar mentioned a new safe rice insecticide that was being registered: chlorantraniliprole (Ferterra G or Coragen SC). In NARC, the Entomology Department is testing spinosad (trade name Tracer) which is Toxicity Class III. KISAN, in conjunction with CSISA and the IPM IL, will promote the registration and use of safer bio-pesticides by training farmers in their usage, thereby creating a demand. Agrovet dealers respond to demands as they do not want their products to exceed the expiry dates whereupon the product has to be destroyed or returned.

2.3 PESTICIDE APPLICATION KNOWLEDGE AND USE OF PROTECTIVE CLOTHING

Pesticides are applied using nine to 16 liter capacity knapsack sprayers. The cheapest models are made of plastic imported from India and China. The more sturdy models are made of stainless steel but cost more. The plastic types are prone to leakages as the screw top is not water tight. This places the farmer who uses this sprayer in grave danger of being poisoned.

Farmers are not likely to wear sufficient PPE and may walk through the spray path with bare legs and no shoes. The US EPA has developed guidelines of PPE needed to protect applicators from the hazards of applying pesticides. The more toxic the ingredient, the more PPE is needed. There are different requirements for dry formulations than for liquid ones. Dry formulations pose a hazard of entering the lungs. Farmers applying a safer pesticide in Toxicity Class III to IV would need only shoes and long pants to comply. If possible, farmers should also wear a waterproof apron or sheet of plastic tied around their waists as they walk through the spray path. Worldwide, it is generally known that farmers are averse to wearing uncomfortable PPE such as goggles, face mask, rubber gloves, and a plastic apron, let alone aspirators that are needed for the most toxic pesticides.

2.4 PESTICIDE REGULATION

The Pesticide Act was passed in 1991 and led to the governing Pesticide Rules and Regulations, passed in 1994. The Pesticide Act provides legal authority but the Pesticide Committee develops the Rules and Regulations to serve as guidelines to remove the most hazardous pesticides from use in Nepal. The Food Act of 1966 and Food Regulation of 1970 established Maximum Residue Limits (MRLs) for pesticides in food products but are limited to cereals, pulses, processed water, and infant food. No MRLs have been set for vegetables yet. These regulations focus mostly on the need for licenses to import, formulate, sell, and for commercial applicators. The Pesticide Act established the Pesticide Committee that is advised by two subcommittees (one technical and one legal) that review applications to import. The Committee is composed of members from various ministries, the Pesticide Association of Nepal, scientists, and consumer groups for the purpose of discussing pesticide related issues, and defining its functions, duties, and powers.

The Committee is mandated to:

- Advise the government in the formulation of national policies regarding pesticides;
- Maintain coordination between private and government sectors in the production and distribution of pesticides;
- Encourage private sector investment in the pesticide industry;
- Regularize or control the quality of pesticides produced by the industry operated under private or government sectors; and
- Set standards for pesticide quality.

Agrovet licenses, which are required to operate a business selling pesticides, are issued by the MOAA Pesticide Registration and Management Division and must be renewed every three years. This office is managed by the Pesticide Registrar.

Pesticide Registration Office. Achyut Prasad Dhakal is the present Pesticide Registrar for agricultural products in the Department of Agriculture. He explained the procedures. Registration of a product costs Rs 2,000 and is required for each formulation and brand of pesticide. Requirements include evidence of foreign registration certificate, three copies of original label of pesticide to be registered, authorized dealership, efficacy data, residue analysis, eco-toxicological data, summary of intended use pattern, and need in Nepal. Labels and leaflets for domestic formulators, producers, and importers must be in Nepalese. The Pesticide Act also created Pesticide Inspectors (PIs) for all 75 districts. The PIs represent the enforcement arm of the government in monitoring pesticide sales, storage, quality, use, and disposal. The duties of PIs are to inspect the premises of each reseller, wholesaler, importer, and formulator. Part of their duties is to advise the farmers on safe practices and use of pesticides. The Pesticide Committee has the power not to allow the import, sale, and use of pesticides deemed to be too toxic or have negative effects on the environment. The Pesticide Committee may cancel a license if the terms and conditions of that license are not followed.

To import a pesticide in Nepal, a local company should obtain a license to import. Pesticides are mainly imported from India, China, and Thailand. The requirement is that the product should be registered in the country where it was made or formulated. A pesticide is registered only for permitted use on a specific crop, not for specific pests as the US EPA requires. If the source of the pesticide is in Nepal, such as a cultured bio-pesticide, the company has to show data from field trials on its efficacy. Registration for each pesticide is renewed every five years. There are 29 bio-pesticides registered but all come from outside of Nepal and thus only have to be registered in their own country. The Pesticide Registrar is considering offering reduced registration fees to bio-pesticide manufacturers to support local business and to develop safer products. There are now five formulation plants in Nepal that are mostly fungicides and ten licenses have been given to Professional Pest Control operators who do residential and commercial urban pest control. There are currently 67 pesticide importers who are actively engaged in the market. These pesticides are making their way to the 8,551 registered pesticide retailers (Agrovets) throughout Nepal, though most are in Nepalgunj which is adjacent to the border with India. As part of a retailer's license, the owner needs to take a three-day training class which, according to the Director, is not long enough.

Nepal's agreement to International Treaties. Nepal is signatory to the Stockholm Convention, which bans the most persistent pesticides; Basel Convention, which protects vulnerable countries from unwanted hazardous waste imports; Rotterdam Convention, which requires prior informed consent for disposal of outdated, obsolete chemicals); and follows the FAO Pesticide Code of Conduct.

The Director of Plant Protection represents Nepal in Asian Regional FAO meetings on pesticide management. The last meeting was held in Delhi and the next one will be in Nepal in October 2013. During the meetings, the members share notes on what problems they are having in registering pesticides and which ones are being banned. There are 75 government inspectors, one per district, who visit the Agrovet shops routinely to ensure that FAO guidelines are being followed in how they manage the shop. For example, inspectors examine whether a product is being sold that has been repackaged without proper labeling or in unsafe containers. Food should also not be sold in the same room and the product must be neatly stacked on shelves. Open bags of pesticide in the shop are not permitted. The same staff visits the various areas and takes note of pest outbreaks.

Challenges in Enforcing the Regulations. Pesticide abuse occurs when Nepalese traders go to India, purchase pesticides, then smuggle them back into Nepal. There are also Indian traders who smuggle pesticides into Nepal and go to villages to sell them. A person can ride over the border on a motorcycle, purchase the pesticide, put it in his backpack, and drive back without anyone stopping him. Some big cities sit on the Indian border and crossing only takes 15 minutes.

1. Nepal Drug and Poison Information Center

"Due to the burgeoning cases of poisoning in the country, the Nepal Drug and Poison Information Center (NDPIC), a private organization, was established in July 1997, operates as a sister center to the Central Ohio Poison Center in the United States. The mission of the NDPIC is to promote the highest standard of drug and poison treatment information to health care providers and to communities in Nepal. The information is provided by a pharmacist trained in clinical pharmacology and toxicology with the help of board certified clinical toxicologists from the United States. The NDPIC serves as a specialized center for education, prevention, and treatment recommendations for any poisoning exposure or hazardous materials events as well as drug information. It operates 24 hours a day, seven days a week. It maintains a dedicated poison hotline." (Lohani, 2013)

In a study of suicide by pesticide at Chitwan Medical College, endosulfan was found the most lethal agent with 28% fatality (Lamsal, 2013). Some 31% of all suicidal deaths in Nepal between 1999 and 2000 were due to poisoning. Organo-phosphates were the most common pesticides chosen for suicides. All who drank m-parathion died. None of the patients who died were exposed to cypermethrin pesticides, a more commonly used insecticide today in Nepal. Endosulfan was banned in 1998 in Sri Lanka after reports of 50 patients successfully committing suicide by poison. Three years after banning, the number of endosulfan deaths fell to three. Therefore, banning the most dangerous pesticides can save lives.

Lohani et al. (2013) (see Table 3) reviewed reports of five hospitals between 2007 and 2011 and found that there are more than 3,000 cases of pesticide poisoning per year. The majority (70%) are suicides committed mostly by women (61% of suicides). On average 76% of deaths from pesticides were classified as occupational (occupational can mean farmers applying them to their fields), while 740 were accidental poisonings. Insecticides were implicated in 74% of pesticide poisoning cases. Thirty-one percent of victims were aged 20 to 29; followed by 21% aged 30 to 39; and 19% of those aged zero to nine years old. The youngest were most likely accidental poisonings due to parental neglect in not securely storing open pesticide which was then drunk by children.

Table 3. Pesticide Poisoning Cases in Nepal from Five Hospitals, 2007 – 2011

	Unit	2007	2008	2009	2010	2011	Average
Reason							
Accidental	%	26	22	22	16	19	22

Table 3. Pesticide Poisoning Cases in Nepal from Five Hospitals, 2007 – 2011							
	Unit	**2007**	**2008**	**2009**	**2010**	**2011**	**Average**
Suicidal	%	69	72	67	72	69	70
Occupational	%	1.7	2.1	2.4	2.2	2.5	2
Homicide	%	0.3	0.3	0.8	0.9	0.9	1
Unknown	%	3.5	3.6	7.1	5.9	8.4	6
Death	%	6.4	7.7	5.9	5.1	5.2	6
Death	No.	191	231	201	172	181	195
Pesticide implicated							
Insecticides	%	70	65	65	64	57	64
Rodenticides	%	14	20	18	18	22	18
Herbicides	%	7	8	10	12	12	10
Fungicides	%	2	1	2	2	3	2
Gender							
Male	%	37	40	39	40	39	39
Female	%	63	60	61	60	61	61
Age in Years							
0 – 9	%	19	21	21	17	18	19
10 – 19	%	22	18	15	15	18	18
20 – 29	%	31	28	30	34	34	31
30 – 39	%	19	21	20	24	20	21
40 – 49	%	7	10	12	8	9	9
>50	%	1.8	2.2	0.6	1.5	1.7	2
Total	No.	3158	3228	3601	3566	3694	

Lohani et al, 2013

2.5 PESTICIDE USAGE IN THE IPM CONCEPT

The GON wants to declare IPM as a policy for agricultural pest control. A parliament vote is required for passage of the policy; however, due to political deadlock, parliament has not met frequently enough to approve. The National IPM program has been active for 15 years. IPM training curricula have been developed for rice, vegetables, and fruits. The National IPM program has been funded by Norway but this funding will end soon. FAO oversees the IPM program but needs external funds. The GON or another donor will need to step forward to continue funding the program. Adoption of IPM practices, if followed, will reduce reliance on pesticides, encourage lower risk products, conserve beneficial arthropods, and raise farmers' knowledge of pests, the agro-ecosystem, and the environment. This will lead to safer food and fewer poisonings nationwide. IPM started in 1997 with support from FAO, and is active in 62 of the 75 districts; there are 131 IPM groups and 3,667 farmer field schools (FFS) who have trained 70,000 farmers. There are societies of FFS trained farmers who are doing other activities as well, such as obtaining credit and engaging in group marketing. There are district, regional, and national IPM Farmer Associations and even associations of FFS trainers. There are now year-long FFS that involve several crops so the farmers attend trainings all year. Even non-IPM farmers can join. The village based FFS act as a counterbalance to normal pest control training which focuses on use of pesticides. FFS teaches farmers alternative methods and has become worldwide in scope since its initial success in

Indonesia in the late 1980s. IPM is operated purely as a training program and does not develop new IPM technologies. IPM IL is doing this for horticultural crops.

The IPM program is now training farmers to acquire marketing skills and make annual plans on a community basis on what crop, variety, and where to grow each year. The program is promoting a new movement to market IPM produce as being healthier since it is grown with fewer and safer pesticides. Since farmers find that organic certification is costly and of too high a standard for Nepal, some farmers are marketing their vegetables saying that there is only minimal pesticide usage. FFS groups work together to ensure that all farmers follow IPM practices. In the market place they put up a banner advertising their low pesticide produce. There is also an effort to educate school youth in understanding IPM; contests have been held to generate enthusiasm. Youth go door-to-door advising neighbors of more healthy foods and to let them know they can arrange for home delivery. Each village will chose one crop. There is also work on livestock IPM. This program is active in 62 districts.

Microbial-based pesticides avoid all of the negative consequences that synthetic pesticides have. They have not been embraced by farmers as there is not enough demand and supply. Agrovets don't always carry them since there is little demand. Famers haven't been educated and therefore don't always realize the benefit. There is an issue of shelf life with microbials under tropical conditions as they are living organisms. They can still be effective for one year if stored in a cool location. There is some talk of farmers producing their own microbials from the bio-control centers; however, these centers are not equipped or trained to perform this useful function. There is even a farmer who started a business in Chitwan producing Metarhizium, a fungus that kills white grub larvae in the soil.

The 2013 Agricultural Diary is a pocket book listing crop husbandry practices for all the key crops in Nepal. It is produced by the Department of Agriculture and is given to extension agents to extend pesticide recommendations and other control measures such as pest resistant varieties, bio-control agents, and cultural controls. It is updated each year. What is glaringly missing is crop monitoring protocols for farmers to make informed decisions on when to use pesticides or other control practices based on pest densities. In other words, for each pest, extension agents and farmers must determine what population densities are likely to cause yield losses above the cost of control. These decision guidelines are called economic thresholds (based on a known pest-yield loss relationship) or action thresholds (based on experience). These are not given in the Agricultural Diary, which is the source of information for the extension service, or in the Entomology Division book, "Management of Economically Important Agricultural and Household Pests of Nepal," by Ram Babu Paneru and Yagy Prasad Giri, July 2011. Both the Agricultural Diary and the book are key sources of technological information to manage pests on all crops.

2.6 PESTICIDES IN FOOD AND THE ENVIRONMENT

Like many developing countries, analysis of pesticide residue in crops, food products, soil, and water, as well as the environmental effects of pesticides have not been systematically studied and monitored in Nepal. There is, however, a unit in NARC in the Department of Food Technology Control and Quality that can take samples of pesticides in Agrovet shops and have them analyzed to ensure that the pesticide is the one listed on the label along with the correct dosage, ±5%. The Gas Liquid Chromatograph (GLC), a laboratory instrument that detects small quantities of pesticides from samples of produce, is not operating now due to the high maintenance costs. The government must allocate additional funds to ensure this is maintained and operational.

The Food Technology Lab began analyzing for pesticide residues in 1978 when the laboratory was set up, with FAO assistance, using Thin Layer Chromatography. From 1995 to 2005, 1,034 samples were analyzed for residues with12% of samples testing positive. Milk and tea had residues of DDT. Tolerances were established in food and residues were monitored mainly in cereals and pulses but not vegetables. The most common residues were from BHC, malathion, and parathion. Today, there is a greater awareness of pesticide residue in tea, coffee, vegetables, and honey. Tea has had the most pesticide usage, up to 25 applications per year. CTC (leaf tea) tea is mainly purchased by India, while orthodox tea is often sold abroad. India now requires tea to be IPM certified or they will not purchase it. Honey samples were taken in vegetable producing districts where the source of nectar was crucifers. Samples were sent to Bangalore for analysis. No residues above the detectable level of 0.005/ppm were detected.

A small sample of vegetables was analyzed for pesticide residues by the Plant Protection Directorate in 2010. As seen in Table 4, residues of the fungicide mancozeb exceeded EPA and FAO threshold levels in both potatoes and tomatoes. Those of the insecticides cypermethrin and m-parathion on potatoes did not.

Table 4. Comparison of pesticide residues detected on potatoes and tomatoes in the marketplace in Kathmandu compared to EPA and FAO minimal tolerance levels*

	Potato		Tomato	
Pesticide	EPA tolerance level in ppm**	Levels detected in Nepal in ppm	EPA tolerance level in ppm	Levels detected in Nepal in ppm
Mancozeb	0.2 (FAO)*	0.45 – 4.8	4	1.48 – 8.6
Cypermethrin m-parathion	0.1	0.0017	0.5 (FAO)**	0.042

**Data from the EPA* http://www.ecfr.gov/cgi-bin/textidx?SID=b684441d7f3267d894c77321b2517ee8&node=40:25.0.1.1.27&rgn=div5#40:25.0.1.1.27.3.19.29

***Data from the Department of Food Technology Control and Quality when tolerance levels for the pesticide on the particular vegetables did not exist*

One study commissioned by the NGO Pro-Public showed significant pesticide levels in the soil, but there are few studies charting the effects of pesticides in the environment.

2.7 RESULTS OF VISITS TO AGROVET SHOPS

In 1995, the GON's Agricultural Inputs Corporation stopped purchasing bulk quantities of pesticides, allowing the private sector to perform this function. This stopped a lot of over-purchase and the need to dispose of outdated and obsolete pesticides. Agrovets are the most common source of information for farmers on what pest control practices should be employed and most often the farmer is asked to purchase a pesticide. One Agrovet owner we interviewed said that half the farmers come in looking for a particular pesticide while the other half wanted to know which one to use. Unfortunately, Agrovet stores are not common in rural areas; therefore, pesticide usage is less than in more urban areas. Two thirds of the population lives in rural areas.

The most popular insecticides are a mixture of chlorpyrifos and a synthetic pyrethroid, such as cypermethrin. Both of these are Toxicity Class II. The pyrethroid is developed from a household fly spray which stuns flies instantly so people can see the effect immediately. Chlorpyrifos is slower acting as are most insecticides and the fly will die in a few hours. But most farmers want to see an immediate effect. This is a misconception that needs to be addressed in the training program. Agrovet stores carry many brands of the same pesticides. Literacy is low among farmers, thus they are often unable to read the labels indicating that the products are very similar or the same. Farmers also prefer small 50 to 100 milliliter containers because they are primarily using them on vegetables in small plots. Visits to Agrovet shops in Nepalgunj and Birendranagar indicated that pesticides were generally for sale in one-liter containers. Agrovets will not carry microbial or bio-pesticides as they do not sell well because farmers have not been trained on how to use them. Microbial pesticides are also slow acting. There is demand for stronger pesticides with immediate results on pests. Unless the impact on pests is instantaneous, farmers are known to attribute that pesticide and the Agrovet as ineffective and will go to another Agrovet shop next the time. Clearly, the popularity of the mixture of pyrethroids with chlorpyrifos can be attributed to rapid pest elimination that farmers prefer.

The prices of pesticides of small containers versus large containers and different concentrations were compared (see Table 5 below). Farmers purchasing smaller containers of pesticides and formulations of lower concentrations pay more money per milliliter or kilogram. For cypermethrin, purchasing the 100 ml bottle of 25% concentration results in a 58% savings over a 50 ml bottle of 10% concentration. A farmer purchasing the 10% formulation in a 100 ml bottle saves 25% over the smallest container. Even *Trichoderma* is more expensive in a smaller container. A farmer saves 63% if he purchases 500 g instead of 100 g. There are exceptions to this trend; for example, carbendazim costs slightly more per milliliter or gram in the larger container (take note that 1 ml = 1 g).

Table 5. Prices of Concentrated Pesticides and Potential Savings

Pesticide	Concentration	Size	Price (Rs)	Price per ml/% (Rs)	Savings (%)

Table 5. Prices of Concentrated Pesticides and Potential Savings

Pesticide	Concentration	Size	Price (Rs)	Price per ml/% (Rs)	Savings (%)
Cypermethrin	10%	50 ml	60	0.12	---
	10%	100ml	90	0.09	25%
	25%	100ml	130	0.052	58%
Trichoderma		100g	400	4	---
		500g	750	1.5	63%
Carbendazim WP	50%	25g	35	0.7	---
Carbendazim EC	50%	100 ml	150	0.75	+6%
Imadacloprid	20%	200 g	180	0.9	---
Dichlorvos Nuvan	80% EC	100 ml	120	1.2	---

Source: Data from visits to agrovet shops in Nepalgunj and Birendranagar July

Agrovets appear to be under pressure to promote high toxicity pesticides to maintain their business. If the recommended pesticide works, then the farmer will return to that Agrovet. The most popular insecticides are the more toxic varieties. One owner said the most toxic red labeled products are in higher concentrations and are being banned in India, so it is likely they will be banned in Nepal as well. However, the Chinese brands have no color code on the label and they continue to make the cheap pesticides regardless of the toxicity. Adding to the confusion is the fact that very few pesticide labels and instructions are in the Nepali language.

Very few pesticides with a green label were found in Agrovet shops and these were mainly fungicides, for example the mixture of carbendazim (12% + mancozeb 63%) or carbendazim 50%WP. No color code was noted on Chinese carbendazim 50% SC. The Agrovet shop owner did not have neem cake in stock currently. One owner said he can order it from India and get supplies in a week. The Agrovet did not have Btk and *Trichoderma* in stock either.

These pesticides are proven solutions and currently in use in other countries, including India. Ram Prasad Mainali, an entomologist at NARC, is testing some safer pesticides. He is testing Spinosad (Tracer) from Birgunj, on the border with India. Along with Spinosad, he has also tested Coragen for eggplant fruit borer. Spinosad is Toxicity Class III and is broad spectrum in action. Coragen, Toxicity Class IV, is being registered against eggplant fruit borer and farmers have said it is effective. He has also tested Emanectin benzoate 5 SG. Emamectin produced by the fungus Streptomyces avermitilis, belongs to the Avermectin family of compounds all of which exhibit toxicity for nematodes, arthropods, and several other pests. It is Class II and was registered in Nepal by Karma Chemical Co. of Kathmandu.

3. PESTS AND PEST MANAGEMENT

The following section describes the main pests found on the key crops that the KISAN Project will work on. The information was gathered during key informant interviews during the consultant's trip and from secondary sources such as the Agricultural Diary 2013, and the manual, Management of Economically Important Agricultural and Household Pests of Nepal, by Paneru and Giri (2011). The consultant drew on his experience to develop control recommendations based on IPM; no monitoring information or guidelines, such as action thresholds, were noted from any source. The consultant's recommendations for IPM-based control measures and crop monitoring protocols are in Appendix III. This information is highly useful for the impending KISAN training program as there is a lack of IPM technologies in the documents seen and interviews conducted.

3.1 RICE

Based on conversations with local agriculturalists the consultant learned that the rice plain in the areas around Nepalgunj is mostly rain-fed with supplemental irrigation from tube wells during the monsoon season; only 30% of the area is planted for a second rice crop in the winter.

The main insect pest is the yellow stemborer *Scirpophaga incertulas* which can survive the periodic flooding in the Terai. The flooding keeps out other stemborer species. Yellow stemborer is the only species that survives in deep water rice and can develop within tillers underwater as the larva can seal off its entrance hole. Damage is to kill tillers (rice stems) which normally can be replaced as the plant produces more than it needs. There have been recent outbreaks of armyworm *Mythimna separata* which is a migratory pest and can come on monsoon winds from the south. The moths descend into grasslands and rice fields and flourish in the absence of their natural enemies. Areas can be defoliated by the larvae which can lead to some yield loss. *Spodoptera litura* cutworm is a minor defoliator as is the rice leaf folder *Cnaphalocrocis medinalis*. Leaf folder is important in swampy locations due to high nitrogen soil. Both would rarely cause yield loss. Grasshoppers, at times, become very abundant; however, based on descriptions, it is likely the grasshoppers are katydids with long antennae. This is surprising as katydids are effective egg predators of rice insect pests (stemborer, rice bug). Farmers mistakenly believe that these insects can cause yield loss, thus they overuse pesticides.

Both brown planthopper *Nilaparvata lugens* and whitebacked planthopper *Sogatella furcifera* have been reported (these two species are often mixed up by farmers and even extensionists). The brown planthopper is the greater pest because it feeds at the base of plants where it is more difficult to reach by knapsack sprayers and has a higher reproductive potential than whitebacked planthopper which feeds on the canopy, much like the green leafhopper. Brown planthopper can cause hopperburn and kill off plants in small patches. Brown planthopper is more of a pest in double-cropped rice where heavy amounts of insecticides are used – insecticides kill off its natural enemies leading to resurgence. There appear to be no resistant varieties to either brown planthopper or green leafhopper. The green leafhopper can be abundant but it does not cause damage. The hot season (April to May) brings about high mortality in rice insects, specifically the brown planthopper.

Rice bugs are abundant in isolated or late-planted fields. In other regions they feed on the grains of grassy weeds before rice is planted. *Echinochloa* grass is the most preferred. They are only found in areas where rice fields are small and out of step in terms of maturity with surrounding fields. Rice bugs readily disperse to the isolated field and cause significant damage. Rice bugs are blamed for causing unfilled grains when in reality a crop normally has 10% to 15% unfilled grains. It is also blamed for black spots on grains, but there are free living fungi that can cause such damage. Therefore, rice bugs' status as a pest is questionable outside of the small fields that flower out of phase. Such fields attract high densities of rice bugs. Farmers tend to plant their fields simultaneously so rice bug numbers are diluted by the large rice area. Rice bugs cannot build up on grass before the rice crop, as it did in the past, due to the large area of rice. In Nepal, rice is both irrigated and rain-fed but the planting time is the same and the whole crop can be transplanted generally within a month; therefore rice bugs cannot build up over time. Tiger beetles are considered to be their major predator but studies elsewhere show that egg parasites and egg predators have a stronger effect combating rice bugs. Rice hispa beetle *Dicladispa armigera* is rarely abundant enough to cause loss. There is no gall midge, caseworm, defoliating worms, or whorl maggot in the Terai.

Among the insect pests there is a scarab beetle in the genus *Heterorynchus* whose larva and adult tunnel into the roots of seedlings in rice nurseries. The adult defoliates plants. These beetles may originate in the forest. Also affecting rice nurseries are mole crickets and field crickets, but these are of minor occurrence. There are also mealybugs that are confined to drought-prone upland rice in the Mid-Hill region. It is unlikely that the project will focus on upland rice.

Bacterial leaf blight, sheath blight, blast, brown spot, and foot rot are the key rice diseases. The latter two occur infrequently; foot rot was not mentioned in the Agricultural Diary. There are no viruses, probably because rice is not grown year round and the hot season from April to May breaks the cycle of the green leafhopper vector. Among the other diseases, only bacterial leaf blight is not a fungus. Normally, plant pest resistant varieties are developed for the common rice diseases. That may not be the case in Nepal. The main line of defense against rice plant diseases is to sterilize the seeds and to use a fungicide seed treatment. Most of the diseases are exacerbated by the rainy season and warm temperatures. Blast is facilitated by warm days and cool nights when dew is present for eight hours allowing the spores to germinate and infect the plant. Resistance efforts against blast are not often durable – however, farmers can minimize its severity by not overusing nitrogen fertilizer.

Information for IPM rice training can be found in the book by Reissig et al (1986) which can be downloaded by Google Books free of cost.

3.2 MAIZE

Maize cultivation is a way of life for most farmers in the hills of Nepal as it is a staple crop cultivated as food, feed, and fodder on the sloping rain-fed uplands. Maize is grown under rain-fed conditions during the summer (April to August) as a single crop or relayed with millet later in the season. In the Terai, inner-Terai valleys, and low-lying river basin areas, maize is also grown in the winter and spring with irrigation. Maize is mainly grown in the hills and does not follow upland rice.

The main insect pest is the maize stemborer *Chilo partellus*. It is probably uneconomical to control with granules as recommended in Nepal's Agriculture Diary 2013-2014. There is more to learn about the severity of the stemborer – new technologies, such as the foliar spray chlorantraniliprole with longer lasting systemic properties, will provide additional insight into potential ways to control stemborer populations. As this is mainly an upland crop, there are a number of soil-borne pests. Certainly there are seed-in-soil pests such as ants, crickets, and termites which reduce plant stand. However, a stand can also suffer from low germination. One way to compensate low germination is to increase the seeding rate.

White grubs are early season soil insects whose larvae live in the soil for up to several years. There are many species of white grubs that feed on maize roots, which can kill the seedlings. Most adults emerge from the soil in the first rains and fly to trees to mate. Adults may feed on the crop but typically inflict minor defoliation. They lay eggs in the ground, particularly grasses. Larvae feed on roots so when a crop is seeded, the larvae concentrate feeding on young plants and can remove all the roots effectively killing the plant. More mature crops are not as vulnerable as they have a larger fibrous root system; the larvae may still feed on the roots, but are less likely to kill the crop. Cutworms and armyworms mainly attack the younger crop as well, often after weeding. Grasshoppers can defoliate the crop, but maize can withstand up to 15% defoliation. If there is lower rainfall at tasseling, the corn leaf aphid can become more of a threat to maize crops as rainfall is a key mortality factor for these aphids.

The main diseases are wilt (damping off), Northern maize leaf blight, Southern maize leaf blight, stem rot (Fusarium), sheath blight, ear or cob rot, and smut. Hybrid maize, such as Pioneer, has high levels of resistance to most of these fungal diseases. Improved open-pollinated varieties have moderate levels of plant diseases, but the local varieties have the most, particularly in the rainy season. Some 10% of farmers use hybrids, 20% to 30% use improved open-pollinated maize, and the rest use traditional varieties. As hybrids are short in height, the cobs can be easily reached by jackals and porcupines. Many of the diseases are best prevented by sterilizing the seed and treating the seed with fungicide.

3.3 LENTIL

Nepal was the sixth largest producer of lentil in the world in 2011 (following Canada, India, Turkey, Australia and the US) with a 36% rise in output, growing nearly 5% of the world's lentils. The common variety grown in Nepal is Masoor, which has brown skin and is orange inside. Farmers are shifting towards pulses, particularly lentils, due to their high value and export potential. Commercial production is concentrated in the Terai where more than 90% of the lentils are grown mainly as a winter crop. Lentils are more drought-tolerant and require less irrigation than wheat. Farmers obtaining good seed from high yielding varieties will be vital to increasing production. There are a number of pests which limit its yield potential, the main ones being Heliocoverpa pod borer and Botrytis grey mold. Other insects that affect lentils are a defoliating hairy caterpillar and aphids; diseases include vascular wilt, collar rot (damping off), and rust. At harvest, Bruchid weevils infest the lentil crop in the field and are carried into storage where, if unprotected, can cause serious damage to the lentil seeds. If farmers plant lentils on residual moisture after rice, many of these soil borne diseases would be controlled by the flooding during the rice crop. Tractor drawn, three-row seeders can come in when the paddy soil is still wet and drop the seeds and fertilizer. Upland weeds are also controlled with flooding.

3.4 THE PROMISE OF VEGETABLES

KISAN is focusing on training farmers on vegetable production following IPM IL technologies of crop culture and IPM. This section presents background information relevant to this planned activity. The GON has undertaken a vegetable promotion strategy, especially among smallholders, to harness comparative advantages of vegetable production and marketing with the ultimate goal of reducing poverty. The cost of production is shown for five popular vegetables, listed in Table 6 below. It shows the cost of pesticides is quite low in most crops except tomato (Pokhrel, 2010). Though they have the highest profits, tomatoes also have the most expensive inputs. The least profitable vegetable was cabbage. The most profitable was tomato at Rs 4.38 per ropani; cucumber Rs 1.61; cauliflower Rs 1.88; while the other three crops were less than Rs 1. In Asia, a benefit-to-cost ratio should be at least 2, meaning that bearing the expenses will lead to twice the income.

Table 6. Farm Production and Marketing Costs and Benefits in Hemja (Rs per ropani)

Particulars	Potato	Cauliflower	Cabbage	Tomato	Cucumber
Poultry manure/FYM	5,000	1,224	750	4,924	--
Fertilizers/micronutrients	197	375	375	652	46
Seeds	1,250	150	110	758	200
Pesticides	209	120	600	3,060	155
Plastic house: polyethene			9,599		
Plastic house: bamboo			4393		
Plastic house: rope etc.			663		
Labor	2,100	2,423	2,423	8,181	4,121
Transport					750
Total expenses*	9,765	5,102	5,058	40,413	4,872
Net profit	7,584	9,597	3,442	117,162	7,828
Benefit: Cost ratio	0.78	1.88	0.68	4.38	1.61

Source: Pokharel, D. M., 2010. Comparison of farm production and marketing cost and benefit among selected vegetable pockets in Nepal. The Journal of Agriculture and Environment, Vol. 11, June 2010.
**Note: Not all expenses are shown.*

3.4.1 Tomato

Tomato is one of the major commercial vegetable crops and is widely grown both in the plains and hills of Nepal. In the hills, tomato can be produced successfully in two growing seasons, spring and rainy season. Rainy season tomato is a profitable enterprise for hill farmers as the supply from Terai is constrained by high temperature, low fruit set, flowering, bacterial wilt, etc.

Tomato production during the rainy season in open field conditions is very difficult and production tends to be low. Tomato production inside plastic houses during rainy season, however, is a new technology to farmers in the western hills and has been adopted by IPM IL. Research has shown that farmers can make lower cost plastic covers for their tomato culture. KISAN will train farmers to adopt this technology. Farmers following IPM IL technologies not only achieve higher production but better pest control and higher profits. Plastic house technology and arrival of hybrid varieties have increased the possibility of tomato cultivation in rainy season in high hills. Current tomato varieties being promoted by various entities fall into the following categories: All Rounder, Bisesh, Dalila, Manisha, Srijana, Suraksha, Trishul, US-04, NCL 1, Pusa, Ruby, and Monprecos. Specifically, USAID's IPM IL project promotes the following varieties: Srijana, Bisesh, Dalila (Medium Fruit), Grescco-1, CL – 1131, Care-Nepal (Small Fruit), BSS-20, Themes-2, Trisana, and Winsari (Large Fruit).

In 2012, 317,657 metric tons[2] were produced, placing it in second place in Nepal in terms of vegetable production. Vegetable production can pay household expenses for an average of five months. The Terai farmers sell the most vegetables in terms of tonnage; however, tomato in the hills earns the highest prices due to the ability to continue cultivation in the rainy season. Heat, early and late blight, and bacterial wilt susceptible varieties cannot be cultivated during the rainy season. In addition to blight and wilt diseases, high ambient temperatures can reduce fruit set and yield. In response to these problems, tomato farmers have been turning to cultivation under a plastic house, which provide some protection from pests and diseases. In a trial, some varieties including LTH-61, BL-410, and NSITH-162 had over 99% plant survivability indicating these varieties are suitable to the environment and resistant to bacterial wilt and other pests and diseases.

Another factor determining competitiveness of off-season vegetables is productivity. In tomato cultivation, farmers produced 21.5 tons per hectare in Palpa, inland from the Terai. Productivity was higher in the cooler Kaski, in the mid-hills, where farmers grew approximately 36.5 T per hectare. Higher net profit could be observed in cauliflower (Rs 12.1 per kilogram), followed by tomato (Rs 8.2 per kilogram) and cabbage (Rs 4.2 per kilogram) at producer level of all of the vegetables grown in Nepal, the greatest amount of pesticides used remains tomatoes, based on crop area (Table 7).

Table 7. Pesticide Ranking by Usage (per total area planted in Nepal, 2009 – 2010)

Ranking	Crop	Pesticide Value ('000Rs)	Area planted (ha)	Pesticide usage (Rs/ha)

[2] Source: http://www.ekantipur.com/2011/02/16/headlines/Nepal-produces-veggies-worth-Rs-45-billion-annually-Report/329674/

Table 7. Pesticide Ranking by Usage (per total area planted in Nepal, 2009 – 2010)				
Ranking	**Crop**	**Pesticide Value ('000Rs)**	**Area planted (ha)**	**Pesticide usage (Rs/ha)**
1	Tomato	283081	19724	14.4
2	Cabbage	71751	14306	5.0
3	Cauliflower	163065	33172	4.9
4	Brinjal	33467	8172	4.1
5	Cucumber	33930	8634	3.9
6	Asparagus bean	35315	11977	2.9
7	Bean	25515	10594	2.4
8	Pumpkin	6436	9757	0.7

Source: Nepal Vegetable Crop Survey 2009 – 2010. A Statistical Report. Central Bureau of Statistics, 2010

The main insect pest is the tomato fruit worm which bores through the fruit and feeds on the flowers; the leaf miner and whiteflies are less important in terms of direct damage. White flies could transmit a number of serious virus diseases, but so far only tomato mosaic virus are prevalent in Nepal and it is not serious. However, with so much interest in plastic houses, and with farmers able to grow two tomato crops per year, it is likely that new viruses will become major pests. Farming the same crop on the same plot of land will allow pests and diseases to take hold. Since farmers earn so much from tomatoes, they do not want to rotate to a lower earning crop which would be a best practice in IPM. With plastic houses they can grow year round. KISAN will encourage farmers to identify two months during which tomatoes will not be grown.

The other major problems for tomato production are: damping off, bacterial wilt, and nematodes. The IPM IL has had success in combating these three problems by growing tomatoes in tunnels, amending the soil with compost and bio-pesticides, and using wild eggplant rootstock to which high yielding tomato varieties are grafted. There are a host of bio-pesticides and bio-fertilizers that have been utilized, although no studies have determined which ones are the most effective. A review of the recommendations from iDE based on their IPM IL work is given in the following section from their packages of practices. The consultant recommends that these technologies be included in the KISAN curriculum.

Pest control starts with sterilizing the seed and ensuring the planting material is free of disease. Seeds should be soaked in either Somguard or household bleach (a 1:10 dilution of a 5.25% sodium hypochlorite solution). The seeds should be air dried after soaking them for 30 minutes. This cleans the seed of fungal spores and bacteria. Seeds are then treated with another set of bio-fertilizers by mixing one kilogram of seed in a slurry of five milliliters of molasses, which acts as a sticking agent and food for microbes, and one gram of Biohume (an additional cocktail of *Ampelomyces quisqualis, Fusarium proliferatum, Tricoderma viride, T. harzianum, Pseudomonas fluorescens,* and *Bacillus subtillis*). This ensures that the bio-agents are inoculated into the compost in the polybags. Soil for the polybags is taken from the forest top soil or solarized soil mixed with neem seed powder. The farmer needs to graft tomato seedlings onto resistant eggplant rootstock and place in polybags. Before applying compost to their seedbeds farmers must make sure that the compost is thoroughly decomposed, or they risk contaminating the field. Farmers can use Silrich, a biocomplex (*Trichoderma reesei, Aspergillus awamori, Cellulomonas uda, Pseudomonas putida*) product that can fully decompose compost in one month.

Fertilizers (per ropani) that should be applied are one ton of well decomposed FYM. 500 grams each of bio-fertilizers: Nitrofix (*Azopspirillum*), P Sol-B (*Bacillus megaterium*), K Sol-B (*Frateria aurantia*), Zn Sol-B (*Thiobacillus thio-oxidans*), S Sol-B (*Thiobacillus ferro-oxidans*), Mn Sol-B (*Corynebacterium)*, VAM (solubilizing P, Bo, Mo, Fe, Cu) *Trichoderma viride*. Then 625 grams each of *Paecilomyces lilacinus* or *Bacillus firmis* is added. Blend all bioagents into 50 kg FYM and store for 15 days in a cool, dry place. At transplanting, apply to the root zone of each transplant.

During the period of seedling establishment, Biohume 6% SL should be applied with five milliliters of water. First top dressing in one month, apply 250 grams per ropani of the same bio-fertilizers and repeat at fruit development stage. In the field, when the seedlings are transplanted next to a stake, mulch is placed in the field and hand weeded. Each week, older leaves are removed from the base of plants to prevent the spread of disease. Any leaves showing disease and rogue must be removed and burn any infected plants.

Trichoderma viride is found naturally in soil and is useful as a biological control as it has been shown to provide protection as a seed dressing or soil amendment in the control of seed and soil-borne diseases including damping off fungi *Rhizoctonia solani, Pythium, Macrophomina phaseolina*, and *Fusarium* species. When it is applied at the same time as the seed, it colonizes the seed surface and kills the pathogens present on the cuticle and provides protection against soil-borne pathogens.

Certain strains of *Pseudomonas fluorescens* belong to a group of important biological components of agricultural soils that suppress diseases caused by pathogenic fungi and some nematodes on crop plants. The bio-control abilities of such strains depend on aggressive root colonization, induction of systemic resistance in the plant, and the production of diffusible or volatile antifungal antibiotics.

3.4.2 Crucifers

The main crucifers are cabbage, cauliflower, and broccoli. Cauliflower is the number one vegetable in terms of annual production at 404,580 tons. Table 7 illustrates the high rate of profit. Cole crops, including cauliflower, cabbages, and broad leaf mustard, are the major winter vegetables of Nepal most profitable to farmers. Clubroot disease has been the most limiting factor for crucifer crop cultivation. Excess water during rainy season is not a problem in the hills as the natural slopes help water runoff. These vegetables can be produced successfully with just a few improvements such as using plastic sheets and draining excess soil moisture in the mid hills and mountains during rainy summer to autumn seasons. The cost of off-season vegetable production per unit area is generally higher than the cost of production of cereals and seasonal vegetables. The reason for higher cost in producing off-season vegetables is the use of improved/hybrid seeds, plant protection materials such as plastic, higher doses of chemicals/materials, and labor intensive cropping operations.

The main insect pests of crucifers are three defoliators, all moths: the cabbage butterfly and cutworm larvae are large while the diamond back moth is small. Another insect pest is the cabbage aphid.

Worms can be controlled with insecticides neem or chlorantraniliprole. There are pheromone-monitoring traps for Spodoptera cutworm and diamond back moth. There is also the possibility that Bacillus thuringiensis var. kurstaki or Nuclear Polyhedrosis Virus of Spodoptera litura, (Spodo-NPV) will soon be registered so they can be recommended to combat these pests. The registered Verticillium lecanii bio-pesticide or a neem product can be utilized against the cabbage aphid. All of these pesticides are selective so that natural enemies can build up on the crop.

For the diseases, club root is important in some vegetable pockets. This protozoan can linger in the soil for many years. If an infestation occurs, farmers cannot plant in that location again. Damping off is a common plant disease as are downy mildew and bacterial wilt. All of these pathogens can be suppressed with the same cocktail of microbial agents that have been recommended for tomato. The bio-fertilizers facilitate stronger growth so the plants can tolerate more damage.

3.4.3 Cucurbits

Cucurbits are important vegetable crops across the hills and Terai region. Cucumber, zucchini, bitter gourd, and sponge gourds are commonly grown. Though cucumber has a year round market, it is difficult to produce cucumber year round in Nepal. There are two major lean periods for the supply in Nepal. The first lean period extends from May to October and is characterized by high temperatures (greater than 25°C) and long day photoperiodic conditions (greater than14 hours) avoiding the excessive production of male flowers resulting in few female flowers and low yield. The second lean period is November to February, which typically has low temperatures and short day photoperiod conditions. The low temperatures during this period inhibit plant growth and can inflict chill damage on cucumbers. Plastic houses can ameliorate the problem of temperature extremes and allow longer growing seasons.

There are several insects and diseases limiting the productivity of these cucurbits. Fruit fly is considered one of the greatest production constraints in Nepal. Cucurbits are pollinated by bees so it is important not to use hazardous insecticides in the pest control program. One way to minimize killing bees is to spray in the late afternoon when the bees have returned to the hive for the night. Another option is to use selective insecticides for the other pests or none at all in the case of fruit flies which are readily controlled by mass trapping males using commercial pheromone traps in combination with mashed fruit to enhance the attraction. Destroying all damaged fruit to reduce the overall infestation is also advisable.

Plant diseases fall into two categories: fungi and viruses. Fungi are the common powdery mildew and downy mildew foliar diseases and are readily controlled if the infection is caught in time. Both are dispersed by airborne spores – covering the crop rows with plastic tunnels may prevent infection and can also stop white flies from landing on the crop. On a visit to an IPM IL site in Kajura, Banke, near

Nepalgunj, the farmers were alarmed by the white flies and virus problem on pumpkins, which is one of their cash crops. They have not been able to prevent the viruses. One control method could be to place sheets of white plastic along the edge of the plants in the rows at the time of planting to repel the white flies since they do not see the reflected light and cannot locate the crop when they disperse. Another option is to spray a high volume soil drench of imidacloprid or thiamethoxam at planting; the plant absorbs the formulation so when white flies feed they are killed. If the infestation is building up, farmers can apply buprofezin which does not affect bees. Buprofezin should only be sprayed if there are nymphs present as this insecticide will prevent them from developing into adults.

3.4.4 Eggplant or Brinjal

Eggplant is one of the three most important vegetables in South Asia. This region accounts for almost 50% of the world's eggplant cultivation. In the hot rainy season, when other vegetables are in short supply, eggplant is one of the only vegetables that is available at an affordable price for the rural and urban poor. Eggplant is cultivated on small family-owned farms, where daily sale of their produce serves as their primary cash income. The eggplant is a warm season crop, thus a long and warm growing season is desirable for eggplant production. Cool nights and short summers can hamper yields. Eggplant is a hardy plant compared to other vegetables grown, which means it can be successfully grown in very dry areas under rain-fed conditions or with minimum irrigation. In Nepal between 2009 and 2010, eggplant was grown more in the Terai (6,844 hectares) than in the hills (1,073 hectares); the Central Terai had the highest total area.

The fruit and shoot borer is the main eggplant pest, which is why pesticide use in eggplant farming is high. Eggplant is not susceptible to any viruses – the potential vectors (aphid and white fly) are only important due to their feeding damage rather than in virus transmission. Farmers can minimize aphids and white flies by installing yellow sticky boards. The epilachna beetle is the most common defoliating pest, but there are few others that attack eggplant.

The main diseases are soil-borne damping off, bacterial wilt, and nematodes which can be suppressed by grafting eggplant onto wild eggplant and amending the soil with bio-fertilizers and bio-pesticides recommended for tomato. Verticillium wilt and Fusarium wilt are also soil-borne and should be suppressed by the amended microbial agents.

4. PESTICIDE EVALUATION REPORT

USAID environmental regulations require that all USAID-funded programs that include assistance for the procurement or use of pesticides must assess risks associated with this assistance following the Pesticide Procedures described in 22 CFR 216.3 (US Government CFR 1976). At least 12 factors must be addressed according to 216.3 (b)(1)(i) (a through l). These 12 factors are normally examined in a technical analysis document called a "Pesticide Evaluation Report and Safer Use Action Plan" (PERSUAP).

USAID pesticide procedures also indicate that when a project includes assistance for procurement, use, or both, of pesticides registered for the same or similar uses by US EPA without restriction, the Initial Environmental Examination (IEE) for the project shall include a separate section evaluating the economic, social and environmental risks, and benefits of the planned pesticide use to determine whether the use may result in significant environmental impact. The rationale for a PERSUAP-type of environmental review (as opposed to a full-scale Environmental Impact Assessment) is that the affected projects are reviewed and an IEE approved for all other activities in the programs. The IEE approves Categorical Exclusions and Negative Determinations with Conditions as appropriate to each case, with deferrals for pesticide use pending completion of PERSUAPs. The other rationale is that the pesticides are used under tight management with well-informed conservation practices, guided by trained and experienced members of staff who implement actions in the Environmental Mitigation and Monitoring Plan.

The five-year KISAN Project will be training to increase productivity which will require managing pests and diseases for three field crops (rice, maize, lentil) and four vegetable groups (tomato, crucifers, cucurbits, eggplant). The consultant visited various experts to gather information for this report and met with pest control scientists at NARC, the main agricultural research institute, National Agricultural Research Institute (NARI), an autonomous agricultural research and extension agency. He also met with experienced field staff within the Agricultural Extension District Offices in Nepalgunj, Banke district and Birendranagar in Surkhet district. While in Nepalgunj he visited two IPM IL field sites under direction of iDE and CEAPRED. The first field site was in Bageshwori VDC in Banke District, and Chhinchu VDC in Surkhet District. IPM IL works exclusively on vegetables; the KISAN PERSUAP has reviewed and recommends all IPM IL pest control practices be adopted with the KISAN project. The IPM IL is limited to using bio-pesticides as per US EPA guidelines and has made no recommendations on chemical pesticide use. Please see Appendix IV.

The following is the mandated topics to review in a PERSUAP as dictated by Pesticide Procedures described in 22 CFR 216.3

a) US EPA registration status of the proposed pesticides

MOAD's Department of Agriculture and the IPM IL projects proposed a total of 45 pesticides including insecticides, fungicides, bactericides, and nematicides for crops, and insecticide/acaricides for ectoparasite control on livestock. The KISAN PERSUAP recommends 19 government-approved pesticides for crops (17) and livestock (2). These are listed in the Executive Summary of this report as well as the KISAN PERSUAP FACE Sheet. More details for the 17 PERSUAP recommended crop pesticides are found in Appendix IV. The pesticide expert also analyzed an additional 18 crop pesticides that are too toxic and are not recommended to be promoted by KISAN.. Appendix V lists the three livestock insecticide/acaricides that are recommended. Of the livestock pesticides recommended, only two are approved by the GON. Should amitraz become approved, this PERSUAP recommends that it be used under KISAN. All of the recommended pesticides are currently registered by the US EPA, and all but eight are registered by the GON. The main criteria for recommendation were that the pesticides belong to US EPA Toxicity Classes III and IV and being categorized as General Use Pesticides (GUPs) with no restrictions (i.e. they are "safe").

It is to be noted that some pesticides that have efficacy against different pest types are repeated in the lists and counted multiple times. For example, azadirachtin is approved as an insecticide/acaricide, fungicide, and nematicide and therefore is listed three times. Sulfur is an insecticide/acaricide and fungicide and is listed twice. Copper oxychloride is approved only as a bactericide and not a fungicide to limit its usage as it is very toxic to earthworms and the copper builds up in soil over time. Depending on its formulations, it can be in Toxicity Class I, II, and III. WHO classifies it as Toxicity Class III. Both the GON and US EPA list the 50%WP formulation in Toxicity Class III. Acetamiprid is listed as Toxicity Class II by GON but is not listed by WHO. US EPA lists the technical formulation in Toxicity Class II, but all the formulated products are in Toxicity Class III. Malathion is approved for ectoparasite control and is classified by WHO in Toxicity Class III but US EPA lists various formulations in Toxicity Classes II and III. The approved EC (liquid formulation) is in Toxicity Class III. Likewise cypermethrin is classified as Toxicity Class II by WHO but US EPA lists it in Toxicity Class II and III. The lower concentration of the liquid 5% EC formulation, which is being recommended, is in US EPA Toxicity Class III. Cypermethrin is listed as a restricted use pesticide RUP by US EPA as it is highly toxic to beneficial arthropods on crops. But this is not a factor when applied on livestock for ectoparasite control, so it is permitted to be procured and used i.e. registered with US EPA for similar and unrestricted use.

Of the recommended pesticides, eight are microbial or botanical and five additional microbials that are suggested pesticides are also bio-pesticides. The IPM IL, whose research forms the basis of many of the recommendations in Appendix III, emphasizes bio-pesticides (microbial based pesticides). They are in US EPA Toxicity Class III and not IV because of the irritation given by solvents and carriers and does not reflect the inherent toxicity of the microbes themselves to humans.

b) Basis for selection of the pesticides

The recommended pesticides were first selected on those approved by US EPA Toxicity Class III and IV and registered with the GON. The primary concern is the safety of the farmer who will be applying them. Nepalese farmers do not wear personal protective clothing and related equipment (termed PPE) and tend to walk in the path of the spray. Training will not likely alter this behavior; therefore, only those pesticides falling in US EPA Toxicity Classes III and IV are considered. Products that are restricted use pesticides (RUP) in Toxicity Classes III and IV are also excluded. Only one exception was made here: cypermethrin usage against ectoparasites (ticks, fleas, lice) on livestock. This chemical has the RUP classification because it is toxic to beneficial arthropods when applied to standing crops. This does not apply to livestock so it is be permitted to be procured and used i.e. registered with US EPA for similar and unrestricted use.

There are health problems with four materials in fungicides:

1. Captan is a known carcinogen;
2. Finocap has significant chronic toxicity to humans endangering reproduction and development;
3. Thiophanate-methyl is both a carcinogen and has chronic reproductive/development issues; and

4. Edifenphos is not only toxic but it is not currently registered by the US EPA.

When chemicals not registered by the US EPA, it normally means that there are safety and health issues with the pesticide and the manufacturer declined to pursue the expensive registration process. Malathion is listed as a GUP by US EPA – it is approved on livestock, but not on crops because it is an organo-phosphate and nerve poison. Using a pesticide on livestock involves much less exposure and risk than spraying crops. All of the recommended pesticides are registered and approved by GON. Efficacy, of course, is a prime consideration and all recommendations in Appendix III are based on US EPA labels for usage on both the crop/livestock and pest. Interestingly, cost is not a significant consideration as farmers seem to be able to afford pesticides. Farmers currently over-apply pesticides so with training on crop monitoring and use of action thresholds, it is anticipated they will use less and thus spend less. The microbial pesticides as a group are cheaper than petroleum based pesticides.

c) Extent to which the proposed pesticide use is, or could be, part of an IPM program.

The GON will soon pass legislation defining IPM as the central policy for pest control in agriculture. The FAO and many others (including USAID) have been active in training farmers to adopt IPM practices for over 15 years and so far have trained about 70,000 farmers from nearly 4,000 farmer field schools. Farmer field schools are hands-on, participatory training methods that rely on significant face-to-face time between the facilitator and farmer. The trainers or "facilitators" present the information in a lecture and then conduct class activities for small groups of farmers.

The IPM IL has been engaged in developing IPM packages of practices for vegetables in Nepal for ten years; the field work is led by two NGOs, iDE and CEAPRED. They strive to replace synthetic pesticide usage, as much as possible, on vegetables and have developed technologies that have reduced usage by 80-90%. KISAN will conduct trainings while IPM IL will continue with its applied research to reduce the need for hard pesticides. KISAN will expand the training on how to cultivate select field crops and vegetables using IPM practices for pest control to target 200,000 farmers in the next five years. IPM IL is utilizing bio-control as the main pest control tactic rather than chemical control which is currently practiced by farmers. CSISA/CIMMYT will also work closely with KISAN to promote pest resistant varieties to reduce maize and vegetable diseases. CSISA/CIMMYT is also working on conservation tillage practices which should reduce pesticide runoff from fields and bolster crop tolerance to pest damage, lessening the need for pesticides.

d) Proposed method or methods of application, including the availability of application and safety equipment.

Many of the bio-pesticides are in the form of dry spores and should be incorporated into compost in the planting hole. No protective equipment or gloves are needed for this operation. Microbial agents should be applied as seed treatment and farmers do not need gloves for this. However, seed treatments using fungicides require gloves. No seeds for the KISAN crops will need to be treated with insecticides. Pesticide sprays, when needed, should be applied by farmers using a nine to 16 liter lever-operated stainless steel knapsack sprayer. Some microbial insecticides will need to be applied as sprays and farmers will need to wear long pants, long-sleeved shirts, and shoes to do this. A bactericide, such as copper oxychloride, and all other foliar applied insecticide/acaricides and fungicides will be sprayed onto the crops. When spraying, farmers need to be careful of chemicals carried by the wind and they should spray to the side to avoid contact with the spray as much as possible. They will need to wear long pants, long-sleeved shirts, shoes, and, if possible, either waterproof rain pants or a plastic sheet wrapped around their waist covering the front of their legs. The recommended plastic sheet or rain pants are not very uncomfortable. One concern, however, is that farmers often purchase or use inexpensive plastic sprayers without proper seals. These sprayers can leak pesticide solution onto the farmer's shirt, which forms a wick where pesticides are continually absorbed into the skin and enter the blood stream. Farmers should not use sprayers that leak. If their sprayer leaks, it should be repaired or replaced by one that doesn't.

e) Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use, and measures available to minimize such hazards.

Acute toxicity should not be a significant problem for KISAN since only pesticides in the safest two categories are recommended. Some of the recommended pesticides have some chronic toxicity concerns, such as risk of cancer or harmful effects on endocrine systems. These toxicities likely would only occur in areas where pesticides are repeatedly used such as on horticultural crops. Such fields are small so farmers will spend less time spraying and being exposed to pesticides. In addition due to the small fields sprayed, pesticides will not significantly accumulate in field runoff of contaminated water or soil.

Because of the emphasis on bio-control or cultural control, in the case of field crops, the frequency of application is not expected to be high. Visits to plastic house tomato culture showed that farmers spray 10-15 times; however, it is hoped that most of these practices will be replaced with improved research by IPM IL and training by KISAN.

f) Effectiveness of the requested pesticides for the proposed use.

Pesticide use on vegetables is based on the ongoing applied research results of the IPM IL model which uses field trials in each new area to verify evolving IPM technologies. The IPM IL has been active for ten years and has built up a package of best practices for the main vegetables. This is an international effort and 15 other countries (including India and Bangladesh) are conducting similar research and sharing results. These efforts have led to the current recommended practices. Regarding field crops, the concerned pesticides have been selected based on field experience of research trials from NARC and Department of Agriculture extension agents and checking labels to verify if the registered uses in other countries match the intended uses in Nepal.

There is a new insecticide that being recommended for eggplant fruit and shoot borer, tomato fruit worm, gram pod borer, stemborers, armyworms, and cutworms. The product is chlorantraniliprole (Coragen SC) which has been registered and used in India for the intended usages in KISAN. It is systemic when applied as a foliar spray and has long residual life in the plant, thus only two applications are recommended for lasting control. It is also selective, safe (Toxicity Class IV), and does not significantly harm beneficial insects. Spinosad, a selective insecticide in Toxicity Class IV, is registered in

India under the trade name Tracer and is new to Nepal. It is widely used against different insect pest groups. It is hoped these two insecticides in particular will replace the more toxic ones that farmers now use.

g) Compatibility of the proposed pesticide use with target and non-target ecosystems.

It is important that pesticides used on vegetables do not harm bees since a number of the crops need to be pollinated. One recommended pesticide, imidacloprid, is very toxic to bees; however, it will be used as a soil insecticide and thus will pose no harm to bees. From the recommended pesticides in Appendix IV buprofezin, chlorantraniliprole, imidacloprid, azadirachtin, carbendazim, copper oxychloride, and mancozeb are highly or very highly toxic to one or two other non-target organisms. Imidacloprid is not likely to affect birds because it is administered in the soil, while copper oxychloride is not likely to be sprayed more than twice a year on any plot as it is only recommended on crucifers. The other non-target organisms live in aquatic environments (fish, amphibians, crustaceans, mollusks, aquatic invertebrates, and plankton). The most aquatic of environments are flooded rice fields. There are four pesticides of potential concern in this environment, namely chlorantraniliprole for crustaceans and aquatic invertebrates; buprofezin for aquatic invertebrates; azadirachtin for crustaceans; and mancozeb for amphibians. As rice fields are not permanent aquatic ecosystems, it is unlikely that many amphibians and crustaceans will be present. Another factor is that each field is small and will probably be sprayed only a few times; and not all fields will be sprayed at the same time. As each farmer sprays on his or her schedule, on a given day pesticide will only be applied to a small area and the residues will be readily detoxified by microbes in the environment. Rice has far fewer pests than vegetables, so fields will be treated zero to two times each season. The foliage will intercept the sprays in most cases as the pests of concern occur after maximum tillage when the canopy closes. These pesticides will degrade rapidly under tropical temperatures and humidity so they will not build up over time significantly lowering the risk of killing large numbers of non-target organisms.

h) Conditions under which the pesticide is to be used including climate, flora, fauna, geography, hydrology, and soils.

Over the past two decades an impressive network of protected areas (PAs) has been established in Nepal covering about 18% of the total area. To date, there are 16 PAs of different categories (nine National Parks, four Wildlife Reserves, three Conservation Areas, and one Hunting Reserve). The area under PAs has been increased more than six-fold, from 4,376 km^2 in 1973 to 27,196 km^2 in 2000. The ratio of PA to total land area in Nepal is one of the highest in Asia. With the introduction of the Buffer Zone concept, the area under conservation regimes has increased even further. Nepal is the home of more than 5,000 species of flowering plants, 181 mammals, 844 birds, 185 fish, approximately 635 butterflies, and 2,250 moths. Notable large animals are rhino, tiger, crocodile, black bear, black buck, and clouded leopard. One threat to this biodiversity is the intrusion of agricultural pesticides into these zones. Often agricultural fields abut PAs. Herbicides can drift into PAs from adjacent agricultural fields. In discussions with staff, the KISAN Project is not using any herbicides. Weed control in rice will be achieved via ponding and hand weeding. In maize, it will be inter-row cultivation and hand weeding. In vegetables, it will be mulching or hand weeding. Pesticides have the potential to enter groundwater in the Terai since the water table is said to be only 10 meters from the surface in some areas. However, due to bore wells, groundwater is dropping further out of reach so none of the pesticides are considered to be a significant threat to groundwater as the chemicals have high propensities to bind with clay in the soil rather than seep downwards. Pesticides applied to rice fields that land on the water surface will be bound to clay and organic matter may be washed away into rivers after heavy rains thereby polluting bodies of water downstream. Pesticides also adhere to soil particles in the uplands and can move into protected areas via soil erosion. Soil erosion is ever-present in Nepal as the Himalayas are still rising. If erosion control berms are not in place in the hill region, pesticide can move downslope and could eventually move into protected areas.

While there are reports of rather high pesticide application frequencies in Nepal on cotton, tea, and some vegetables, only the tea area would be large enough to be of ecological significance as farm sizes where vegetables are grown are very small and the environmental impact is likely to be minimal. In the absence of more studies, these conclusions are only assumptions. Regarding non-target organisms, while chlorantraniliprole is safe to most natural enemies of insect pests, it is highly toxic to aquatic invertebrates and crustaceans. Imidacloprid is highly toxic to birds and bees. Copper is highly toxic to earthworms and plankton. Azadirachtin is highly toxic to crustaceans and buprofezin is highly toxic to aquatic invertebrates. These selective toxicities for the recommended products are considered of minor significance due to the unlikelihood of their entering streams in any significant quantities. The adverse effects on non-targets are considerably less than effects of products being recommended to be replaced.

i) Availability of other pesticides or non-chemical control methods.

Previously called IPM-CRSP, the IPM IL program was previously implemented directly through core funding from the international IPM team and had the provision of scholarships. Some Masters and Doctorate studies are thought to be ongoing.

In other IPM IL countries such as Bangladesh and Indonesia, the training of similar government staff in US universities on how to produce bio-fungicides and bio-insecticides created the breakthrough that was needed to make these agents a reality, resulting in the significant reduction of synthetic pesticides. Currently, IPM IL has to import bio-pesticides from India, but as there is a very limited demand, importation is only a trickle. The government labs can play a vital role in maintaining colonies of the various strains to offer to farmers who would then culture them in plastic bags of cereal grains.

j) Host country's ability to regulate or control the distribution, storage, use, and disposal of the requested pesticide.

The Food Act was passed in 1966 and Food Regulation of 1970 established Maximum Residue Limits (MRLs) for pesticides in food products, but not vegetables. Nepal passed its Pesticide Act in 1991and Regulations in 1994. Since 1997 the Nepal Drug and Poison Information Center, an NGO-funded entity but under the GON Department of Drug Information, has been open to the public to provide information on poisonings from pesticides as well as other causes. It has helped bring down the fatality rate from pesticide poisonings nationwide. Nepal is a signatory to the Stockholm Convention (bans the most persistent pesticides), Basel Convention (protects vulnerable countries from unwanted hazardous waste imports), Rotterdam Convention (prior informed consent for disposal of outdated, obsolete pesticides), and follows the FAO Pesticide Code of Conduct. These regulations focus mostly on the need for licenses to import, formulate, sell, and for commercial applicators.

The Pesticide Committee, formed by the Regulations, has the power to forbid the import, sale, and/or use of pesticides deemed to be too toxic or have adverse effects on the environment. The majority of the world's most dangerous pesticides have been banned. POPs were banned in Nepal in 2001 some twenty years after most Asian countries did so. In May 2005 the Registrar prohibited quinalphos, ethion, monocrotophos, and phorate on tea since exports were rejected by India due to unallowable pesticide residues. In 2012 the Pesticides Registrar began removing endosulfan, carbofuran, methomyl, and phorate from circulation by not allowing them to be re-registered due to high toxicity. However, there are inspectors in each district who can allow a non-registered pesticide to be used based on demand from farmers regardless of toxicity level. There is still significant progress to be made: the latest Agricultural Diary recommends phorate, carbofuran, demeton-S-methyl (Metasystox), and endosulfan even though the first three are Toxicity Class I and endosulfan is Class II and is banned in many countries as it kills fish. Of all registered pesticides, only 2% are in the most toxic category, Class I; 36% are in Class II; 42% are in Class III; and 2% are in Class IV. It is anticipated that a number of the most toxic pesticides will be banned in the near future. The Department of Agriculture finally arranged for the disposal of 74 tons of obsolete pesticides by GTZ after 30 years lingering in more than 20 warehouses. There are Pesticide Inspectors in each of the 75 districts whose job it is to monitor Agrovet stores to ensure that pesticides are being managed as per FAO Code of Conduct.

Each year the Office of Pesticide Registration publishes the complete list of registered products online. There has been an explosion of brand names going from 650 in 2010 to 1,098 in 2013, a 69% increase. This boom is due to the ease of obtaining a license to sell and registering pesticides, and low fines. The capacity to detect pesticide residues in market basket sampling and to verify pesticides being sold in Agrovet stores is hampered due to insufficient budgets. Gas liquid chromatographs (GLC) are functional in very few labs due to an inadequate budget. Currently there are 49 pesticide importers; pesticides are then sold in the 8,551 registered Agrovet shops.

Visits to Agrovet stores found they comply with the Code of Conduct as all products had labels, there was no repackaging in non-authorized containers, and food and other commodities were not being sold on the premises.

The Pesticide Inspectors are mainly focused on detecting products that have not been registered and thus were not paying fees. It is widely known that pesticides easily flow illegally into Nepal from India. Some of these traders are caught, but the fine is so low that it is not an effective deterrent. Many pesticides did not have labels in the Nepali language, some did not have color code symbols (particularly Chinese products), some products had labels that did not give information on crops or pests in Nepal, and the pesticide's common name was not indicated on some products.

k) Provision for training pesticide users and applicators.

USAID recognizes that safety training is an essential component in programs involving the use of pesticides. The need for thorough training is particularly acute in developing countries where applicators' level of education is typically lower than in developed countries. KISAN will utilize training materials provided by the Department of Food Technology and Quality Control as well as the FAO and the pesticide industry standard Crop Life. These materials include posters and training aides that will be placed in areas where farmers gather and will be used in training sessions for the 200,000 participating farmers.

KISAN will train farmers on IPM practices including safe and effective use of pesticides. The consultant's counterpart was KISAN's Capacity Building and Training Manager who will develop the training curriculum. It had not been developed at the time this PERSUAP was conducted. The trainers will use information in Appendix III for a guideline to IPM practices and safer pesticides as well as knowledge of pest monitoring and decision making in taking corrective actions such as an application of a pesticide. An outline to address safe use practices is in Table 12.

l) Provision made for monitoring the use and effectiveness of each pesticide.

The Environmental Mitigation and Monitoring Plan (EMMP) has been developed, and this PERSUAP covers information on safe and effective use of pesticides. Information on the recommended and safest pesticides, presented in Appendix IV, as well as safe use practices in Table 12, will form the basis of the KISAN's pesticide usage. Winrock/KISAN is responsible to implement the EMMP and follow the guidance of the PERSUAP. The COR, assisted by the Mission Environmental Officer, will monitor the implementation of the EMMP. The COR will request updates from Winrock's Chief of Party. The consultant recommends that in addition, a committee be formed to review pesticide usage and review progress through annual meetings during KISAN's five-year period. This could be a sub role of the National Project Advisory Committee (NPAC). Through this committee, KISAN could coordinate with the Pesticide Committee of the Ministry of Agricultural Development, Department of Agriculture, and Plant Protection Division to monitor changes in approved pesticides.

5. FINDINGS AND RECOMMENDATIONS

Most causes of pesticide poisoning in developing countries stem from weak regulation, low hazard awareness of users, inadequate PPE, lack of proper care during application, and use of highly toxic pesticides. These concerns and associated mitigation recommendations are elaborated in this section. Sections highlighted in bold italics are key topics that should be incorporated into the KISAN trainings for famers. All staff (agriculture and health staff) should be trained on some of the key dangers of pesticides. All agriculture trainings (including homestead gardening trainings) should include a section on the dangers of pesticides.

Other suggestions are based on observations by the PERSUAP expert and are recommendations that USAID Nepal could consider promoting through other programs or additional funding.

The KISAN training directors should know that the UN Food and Agriculture Organization (FAO) has more detailed guidelines that follow international standards. The head of the Plant Protection Directorate attends regional meetings to receive updates on pesticide regulations in the region. FAO has a developed complete set of training manuals describing safe practices for transportation, storage, labeling, advertising, disposal, application equipment, safe use, etc. These should serve as reference materials for the preparation of the training curriculum. There are Material Safety Data Sheets (MSDS) that are required for each chemical sold in the world that follow international standards for hazardous chemicals including pesticides. The MSDS is an important component of product stewardship and occupational safety and health. It is intended to provide workers and emergency personnel with procedures for handling or working with a chemical in a safe manner, and includes information such as physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, firefighting guide, and spill-handling procedures. MSDS formats can vary from source to source within a country depending on national requirements. It is a useful source of information on all products and can be downloaded from the web.

5.1 REQUEST FOR PERMITTED PESTICIDES

Table 8. Pesticides recommended to be used under KISAN

Fungicides	Insecticides	Bio Fungicides	Bactericides	Bio Insecticides	Bio-Nematicides
Crops					
Metalaxyl + Mancozeb	Acetamiprid	Azadirachtin	Copper oxychloride 50% WP formulation	Azadirachtin (Neem oil extract)	Azadirachtin (Neem cake)
Carbendazim	Chlorantraniliprole	Pseudomonas fluorescens	Steptomycin sulphate	Beauveria bassiana	Pseudomonas fluorescens
Sulpher	Buprofezin	*Trichoderma sp*	*Tetracycline hydrochloride*	*Metarhizium anisopliae*	
Mancozeb	Thiamethoxam				
	Sulphur				
	Imidacloprid				
Livestock					
	Cypermethrin 5% EC				
	Malathion EC				

5.2 WEAK PESTICIDE REGULATORY AND ENFORCEMENT SYSTEM

1. Hazardous pesticides are still sold and recommended in Nepal.

The 2013 Agricultural Diary recommends dangerous pesticides such as phorate, carbofuran, demeton-S-methyl (Metasystox), and endosulfan. The first three are Toxicity Class I; endosulfan is Class II and is currently in the process of being banned in Nepal. Other recommendations (Paneru & Giri, 2011) call for aldicarb, disulfoton, and dichlorvos (all Toxicity Class I) to be prohibited, but only dichlorvos was seen in Agrovet stores. Aluminum phosphide (Phostoxin/Celphos), a very toxic fumigant that should only be used by professionals using respirators/proper equipment to kill insects in stored grain, has been implicated in many deaths in Nepal and is sold in Agrovet shops for farmers to use at home.

Recommendations: Aluminum phosphide fumigant cannot be detected by smell, leading to many deaths associated with not following directions. In 2002 alone 89 people died. This fumigant is much too hazardous to be permitted for use by farmers, many of whom are illiterate and are not aware of the dangers. The PERSUAP recommends raising awareness of the dangers of these chemicals in Agrovet and farmer communities to discourage access to and use of these toxic pesticides.

2. Pesticides are smuggled to Nepal from India.

Smuggling causes more problems than avoiding paying registration fees. Many of the infractions of imported hazardous and banned pesticides can be traced to chemical companies in India. Large companies are not the main source since they have a stake in maintaining public confidence in their trade name. Instead, "fly by night" formulators selling dangerous pesticides rebranded as "new" pesticides to farmers are the primary source of these illegal imports.

Recommendations: The Pesticide Inspectors should be able to find out from the farmers when people come into villages to sell smuggled pesticides. If labeling were properly enforced, any product lacking a label in Nepali language would be suspect. The GON should coordinate with the Pesticide Regulators in India to identify these small formulators and stop their illegal exports to Nepal.

3. Many farmers cannot read pesticide labels as the font is too small, even in the accompanying leaflets.

Farmers like to purchase small containers of 50 to100 grams or milliliters and consequently the fonts of the pesticide labels are so reduced that one cannot read what is printed. Most products, however, come from India with a leaflet that gives more information, but as there are many languages in India, the information is repeated in eight languages. One Agrovet owner even produced a magnifying glass to help customers read the labels. Though the information on the labels is incomplete and not particularly useful, most farmers just want to know the name of the product. They do not expect the pesticide labels to have any useful information.

Recommendations: The regulations state that the labels should follow FAO standards but often much of the necessary information was lacking. Farmer and Agrovet awareness needs to be enhanced.

4. Labels are not in the Nepali language as mandated by regulations and do not indicate usage on local crops and pests.

The vast majority of pesticides inspected in Agrovet stores were meant for farmers in countries other than Nepal. It would not be costly for a company to make labels in Nepali giving specific instructions for use against the most common pests and crops in Nepal.

Recommendations: Highlight this issue with GON and related stakeholders, including IFPRI.

5. Some imported pesticides lack the color code symbol.

Even on a label with reduced font, the red, yellow, blue, and green toxicity symbol could not be seen. This is important information for farmers concerned about their safety during application. Most farmers do not know what the color codes indicate.

Recommendations: Build farmer and Agrovet awareness and ability to assess pesticide use and toxicity. Some ingredients are not identified on labels.

6. A pesticide label should state the contents, including the common name of the pesticide and its concentration. Products were found in Agrovet stores where this information was missing. Examples include Vircon H, Bollout, and Tozen.

Recommendations: Build farmer and Agrovet awareness and ability to assess pesticide use and toxicity through KISAN's trainings.

7. There are too many brands because pesticides are too easy to register.

The requirements to acquire a license to import and obtain registration for a pesticide are lax. In most countries, field trials are required to demonstrate efficacy for at least two seasons against every pest listed on the label. For example, if a pesticide is said to kill leafhoppers, data must be shown to prove this. Currently, pesticides are registered only for the crop and not for specific pests. Additionally, it is too cheap to register a new pesticide.

Recommendations: Consider working with the GON to encourage them to ensure pesticides are renewed annually and they could charge higher fees to pay for field testing.

8. Adulteration by dilution, product substitution, and altering expiration dates contribute to farmers not being able to rely on the quality of pesticides they purchase.

Poor quality pesticides results in waste of farmers' money and low yields as the pesticides will not be effective in controlling pests. There are three causes of low pesticide quality. (1) Unlicensed traders often sell smuggled adulterated pesticides directly to farmers in their communities. Many farmers do not have access to information regarding illegal imports of adulterated products. Unlicensed traders also use other methods to increase their profit. For instance, some dilute pesticides making them less potent while maintaining the appearance of a standard pesticide, increasing their profits. (2) Smugglers also substitute non-pesticide products or cheaper pesticides and sell them at higher prices. (3) They also illegally sell outdated products by altering the expiration dates. The pesticide chemistry changes with increased storage time. In some instances it produces more toxic chemicals but the most common effect is to reduce the concentration of the pesticide rendering it ineffective. These are a few ways Indian companies can get rid of out-of-date stock.

They sell the old pesticides cheaply to willing Nepali farmers in community marketplaces. This is also a way of getting rid of pesticides banned in India.

Recommendations: Farmers need to be told to contact Pesticide Inspectors when they see these traders selling in their village.

9. Fines for violating regulations are too low.

Many of the regulations are not followed because the penalty is trivial and few are ever punished. The Pesticide Act of 1991 and its first amendment in 2008 have a provision of a maximum fine up to Rs 5,000 for trading illegal pesticides and seizure of products.

Recommendations: High penalties need to be set for people who use endosulfan for fish poisoning. Traders who dip vegetables in pesticide to make them shiny and thus more attractive to consumers need to be arrested as this practice is criminally dangerous.

5.3 FARMERS LACK KNOWLEDGE ON THE CHARACTERISTICS AND USE OF PESTICIDES

1. There are serious hazards during mixing and application.

Farmers normally measure pesticide from the container using a tablespoon or small cup. Spills are likely during this process, with concentrated pesticides coming into contact with the hands and body.

Recommendations: KISAN training needs to address the issue that pesticides are most concentrated in the container so farmers need to have a bucket of water on hand to wash the pesticide off should it spill. This is one of the most hazardous operations in spraying.

2. There are grave dangers from leaking sprayers.

Another hazardous situation occurs if the sprayer is leaking, which happens when the solution sloshes in the sprayer tank. If the cap of the spray tank does not seal properly then pesticide solution will splash onto the shirt of the farmer. The shirt becomes wet and acts like a wick. Wet skin allows the pesticide to seep into the body rapidly.

Recommendations: KISAN should train farmers on (and Agrovets need to be made aware of) the very severe dangers of improper handling of pesticides; proper measures need to be demonstrated.

3. Wearing appropriate protective equipment and clothing (PPE).

US EPA has specified the PPE items to wear based on the toxicity level of the pesticide being applied. If it is a mixture of pesticides the amount is based on the most toxic variety in the mixture. Toxicity Class I pesticides require the most protection.

Recommendations: KISAN should train farmers and Agrovets about the very severe dangers of improper handling of pesticides; proper measures around protective equipment and clothing need to be demonstrated. Detailed information on what protective clothing and equipment are appropriate for pesticides by level of toxicity can be referenced in Table 9. This information was developed by the US EPA.

Table 9. Standard Personal Protective Clothing Recommendations

Route of exposure	Toxicity class by route of exposure of end-use product			
	I Danger	**II Warning**	**III Caution**	**IV Caution**
Dermal toxicity or skin irrigation potential	Coverall worn over long-sleeved shirt and long pants	Coverall worn over long-sleeved shirt and long pants	Long-sleeved shirt and long pants	Long-sleeved shirt and long pants
	Socks	Socks	Socks	Socks
	Chemical resistant footwear	Chemical resistant footwear	Rubber boots or shoes	Rubber boots or shoes
	Chemical resistant gloves	Chemical resistant gloves	Chemical resistant gloves	No minimum
Inhalation toxicity	Respiratory protection device	Respiratory protection device	No minimum	No minimum
Eye irritation potential	Goggles	Goggles	No minimum	No minimum

Source: US EPA Agricultural Fact Sheet No. 12. EPA Worker Protection Standard for Agricultural Pesticides, 1996

4. <u>Walking through the spray path can lead to direct exposure to and contact with the pesticide in use.</u>

As seen in the photo, the farmer's legs are exposed to the pesticide he is applying to his crops. Such direct exposure to pesticides significantly increases potential health risks, depending on the toxicity level.

Figure 2. Farmer applying pesticide to his crops with his legs exposed.

<u>Recommendations:</u> KISAN training needs to make farmers and Agrovets aware of the very severe dangers of improper handling of pesticides; proper measures need to be demonstrated. Farmers need to wear the appropriate PPE when spraying crops.

5. Farmers often use the method of spraying crops in front of them while walking forward, risking direct contact with the pesticide in use.

For convenience, and perhaps not knowing that there is any danger, farmers prefer to spray in front of them moving the lance from side to side while walking forward. This means that the pesticide covers the front of the farmers' legs during the entire spray operation. This is hazardous as again the pants get wet and act as a wick, or the skin becomes soaked with pesticide if the farmer wears shorts and the pesticide readily enters the body and bloodstream.

Recommendations: KISAN needs to train farmers to spray to the side and let the wind blow the pesticide onto the crop. Farmers can also wear waterproof pants or a waterproof apron made of a plastic sheet tied around the waist. The waterproof attire is an alternative – the top recommendation is spraying to the side.

6. Pesticides can enter the body in several ways.

Farmers can take the necessary precautions if they know the most sensitive routes through which pesticides enter the body and bloodstream. Pesticides pass into the body most readily through mucous membranes (eyes, lips, mouth, lungs). The second most common method is through any wet skin, whether due to perspiration or liquid spray, as it facilitates entry to the bloodstream. A study by Murphy et al. in 2000 showed that the legs, back, and loin come into contact with pesticides most frequently during typical spraying by farmers (Table 10).

Table 10. Exposure to the body using Knapsack Sprayer

Body Part	Frequency of applications (%)
Legs	88
Back	85
Loins	78
Shoulders	55
Hands	25
Arms	16
Feet	16
Neck	3

Source: Murphy, et al, 2000

Recommendations: KISAN needs to train farmers and Agrovets about the dangers of improper handling of pesticides; proper measures need to be demonstrated. Pesticide dust or powder formulations do not enter the body or bloodstream if they come in contact with dry skin, so the skin must be perfectly dry.

7. Pesticides that kill pests quickly are the most hazardous to humans.

The organo-chlorine (endosulfan), organo-phosphate (demeton-S-methyl, disulfoton, dichlorvos), and carbamate (carbofuran, phorate, methomyl, aldicarb) insecticides are all nerve poisons. The nervous system of people and insects are very similar in makeup and function, which means that people are just as susceptible as insects, depending on the dosage. A high dosage can be transferred to people by prolonged exposure such as spraying for a number of hours with a leaky sprayer or walking in the spray path. The aforementioned pesticides are the last of the pesticides developed before the 1970s which are highly toxic to people.

Recommendations: KISAN should include information in their training for farmers and Agrovets on the very severe dangers of using highly toxic pesticides; safer alternatives need to be identified.

8. Farmers cannot spray grain directly with insecticide if it is intended for human consumption.

Stored grain is sometimes directly sprayed with insecticide to prevent storage pests. However, this is a dangerous practice as pesticide residues lingers on the grain and can poison people who consume it.

Recommendations: KISAN needs to address this issue in their training for farmers and Agrovets so they are aware of the very severe dangers of improper handling of pesticides; proper measures need to be demonstrated.

9. Farmers often do not adhere to the recommended waiting period between last spray and harvest.

Studies of each kind of pesticide and crop have determined how long the pesticide, when applied at the recommended dosage, remains on each crop before becoming degraded by heat and humidity. This number of days before harvest is called the waiting period. The farmer needs to wait the number of days specified by the waiting period, which should be indicated on the pesticide label. Harvesting the crop sooner means that the crop is toxic to people. Generally, the older pesticides require longer waiting periods.

Recommendations: The GON should undertake pesticide residue tests on vegetables and fruits to see how serious this problem is and locate areas where farmers are not following the waiting period so that they can be targeted for extension programs to inform them of the risks. ***KISAN should train farmers and Agrovets about the importance of letting pesticides degrade before selling or eating the crops.***

10. Dust, powder, and granular formulations should not be handled without gloves.

Direct contact with pesticides with bare hands is dangerous, particularly if the hands are wet due to perspiration which facilitates pesticide entry into the body.

Recommendations: Farmers and Agrovets need to be made aware of the very severe dangers of improper handling of pesticides; proper measures need to be demonstrated. To avoid potential poisoning, farmers need to wear gloves when handling dust, powder, or granular pesticides.

11. Over-application of pesticides occurs because farmers do not regularly monitor their fields for pests and base usage on recommended action thresholds rather than presence of pests.

One of the tenants of IPM is to not apply a corrective action, such as a pesticide, just upon seeing the pest (unless this has been found to be the best practice). Action thresholds are guidelines on pest populations that have reached economic levels that justify a corrective action.

Recommendations: KISAN should adapt the threshold guidelines provided in Appendix III for its training to farmers. Generally pesticides should not be applied upon seeing a pest. This is the best practice only for fungal and bacterial diseases because they reproduce so fast. IPM relies on regular crop monitoring, usually on a weekly basis and sometimes twice a week when infestations are building up rapidly.

12. Bio-insecticides do not kill immediately and need to be applied when pests are young.

Recommendations: Ensure farmers and Agrovets understand the importance of timely application of biological insecticides, that they need a few days to act, and are most effective when applied before pests mature. This is the case with Btk against worms. If Btk is sprayed on large worms, it will not work (and neither will regular insecticides).

13. Farmers do not know what information is on a label.
14. FAO guidelines for pesticide containers require a label with a color symbol denoting the toxicity: red indicates greatest toxicity, yellow for moderate toxicity, blue for slight toxicity, and green for least toxic. Farmers need to learn these colors and what they mean.

Recommendations: KISAN trainings should address the significance of the color coding system and how to read labels.

15. Farmers do not know pesticides' common names versus their brand names.

A common name refers to the international standard name of a pesticide. When a company produces a new pesticide, it gives it a common name and a trade or brand name. A new pesticide is protected by patent law for 20 years so that no other chemical company can legally make it until the patent expires. Most of the pesticides on the market now are old enough that their patent protection is over. These are the old chemicals for insecticides and synthetic pyrethroids that were developed in the 1970s. Now many companies can make these. Therefore, there are only 49 different insecticide common names but 391 trade or brand names for them. That means there is an average of eight trade names for every common name. There is no difference in the performance between trade-named and common-named products as they are the same pesticide chemically.

Recommendations: Farmers and Agrovets need to be made aware of the pesticide brand and common names to be able to assess and purchase the most suitable permitted pesticide for their needs.

16. Farmers do not know how to tell the least expensive price for pesticides.

Recommendations: KISAN could develop a simple table and share it with farmers on how to calculate the cost of concentrated pesticides. If a farmer can learn to tell the common name for pesticides and the concentration, he/she can determine the least expensive one to buy. Generally, the lower the concentration the cheaper the pesticide is; often, buying a larger container saves money as well.

17. Farmers do not know the acute signs of pesticide poisoning.

Mild poisoning or early symptoms of acute poisoning are headache, fatigue, weakness, dizziness, restlessness, nervousness, perspiration, nausea, diarrhea, loss of appetite, loss of weight, thirst, moodiness, soreness in joints, and irritation of the skin, eyes, nose, or throat. Moderate poisoning or early symptoms of acute poisoning are nausea, diarrhea, excessive saliva, stomach cramps, excessive perspiration, trembling, no muscle coordination, muscle twitches, extreme weakness, mental confusion, blurred vision, difficulty in breathing, cough, rapid pulse, flushed or yellow skin, and weepiness. Severe or acute poisoning symptoms are fever, intense thirst, increased rate of breathing, vomiting, uncontrollable muscle twitches, pinpoint pupils, convulsions, inability to breathe, and unconsciousness.

Recommendations: KISAN will work with local health posts on posters depicting/explaining key symptoms of pesticide poisoning. If such materials are not developed in Nepal, KISAN will consider bringing a volunteer expert to help develop the simple posters for Agrovets and local health experts.

18. Pregnant women and children often spray.

Farmers and extension workers told of women and children applying pesticides in the field using knapsack sprayers. Pesticide toxicity is based on body weight and body stress. The smaller the body the less pesticide is needed to kill it. Children, unborn fetuses, the elderly, and those with chronic illnesses such as AIDS are most susceptible among humans.

Recommendations: KISAN should ensure in agriculture and FCHV training that everyone understands the pesticide hazards to pregnant women and young children in particular.

19. Farmers do not use sufficient caution/protection when measuring pesticide from a container.

One of the gravest concerns is that when measuring pesticides, farmers do not protect exposed skin. Pesticides can spill while being measured and move into the blood stream through the skin.

Recommendations: If concentrated pesticide is spilled directly onto the skin, the pesticide needs to be immediately washed off. It is recommended to have a bucket of water nearby when measuring out concentrated pesticides.

20. Farmers do not know the proper disposal of pesticide containers.

An empty pesticide container should never be reused for any purpose around the home. Recently in Bihar, 22 children were killed as a direct result of consuming food served in pesticide containers. Residues of the pesticide can linger inside and create a hazard.

Recommendations: Metal containers should be rinsed three times and then punctured so they cannot be reused. Glass containers should also be triple rinsed, wrapped in newspaper, carefully broken, and disposed of in a landfill. Table 11 shows proper disposal of pesticides and pesticide containers and was developed by US EPA. It can be referenced in developing the training curriculum.

Table 11. Proper Method of Disposal for Pesticides and their Empty Containers

Container Type	Disposal Methods
Metal containers (non-aerosol)	Triple rinse. Offer for recycling or reconditioning; or puncture and bury.
Paper and plastic bags	Completely empty bag into application equipment. Bury empty bag.
Glass containers	Triple rinse. Dispose of in a sanitary landfill.
Plastic containers	Triple rinse. Puncture and bury.

Source: http://www.epa.gov/pesticides/regulating/disposal.htm

21. Farmers are unaware of chronic health problems from continual pesticide exposure.

Some farmers also hire themselves out to apply pesticides for their neighbors. If they are not properly protected, continual exposure over time leads to buildup of pesticide in the body which can cause chronic illnesses. Common chronic pesticide toxicity is exhibited as birth defects, cancers, blood disorders, neurological problems, and reproductive system malfunction.

Recommendations: Farmers need to be made aware of the chronic dangers of prolonged exposure to pesticides.

22. Farmers are unaware of the negative effects pesticides have on the environment.

Over 98% of sprayed pesticides do not impact the targeted plant. Instead, they drift into the air, water, and the bottom of ponds, lakes, streams, etc. Sprayed pesticides applied with a hand sprayer can be blown into the air and enter the atmosphere. Pesticide mist can travel hundreds of kilometers before returning to the ground in rainfall, contaminating soil and bodies of water. Upon landing in the water, the pesticide is taken up by small organisms or algae and eventually will be deposited at the bottoms of lakes and streams. When a field is sprayed, some pesticide lands on the soil and sticks to soil particles such as clay. Contaminated soil can spread due to soil erosion after heavy rainfall and the mud will flow into streams, ponds, lakes, and eventually the ocean endangering organisms living in those environments.

Recommendations: Farmers often do not have access to this information, but it is crucial that farmers, Agrovets, and associated local stakeholders are aware of these dangers to avoid potential contamination of water sources.

5.4 LACK OF TRAINED MANPOWER, SERVICES, AND SUFFICIENT INSTITUTIONAL BACKING

Nepal currently lacks the strong institutions and skilled staff necessary for successful implementation of IPM. Some of these deficiencies are highlighted below.

1. <u>There is a lack of accredited pesticide residue labs in Nepal.</u>

Functioning pesticide residue laboratories can perform a number of vital roles in pesticide management including detecting residues on fresh produce, protecting public health, monitoring pesticide content in retail shops to avoid adulteration, and monitoring residues in the environment and in toxicology departments of universities conducting research and training. Gas-liquid chromatographs (GLCs) are able to detect residues in very small quantities of parts per trillion. There are a number of these instruments in various laboratories in Nepal but few are functioning. These instruments are highly sensitive to fluctuations in electricity voltage. Also the solvents are costly and operating budgets are not sufficient to maintain. They need ready access to manufacturers' service providers which is difficult given the limited number of machines available.

<u>Recommendations:</u> If the goal of GON is to comply with international maximum residue limits, eliminate adulteration of pesticides in the market, and minimize pesticide residues in the environment, then it needs to establish at least one laboratory where GLCs can function properly and attain international accreditation. This requires powerful surge protectors and trained staff in addition to a sufficient budget to operate and repair instruments. Unfortunately, this is only an aspiration in 2013.

2. <u>Regional bio-control labs and staff are operating at a high enough level to provide strains of bio-pesticides to culture locally.</u>

<u>Recommendations:</u> The government needs to make its five bio-control labs more functional by outfitting them with equipment to mass produce beneficial fungal, bacterial, and viral organisms. In neighboring countries, government laboratories maintain pure cultures of the best performing bio-control agents that are given to farmers to mass produce either for local companies that sell them or to individual farmers or farmers groups to mass produce for themselves. There is a need for trained plant pathologists and insect pathologists to run the five NARI regional bio-control labs so more biological agents become available to farmers. These laboratories also need sufficient budgets to operate.

3. <u>Pesticide use is not utilized in the context of IPM.</u>

The consultant could find no evidence for crop monitoring protocols that have been developed for the main crops grown in Nepal. The only crop monitoring is taught in the context of farmers' field schools where farmers quantify densities of pests and natural enemies as a way to measure the need for pesticide control.

<u>Recommendations:</u> Recommendations for crop monitoring and decision thresholds for the main KISAN crops is provided in Appendix III.

4. Nepal does not have adequate pest diagnostic services.

The consultant found that there are weak taxonomic services in NARC's Entomology and Plant Pathology Departments to identify pests as a number of pests such as the rice seedbed beetle had not been identified. The consultant had to seek other sources to identify it. The IPM IL is in a position to help in this regard as several of its global programs focus on assisting national programs to improve these services.

Recommendations: Increase the capacity of staff in diagnostic services either through consultancies or through short-term training courses in US universities that specialize in pest identification. Also, modern methods of identifying plant viruses have been developed and there are standard practices for plant virus identification.

NARC should embrace this opportunity and ensure that a cadre of staff is trained to undertake accurate pest identification, particularly for plant pathogens and arthropods.

5. There is a lack of sufficient bio-rational tools, bio-pesticides, and green-labeled pesticides in Agrovet stores.

Few safe green insecticides were seen in the market and of the many pesticides being registered, less than 1% fall into the category of bio-pesticide based on microbial agents. The IPM IL has been conducting applied research in Nepal for a decade and has developed packages of best practices for the main vegetable crops of concern in KISAN that replace the need for synthetic pesticides. These products are not stocked in Agrovet stores as there is no farmer demand for them. Bio-rational tools consist of pheromone traps, fruit fly lure traps, yellow sticky traps, and reflective plastic mulches. Most of these products are currently sourced from India by Agrovets. It is hoped that this will occur on a wider scale in Nepal as a result of the IPM training course KISAN will conduct for farmers and relevant change agents. As demand increases, local Agrovets are expected to begin importing bio-pesticides from India.

Recommendations: KISAN should provide training to Agrovets on safe pesticides and facilitate linkages to suppliers. When possible, local production should be encouraged. If the demand is high, companies are anticipated to be motivated enough to begin production in Nepal.

6. PESTICIDE SAFER USE ACTION PLAN

Based on the findings and recommendations presented in preceding sections, the PERSUAP expert has developed a plan that itemizes key tasks so that pesticide usage can be carried out in a safe and environmentally friendly manner in Nepal for the benefit of those who depend on safe food being available in the market place. These draw on guidance from US EPA, FAO, and GON. Table 12 summarizes the actions recommended for KISAN to adopt to improve safe pesticide use.

Table 12a. Recommendations for a Pesticide Safer Use Action Plan: GON

Concern	Mitigation Recommendations	Responsibility
Lack of trainer manpower, services, and sufficient institutional backing to implement improved IPM	Ministry of Agricultural Development or NARC prioritizes:	
	1. Establishes and funds an accredited pesticide residue laboratory and trains staff to run them.	Ministry of Agricultural Development Department of Agriculture Plant Protection Directorate
	2. Functionally equip and train staff to run the five bio-control laboratories in Nepal	*ibid*
	3. More research emphasis should be devoted to developing IPM crop monitoring protocols and decision thresholds for major pests	*ibid*
	4. Pest diagnostic services improved through better linkages with IMP IL.	*ibid*
	5. Supports more bio-rational tools, bio-pesticides, and green labeled pesticides available for sale to farmers in Agrovet stores.	*ibid*

Source: Based on consultant's interactions and assessments.

Table 12b. Recommendations for a Pesticide Safer Use Action Plan: USAID

Concern	Mitigation Recommendations	Responsibility
	The USAID MEO should form a committee of stakeholders to be able to follow up on the mitigation recommendations of this PERSUAP and agree on the frequency of meetings to ensure compliance. The MEO should coordinate with the Pesticide Technical Committee and the Plant Protection Directorate. Minutes should be taken in all formal meetings. Meetings should be at least twice a year. This could be called a Pesticide Safer Use Action Committee	USAID Mission Environmental Officer
	USAID should consider having IFPRI, who is working on Feed the Future Policy issues, raise a broader awareness of pesticide issues in Nepal including market access issues and the institutional framework.	USAID

Source: Based on consultant's interactions and assessments

Table 12c. Recommendations for a Pesticide Safer Use Action Plan: KISAN

Concern	Mitigation Recommendations	Responsibility
Farmers lack of knowledge on the characteristics and use of pesticides	KISAN training programs to include in curricula:	
	1. Farmers to take care when measuring pesticide into a sprayer from pesticide container not to spill and have a bucket of water nearby in case they do spill.	KISAN Staff
	2. Farmers to understand the severe danger of spraying with a leaking sprayer and replace it when discovered.	*ibid*
	3. Wear appropriate PPE for each level of toxicity (stress learning how to spray to the side; wear a waterproof apron or rain pants).	*ibid*
	4. Learn the parts of the body most prone for entry of pesticides.	*ibid*
	5. How to tell from a pesticide label the most toxic pesticides.	*ibid*
	6. Do not spray grain directly with pesticide.	*ibid*
	7. Observe the waiting period for each pesticide.	*ibid*
	8. Use gloves to directly handle pesticides.	*ibid*
	9. Learn how to monitor each crop for pests and what the action thresholds are for the main pests.	*ibid*
	10. Learn the bio-pesticides do not kill the pest rapidly, but that is alright.	*ibid*
	11. Farmers learn how to read pesticide labels.	*ibid*
	12. Farmers know the difference between a pesticide common name and trade name.	*ibid*
	13. Farmers learn how to calculate the least expensive trade names for the same pesticides.	*ibid*
	14. Farmers learn the acute signs of being poisoned.	*ibid*
	15. Pregnant and nursing women and children never apply pesticides.	*ibid*

Table 12c. Recommendations for a Pesticide Safer Use Action Plan: KISAN

Concern	Mitigation Recommendations	Responsibility
	16. Know how to properly dispose of empty pesticide containers.	*ibid*
	17. Learn what chronic illness' can be contracted from prolonged exposure to pesticides.	*ibid*
	18. Learn how pesticides can contaminate the environment.	*ibid*

Source: Based on consultant's interactions and assessments.

In addition, USAID and KISAN could take three primary steps to ensure pesticide safer use action planning in Nepal.

Step One: Establish Pesticide Safer Use Action Committee

The USAID Mission Environmental Officer should set up a committee of the stakeholders at his discretion, such as those that were invited to the PERSUAP consultant's debriefing, that would meet at least once a year to review progress in implementing the recommendations outlined in the Safer Use Action Plan. Each stakeholder may identify personnel who would have this duty and would act as monitors. The USAID Mission Environmental Officer would visit project sites as follow-up to see progress first hand. Minutes of the meetings would be shared with the Senior Regional Environmental Officer and others as deemed appropriate. As many of the concerns do not directly imply changes in procedures of the partners themselves but of GON agencies, stakeholders can only make suggestions.

Step Two: Identification and use of US EPA and GON-recommended safe pesticides

The PERSUAP will reduce the hazards of pesticide use in project activities by requiring that only those in Toxicity Classes III and IV be used by KISAN trained farmers. There are a sufficient number of pesticides that are available and duly registered both with GON and US EPA that can be recommended for all the crops and livestock uses that will be considered by KISAN. All pesticides are approved by US EPA for unrestricted same or similar use as mandated by 22 CFR 216.3(b)(1)(i.). These are listed in Appendix IV for crop pests and include:

- Six insecticides (acetamiprid, buprofezin, chlorantraniliprole, imidacloprid, sulphur, and thiamethoxam), and three bio-insecticides/acaricides (azadirachtin, Beauvaria bassiana, Metarhizium anisopliae);
- Four fungicides (carbendazim, mancozeb metalaxyl + mancozeb, sulfur);
- Three bio-fungicides (azadirachtin, *Pseudomonas fluorescens, Trichoderma viride*);
- Three bactericides (copper oxychloride 50% WP formulation, Streptomycin sulphate, Tetracycline hydrochloride); and
- Two bio-nematicides (azadirachtin [neem cake], *Pseudomonas fluorescens*).

Pesticides that were considered to be too toxic or hazardous are not allowed include:

- Fourteen insecticides (alphamethrin, carbofuran, chlorpyrifos-ethyl, cypermethrin, deltamethrin, demeton-S-methyl, dichlorvos, diflubenzuron, dimethoate, endosulfan, fenitrothion, fenvalerate, malathion, phorate); and
- Four fungicides (captan, dinocap, edifenphos, thiophanate-methyl).

The PERSUAP also encourages safer pesticides as replacements as soon as they become registered in Nepal. These include:

- One insecticide (spinosad);
- Three bio-insecticides (*Bacillus thuringiensis*- var. kurstaki, *Heliocoverpa* NPV, *Spodoptera* NPV);
- Two bio-fungicides (*Bacillus subtilis, Trichoderma harzianum*); and
- Two bio-nematicides (*Bacillus firmus, Paecilomyces lilacinus*).

In addition, this PERSUAP covers pesticides effective against ectoparasites of livestock, such as ticks and lice.

- Three insecticides/acaricides are approved (amitraz, cypermethrin 5% EC, malathion EC); and
- Not approved were two insecticides/acaricides (deltamethrin, fenitrothion).

The PERSUAP will be implemented mostly through the farmer training program carried out by KISAN staff. The training curriculum will stress the importance of IPM and not to use pesticides until an action threshold has been reached. This information is detailed in Appendix II. The KISAN training team now has to flesh out this information in their crop-based curricula along with training on safe use of pesticides to address concerns outlined in Section 5 of the report. There are enough safe insecticides already recommended in this PERSUAP that are approved by the GON so that training can be implemented without waiting for new pesticides to be registered. USAID should press GON to implement other recommendations for mitigation in the Pesticide Safer Use Action Plan. To do this, the MEO stakeholders' committee should work with the GON Pesticide Technical Committee and meet regularly to strengthen pesticide regulations as outlined in Section 5 of this report which lists concerns.

Step Three: Integration with GON for wider impact

The KISAN Project will work in close coordination with GON. An outline of the mitigation measures which will address the consultant's concerns are elaborated in Section 5. KISAN will work to integrate the PERSUAP recommendations at a wider level through alignment with GON at national and district levels. Minutes should be taken in all meetings.

1. The first area the GON needs to strengthen is its pesticide regulatory and enforcement system by addressing the five points in Table 12b. These will need to be addressed first by the Pesticide Technical Committee.
2. To address the areas where farmers lack appropriate knowledge, the training curriculum needs to tackle the points listed in Table 12c.

In summary, the KISAN PERSUAP Action Plan is presented in Table 13 below. The finding of the KISAN PERSUAP is that after rejecting the most toxic pesticides, that there are enough safe ones to recommend to farmers without having to find replacements. Even after the hazardous pesticides are rejected, those that are recommended (Appendix IV and V) are sufficient to control the common pests of the crops in Appendix II as well as livestock ectoparasites. This means that there can be immediate training of farmers without having to recommended replacements.

Table 13. KISAN PERSUAP Action Plan

Immediate actions recommended for safety

- KISAN should promote the use of pesticides in Appendix IV for crops and the two recommended/GON approved pesticides in Appendix V for livestock.
- KISAN should incorporate the IPM practices in Appendix II and those pesticides in Appendix III in its training curricula including the pesticide safety information outlined in Table 12 and the concern for 'Weak pesticide regulatory and enforcement system' of section 5.1. KISAN must only promote pesticides approved by GON and US EPA.
- Findings of this PERSUAP should be disseminated broadly to project staff and project partners who will need to abide by the PERSUAP recommendations.
- Sharing the broad findings with the Plant Protection Directorate, FAO project that promotes IPM and Entomology Department of NARC

Continuous actions recommended for safety

- KISAN must not promote the use of the more hazardous pesticides (EPA Toxicity I and II) in KISAN's extension activities or extension materials, unless specified otherwise in this PERSUAP.
- As other safe pesticides become registered by GON, they should be considered approved for permitted use under this PERSUAP
- Train Agrovets and commercial sprayers and producers in safe pesticide use practices covering topics such as: use of protective clothing, pesticide storage and disposal, restricted entry intervals, environmental protection – especially regarding protection of aquatic habitats and terrestrial wildlife including bees, environmental, health and safety (EHS) procedures[3] or the projects EMMP procedures. Trainings should have a special focus on extreme toxicity and dangers of aluminum phosphide.
- Implement a training program for agronomists working in agricultural supply stores (Agrovets). This training program should include a complete curriculum on pests/disease, plant protection products, application methods, safe use practices, pesticide storage and waste handling, EHS procedures. The training should be designed in cooperation with the Pesticide Registration Directorate.

Actions recommended by January 2014

- Update WI's IPM training modules that cover vegetables to also cover cereals by drawing on other USAID funded manuals already produced. These should provide information on practical ways/cultural methods to reduce pesticide use.

- Integrate aspects of simple safe pesticide use in training courses for KISAN staff, Agrovets, and farmers with general information on pesticide toxicity, safe handling practices, safety clothing, EHS procedures, and best practices in disposal of empty pesticide containers. KISAN will consider possibilities of translating IPM-related material into the major local languages in the project areas.

[3] Environmental health and safety procedures are a set of guidelines that companies must abide by to prevent accidents and adverse effects.

Table 13. KISAN PERSUAP Action Plan

Actions recommended by June 2014

- If resources allow, conduct stakeholder meetings/roundtables that will include key industry leaders, Ministry of Agriculture representatives, input suppliers, and others are a great strategy to getting the word out. Pesticide issues should be raised through the media to discuss pesticide use as well as market demands for safe products. Such events could be conducted in cooperation with the Plant Protection Directorate and the FAO project that promotes IPM.

Program management actions on compliance

- KISAN will annually review this PERSUAP and US EPA registration status, and EPA and WHO Toxicity Classes of approved pesticides, and will report to USAID on any significant revisions.

- As part of its EMMP, KISAN will implement the risk mitigation and monitoring plan described herein, and report in Project Quarterly Reports on successes and failures. Where monitoring indicates that safer use practices are not being implemented, or where they are not adequately addressing impacts, KISAN will report to USAID and develop ways to respond to the problem.

- PERSUAP mitigation and monitoring requirements will require KISAN to provide funding to implement the above measures; the KISAN project budget will be adjusted accordingly.

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Bio Fungicides (Crops)

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Environmental Protection Agency. Pesticide Product Label System
http://iaspub.epa.gov/apex/pesticides/f?p=PPLS:102:::NO::P102_REG_NUM:2217-836

2. **Pseudomonas fluorescens**

Environmental Protection Agency. Pesticides registration review.
http://www.epa.gov/oppsrrd1/registration_review/pseudomonas_fluorescens/

3. **Trichoderma sp**

Washington State University Extension
http://ext.wsu.edu/PNN/user/files/Trichoderma%20species%20Final%20Review%20Decision.pdf

Bactericides

4. **Copper oxychloride 50% WP formulation**

Environmental Protection Agency. Pesticide Product Label System
http://www.epa.gov/oppsrrd1/REDs/copper_red_amend.pdf

5. **Steptomycin sulphate**

Environmental Protection Agency. Data Evaluation Record.
http://www.epa.gov/opp00001/chem_search/cleared_reviews/csr_PC-006310_16-Jun-92_a.pdf

6. **Tetracycline hydrochloride**

PAN Pesticides Database – Chemicals. Chemical Search.
http://www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC36448

Bio Insecticides

7. **Beauveria bassiana**

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http://npirspublic.ceris.purdue.edu/ppis/product.aspx
Environmental Protection Agency. Pesticide Product Label System
http://iaspub.epa.gov/apex/pesticides/f?p=PPLS:102:::NO::P102_REG_NUM:100-936

13. Sulphur

National Pesticide Information Retrieval System (NPIRS). Product Report.
http://npirspublic.ceris.purdue.edu/ppis/product.aspx
Environmental Protection Agency. Pesticide Product Label System
http://iaspub.epa.gov/apex/pesticides/f?p=PPLS:102:::NO::P102_REG_NUM:4-62

14. Imidacloprid

National Pesticide Information Retrieval System (NPIRS). Active Ingredients. BAYER CROPSCIENCE LP, 264 http://npirspublic.ceris.purdue.edu/ppis/chemical2.aspx
Environmental Protection Agency. Pesticide Product Label System
http://iaspub.epa.gov/apex/pesticides/f?p=PPLS:102:::NO::P102_REG_NUM:264-755

Fungicides

15. Metalaxyl + Mancozeb

Environmental Protection Agency. Pesticide Product Label System
http://www.epa.gov/pesticides/chem_search/cleared_reviews/csr_PC-113501_14-Feb-86_a.pdf

16. Carbendazim

PAN Pesticides Database – Chemicals. Chemical Search.
http://www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC32862
Pesticides: Topical & Chemical Fact Sheets http://www.epa.gov/pesticides/factsheets/chemicals/carbendazim-fs.htm

17. Mancozeb

National Pesticide Information Retrieval System (NPIRS). Product Report.
http://npirspublic.ceris.purdue.edu/ppis/product.aspx
Environmental Protection Agency. Pesticide Product Label System
http://iaspub.epa.gov/apex/pesticides/f?p=PPLS:102:::NO::P102_REG_NUM:2935-496

Insecticides (Livestock)

18. **Cypermethrin 5% EC**

Environmental Protection Agency. Pesticide Product Label System
http://www.epa.gov/oppsrrd1/REDs/cypermethrin_red.pdf

19. **Malathion EC**

National Pesticide Information Retrieval System (NPIRS). Product Report.
http://npirspublic.ceris.purdue.edu/ppis/product.aspx
Environmental Protection Agency. Pesticide Product Label System
http://iaspub.epa.gov/apex/pesticides/f?p=PPLS:102:::NO::P102_REG_NUM:4-99

APPENDICES

APPENDIX I. LIST OF PERSONS MET AND INTERVIEWED.

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District Coordinator

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Department of Agriculture
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Khajura

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Banke, Nepalgunj

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Eak Jaj Budhathoki

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Khajura

Regional Agricultural Research Station (RARS) Khajura
Yubaraj Pandey
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Bishnu Gyawali
IPM Specialist

CEAPRED

Nepalgunj
Banke District, Bageshwori VDC, B-gao village
Panhajhoti Agriculture Cooperative
Private entities

Agrovets
National Seed Centre
Lagankhel, Scout Building
Lalitpur

Bhupsh Man Joshi
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Email: jaju_J@yahoo.com

Seed suppliers
Dr. Kedar Budhathaki
Tomato breeder and seed producer
Lallitput

APPENDIX II. IPM IL TOMATO PACKAGE

Hill - Tomato Non-Chemical IPM Package

Technology	Transplanting Time	Harvesting Time
Plastic tunnel	April-September	June-November
	September-November	November-January
Open field	February-August	April-October
	September-November	November-January

Region: Mid-hills (temp. 20-30^{0}C)

Varieties: Srijana, Bisesh, Dalila (Medium Fruit), Grescco-1, CL – 1131, Care-Nepal (Small Fruit), BSS-20. Themes-2, Trisana, Winsari (Large Fruit)

Seed

Use disease-free seed or seed washed with Somguard at 20ml/liter of water to remove virus, bacteria and fungus from the seed coat, soaking seed for 20 minutes, then shade drying. Mix 1kg of healthy seed with Molasses slurry five ml, Biohume[4] 5ml and Microbial consortium[5] 1g. Dry mixture and sow within a few days.

Seedling preparation: Seedlings are raised in poly bags containing forest top soil or solarized soil, neem seed powder, bio-fertilizers and bio-pesticides amended compost.

Seed/seedling: 5g/800-1000 seedlings/ropani[6]

Spacing: Row to row: 75cm; plant to plant: 45-60cm

Soil test: From well drained field plot, test the soil and determine the requirement of nutrients and its availability, accordingly apply bio-fertilizers, then determine soil pH before and after harvest of the crop.

Soil pH: Tomato requires soil pH of 6.2 to 6.8.

Cultural practice: Stack, mulch, hand weed and clip off lower leaves from the main stem.

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[4] Bioactive, Humic & Fulvic Substances from vermi compost (contains balanced nutrients required for the crop).

[5] Microbial consortium (Bio-fit) consists of *Ampelomyces quisqualis, Fusarium prolifiratum, Trichoderma viride, Trichoderma harzianum, Pseudomonas fluorescence* and *Bacillus subtilis.*

[6] 1 ropani = 500m^2.

Trade link: Information on access to market and the duration of peak price period.

Fertilizers (Bio)	Basal dose
Well decomposed farm yard manure (FYM)	1000kg/ropani
Nitrofix – AZ, *Azospirillum*	500g/ropani
P Sol – B, *Bacillus megaterium*	500g/ropani
K Sol – B, *Frateuria aurantia*	500g/ropani
Zn Sol – B, *Thiobacillus thio-oxidans*	500g/ropani
S Sol – B, *Thiobacillus ferro-oxidans*	500g/ropani
Mn Sol –B, *Corynebacterium*	500g/ropani
VAM – Vassicular Arbuscullar Mycorryza (solubilizing P, Bo, Mo, Fe, Cu)	500g/ropani
Meterhizium anisoplae, M.a. (W.P.) against soil borne insects pests	500g/ropani
Trichoderma viride, T.v.(W.P.) against soil borne diseases	500g/ropani
Paecilomyces lilacinus, P.l. (W.P.) or Bacillus firmus, B.f. (W.P.) against root knot nematode	625g/ropani

Amend all bio-fertilizers, bio-insecticides & bio-fungicides in 50kg FYM and apply at root zone of each plant. Prepare the mixture 15 days before use and keep in air tight poly bags with 80% moisture. Store in a dark, dry, cool place.

Crop establishment: During initial stage of crop or period of stress, apply Biohume 6%SL; mix five ml/liter of water for root dip or nursery drenching applied by drip or spray. If needed, mix five g of Oxyrich - N/liter of water and drench nursery bed for planting 800m^2 of seedling.

Irrigation: Drip for hill and treadle pump for terai.

Pests (Insects & Disease) Management

Tomato fruit worm: Larvae feed with head inside the fruit and the body outside. Install five pheromone traps/ropani using "*Helicoverpa armigera* -lure in a funnel trap" and also monitor the fruit worm moths from the date of planting and continue till the date of final harvest. Manage at early stage of larval development by spraying Nuclear Polyhedrosis Virus of *Helicoverpa armigera,* (*Heli*-NPV) at 0.5-1ml per liter or *Bacillus thuringiensis* var. *kurstaki* (*Btk*) at one to two g per liter or Borer guard[7] at 0.5-1ml per liter of water to the point of drenching at 15 days interval.

White fly: Flies suck the cell sap and leaves become yellow; plant looks diseased and finally wilts. Flies transmit virus to new plants. Practice trap crops (Beans or Soybean). Spray *Verticillium lecanii* at 0.5g per liter or *Karanjin* at one to two ml per liter or *Azadirachtin* at two to fiveml per liter of water on the lower surface of leaf to the point of drenching at 15 days interval.

Myrid bug: Adults suck the sap from pedicel of leaves, flower and twigs, making a ring. Affected part breaks after a few days. Control management as indicated for white fly after appearance of symptoms.

Leaf minor: Maggots create irregular tunnel in the upper layer of the leaf. Control management as indicated for white fly after appearance of symptoms.

Damping off: Shoots near the soil get infected and plant topples down. Treat the seed with Bio-fit at 1g/kg of seed, use solarized soil or use compost amended with *Trichoderma* sp. at 10g per kg of compost.

[7] Borer guard consists of *Bacillus thuringiensis* var. *kurstaki, Verticillum lecanii, Beauvaria bassiana* and *Metarhizium anisoplae* and a microbes like Silrich constituting *Aspergillus awomori, Trichoderma viride, Cellulomonas uda*, and *Cellulomonas gelida*.

Leaf blight or fruit rot: Leaves are blighted, later on fruits are also blighted, and fungal growth can be seen under the leaf during cool and humid weather. Use healthy seeds and treat seeds as indicated under seed treatment.

Plant wilting (Bacterial): Whole plants wilt and die. Use healthy seeds and treat seeds as indicated under seed treatment.

Plant wilting (*Fusarium*): Plant wilts and dies. Use healthy seeds and treat seeds as indicated under seed treatment.

***Alterneria* leaf spot /Early blight:** Brown or black spot with concentric rings formed in the leaf, which merge later on to give leaf a blighted appearance. Use healthy seeds and treat seeds as indicated under seed treatment. Use disease-resistant variety like Srijana, do not grow in sick plot, and practice crop rotation.

Mosaic virus: Mosaic pattern appears on the leaves, leaf wrinkle and yellowing. Use healthy seeds and treat seeds as indicated under seed treatment. Raise seedling in solarized soil, uproot the plants, using fresh cow milk at 20ml per liter of water.

Nematode: Stunted growth, small leaf, and small nodules in roots. Use healthy seeds and treat seeds as indicated under seed treatment. Raise seedlings in solarized soil, use tolerant variety to Nematode, use neem seed powder two to three kg per ropani, crop rotation, use grafted seedlings with resistant to root knot nematode and wilt (*Solanum sysembifolium*) as root stock and Srijana as scion.

Gray wall: Dark gray color in fruit peel, hard fruit. Poor light intensity due to cloudy weather and potash deficiency. Maintain proper aeration.

Blossom end rot: Gray to black color in fruit blossoms and fruit end.

Agro boom – (Induce flowering) Spray at 2g/liter of water 15 days before flowering stage if necessary repeat after 15 days only.

1st Top dressing (One month after field transplant or at flowering stage)

Well decomposed farm yard manure (FYM)	500kg/ropani
Nitrofix – AZ, *Azospirillum*	250g/ropani
P Sol – B, *Bacillus megaterium*	250g/ropani
K Sol – B, *Frateuria aurantia*	250g/ropani
Zn Sol – B, *Thiobacillus thio-oxidans*	250g/ropani
S Sol – B, *Thiobacillus ferro-oxidans*	250g/ropani
Mn Sol –B, *Corynebacterium*	500g/ropani
VAM – *Vassicular Arbuscullar Mycorryza (solubilizing P, Bo, Mo, Fe, Cu)*	250g/ropani
Meterhizium anisoplae, M.a. (W.P.) against soil borne insects pests	250g/ropani
Trichoderma viride, T.v.(W.P.) against soil borne diseases	250g/ropani
Paecilomyces lilacinus, P.l. (W.P.) or	
Bacillus firmus, B.f. (W.P.) against root knot nematode	315g/ropani

Amend all bio-fertilizers, bio-insecticides and bio-fungicides in 25kg FYM and apply at root zone of each plant. If the proportion of female flowers is low, then apply Biohume 6%SL at 5ml/liter of water.

2nd Top dressing (At fruit development stage)

Well decomposed farm yard manure (FYM)	500kg/ropani ($500m^2$)

Amend all **bio-fertilizers bio-insecticides,and bio-fungicides** in 25kg FYM and apply at root zone of each plant

Nitrofix – AZ, *Azospirillum*	250g/ropani
P Sol – B, *Bacillus megaterium*	250g/ropani
Zn Sol – B, *Thiobacillus thio-oxidans*	250g/ropani
S Sol – B, *Thiobacillus ferro-oxidans*	250g/ropani
K Sol – B, *Frateuria aurantia*	250g/ropani
Mn Sol –B, *Corynebacterium*	500g/ropani
VAM – *Vassicular Arbuscullar Mycorryza (solubilizing P, Bo, Mo, Fe, Cu)*	250g/ropani
Meterhizium anisoplae, M.a. (W.P.) against soil borne insects pests	250g/ropani
*Trichoderma viride, T.v.(*W.P.) against soil borne diseases	250g/ropani
Paecilomyces lilacinus, P.l. (W.P.) or	
Bacillus firmus, B.f. (W.P.) against root knot nematode	315g/ropani
Biohume – Bioactive, Humic & Fulvic Substances	

APPENDIX III. IPM CROP MONITORING PROTOCOLS

The follow are IPM crop monitoring protocols and actions to address insect pests and plant pathogens on rice, maize, lentils, tomatoes, crucifers, cucurbits, and eggplant in the context of integrated crop management.

Crop	Pest	IPM practices
RICE		
Insect pests	Rice has a high ability to tolerate insect pest damage especially when managed well agronomically. Incorporate P and K into the soil before planting and broadcast N (urea) after transplanting to promote tillering. The second top dressing should occur at panicle initiation stage 60 days before harvest at panicle initiation. Grow a medium maturing variety to provide capacity for borers and gall midge to tolerate damage. Normally, there are enough beneficial arthropods in the field to control most insect pests but if the field is sprayed, the natural enemies will be killed and the farmer is deprived of the control they do naturally. Also the action thresholds (AT) will be lower if the crop is under other stresses. The less you use insecticide the more natural enemies will thrive to give natural control.	
	Stem borer *Scirpophaga incertulas*	Beginning the third week after transplanting and weekly until panicle exertion, examine the rice field for deadhearts caused by stemborer. In the early stages before panicle initiation the crop can tolerate 20 to 30% deadhearts. After panicle initiation, the crop can tolerate 10 to15% deadhearts. Do not monitor whiteheads as it is too late. The key crop stages where stemborer damage can be greatest are tiller elongation and panicle exertion. Only apply chlorantraniliprole (Ferterra G or Coragen SC) insecticide at these stages when greater than 20% deadhearts during tiller elongation and greater than10% in panicle exertion.
	Green leafhopper *Nephotettix*	Resistant variety. Green leafhopper is only a pest as a vector of virus diseases such as tungro, as even in high numbers it does not damage rice. At times, high numbers occur which indicates that the farmers are planting highly susceptible varieties.
	Brown planthopper (BPH) *Nilaparvata lugens* Whitebacked planthopper (WBPH) *Sogatella furcifera* can be mistaken for BPH	If the variety of rice is not resistant to BPH then scout. Beginning the third week after transplanting walk across the field and slap a number of plants with your hand. This will dislodge hoppers onto the water surface where they can be seen. If they are present in moderate numbers then count their number on 20 hills. The AT is one hopper per tiller and

Crop	Pest	IPM practices
		the field should be sprayed when large nymphs are dominant. Do not spray when there are only small nymphs or adults as the eggs will not be killed and resurgence can occur. If the population is building up, then sample twice a week. Once the AT surpasses, spray buprofezin and direct the nozzle below the canopy
	Seedling nursery beetle	Adults and larvae of a scarab beetle *Heterorynchus* sp. is a reported pest of seedbeds. Young plants can tolerate up to 50% defoliation at this stage. Spray a **neem** based insecticide when 20% damaged leaves is reached.
	Armyworms *Mythimna,* grasshoppers	Rice can tolerate 30% defoliation before panicle initiation therefore spray **acetamiprid** or **neem** based insecticide when 20% damaged leaves is reached. Flooding is a method to control armyworms.
	Mealybug *Pseudococcus*	Mealybug, a pest of upland rice, and is only going to be a problem when the crop is drought stressed. Then spray **neem** based insecticide to the areas of the field where the infestation is.
	Hispa *Dicladispa armigera*, leaf roller *Cnaphalocrocis medinalis*	Both of these pests reduce the leaf area for photosynthesis but normally rice has more leaves than it needs. The crop can withstand more defoliation in the vegetative stage and early reproductive stage so the AT then is 20% damaged leaves and 10% at later stages. Determine the percentage of damaged leaves from 20 hills by counting all tillers. Spray a **neem** based insecticide or **acetamiprid** when the threshold is reached.
	Rice bug *Leptocorisa oratorius*	This insect is only a problem in small isolated fields or fields that were planted out of synchrony with the neighbors. It seeks flowering and milky stage rice. Unfilled grains are normally 10% in modern rice so their presence does not mean rice bug was the problem. Also various fungi cause black spots on grains not just rice bug. The AT is six rice bugs/m^2 spray a **neem** product.

DISEASES Seed sterilization or pathogen free seed is the easiest way to minimize most diseases. Use disease-free seed or seed soaked for 10 minutes with a disinfectant such as Somguard (20ml/liter of water) or household bleach (a 1:10 dilution of a 5.25% sodium hypochlorite solution, do not rinse, then shade dry). This practice will remove virus, bacteria and

Crop	Pest	IPM practices
	fungus from the seed coat. It is also prudent to treat the seed with a fungicide such as **carbendazim** or **mancozeb**. The fungicide becomes systemic in the plant giving broad protection. Remove plant debris after harvest and rotate rice with another crop.	
	Blast *Magnaporthe grisea*	If blast is a common problem in the area and a resistant variety is not available, treat the seed with **carbendazim**. Blast is more severe when N application is high and dew occurs at night. Start scouting in the seed bed as close planting and high N encourages more blast. If the disease is increasing, then spray the mixture of **carbendazim + mancozeb** WP. If the infection is high, then several applications will be necessary
	Bacterial leaf blight *Xanthomonas oryzae*	Chose a resistant variety if the disease is common in the area. The bacteria are spread through wounds that are caused during high winds. The infected field should be kept well drained and avoid water stagnation soon after infection is detected. Apply potassium fertilizer in two split doses at tillering and pre-flowering stages. Avoid using high doses of nitrogenous fertilizers. It is a bacterium thus fungicides are not effective. Bactericides also are usually ineffective as foliar sprays.
	Brown leaf spot *Bipolaris oryzae*	The fungal disease attacks the crop from the seedling stage in the nursery to the milk stage in the field. Destroy crop residues and stubble of previous crop. Avoid using high doses of nitrogenous manures/ fertilizers. Emphasis should be given on phosphorous availability to rice crop because the brown spot disease incidence is more in phosphorous deficient soils.
	Foot rot or bakanae *Fusarium moniliforme*	Tillers elongate. This fungus can be controlled with **mancozeb** spray when the incidence is increasing.
	Sheath blight *Rhizoctonia solani*	Timely weed management, spaced planting and balanced fertilization (especially P_2O_5 and K_2O) are some of the practices that can reduce inoculum and disease development. Three foliar sprays of **mancozeb** at 10 d interval minimize disease spread.

MAIZE – Farmers plant traditional varieties, improved open pollinated varieties, and hybrids

Crop	Pest	IPM practices
	Insects – Seed pests generally have been overlooked but achieving a proper plant stand is an important yield component	
	Seed pests (ants, field crickets)	These soil insects mainly feed on sown seed or newly germinated seedlings. Their effect is to reduce the stand so the best remedy is to increase the seeding rate 5 to10%.
	Termites *Microtermes, Macrotermes*	Termites can also feed on young plants but later on will feed on standing plants particularly on dead tissue. Their damage is generally minor so control is not economical.
	Cutworms *Agrotis ypsilon*	Monitor the field weekly until the sixth leaf stage in five locations sampling 5m row each one and determine percent cut or damaged seedlings. When 10% of plants are cut or damaged, apply a soil drench of **imidacloprid**. Treatment is warranted when corn plants are in the second to sixth leaf stage.
	White grubs *Phyllophaga, Cyclocephala*	If white grubs are a persistent problem, then increase the seeding rate. Apply *Metarhizium anisolopae* bio-fungicide along the rows as a soil drench or treat the seed when planting.
	Armyworms *Spodoptera, Mythimna*	Densities of 0.2 to 0.8 larvae per plant during the late whorl stage can reduce yield by 5 to 20 %. Weekly monitor the crop and monitor egg masses and larval damage from five locations of 5m-row samples. Thresholds: Greater than five percent of plants with egg masses or 25% of plants damaged and larvae present are guidelines for treatment. Apply **chlorantraniliprole**.
	Grasshoppers	Maize can tolerate 30% defoliation before tasseling therefore spray **acetamiprid** or **neem** based insecticide when 20% damaged leaves is reached.
	Maize stem borer *Chilo partellus*	It is advisable to destroy corn stalks after harvest by feeding them to animals or making compost but burning is not as effective in destroying lingering larvae. This will be particularly important between two corn crops where double corn cropping occurs. Weekly sample five times 5m-row: greater than one live larva feeding in the leaf sheaths in 10% of plants, apply **chlorantraniliprole**.

Crop	Pest	IPM practices
	Maize leaf aphid *Rhopilosiphum maidis*	Aphids have great powers of fecundity and also disperse long distances. The aphid population will build up especially when the plants are tasseling and when the crop is under drought stress as rainfall washes many away. Aphids excrete large amounts of honeydew that become infected with black mold so that photosynthesis is curtailed. When they become very abundant they block pollination. There are many natural enemies that will be present that normally keep aphids in check. Weekly sample five times 5m-row: when greater than 25% of the plants have more than 100 aphids per plant and plants are under drought stress, spray **neem**.
	DISEASES	The same disinfectant methods for rice apply to maize seed. Having healthy and clean seed is the first order of priority. If diseases are common in the area disinfect with bleach and treat the seed with a fungicide before planting each season with **carbendazim or mancozeb.** The term an ounce of prevention yields a pound of cure rings true here. Many pests also breed on weeds, so timely and frequent weeding is a very important cultural practice. Early planting and/or early maturing varieties will escape much injury. Then good fertilization of compost or manure plus inorganic fertilizers allows the crop to tolerate much damage for grain loss occurs. Crop rotation and destroying plant residue after harvest are good preventative measures. If diseases occur in the young stage, then try sowing on ridges to drain the soil. In longer maturing varieties, split N into three applications. Hybrids have the most disease resistance, most diseases occur in the rainy season
	Damping off or wilt *Fusarium, Pythium, Rhizoctonia* etc	Fungal pathogens are in the soil and are favored by wet soil. One preventative practice is to sow maize on ridges rather than in a furrow if early rains generally occur in the area. Treating the seed with carbendazim or mancozeb can control soil pathogens.
	Northern leaf blight *Helminthosporium turcicum*	This fungal disease is especially important in the hills. Planting a resistant variety is the only practical control method.
	Southern leaf blight *Bipolaris maydis*	The fungus overwinters in corn debris as spores. Spores are spread by wind or splashing water to growing plants. Select a

Crop	Pest	IPM practices
		resistant variety and undertake crop rotation.
	Stem rot/cob rot *Fusarium graminearum (*sexual stage *Gibberella zeae)*	This fungal disease is associated with mycotoxins that affect human health. Select a resistant variety or apply bio-pesticide **Pseudomonas fluorescens** as a seed treatment.
	Sheath blight *Rhizoctonia solani*	Fungicide seed treatment is a preventative measure and **mancozeb** or **carbendazim** are recommended. If the disease spreads on the foliage then spray the mixture of **mancozeb + metalazyl** WP
	Downy mildew *Perona sclerospora*	The main management interventions include crop rotation, resistant varieties, and remove crop debris after harvest. Also ensure seed has low moisture content (below nine percent) before planting. If the disease is spreading on the foliage, then spray the mixture of **mancozeb + metalazyl** WP
	Head smut *Sphacelotheca reiliana*	The seed treatment with **mancozeb** or **carbendazim** should minimize this pathogen but it is generally uneconomical to spray the standing crop with fungicides.
LENTIL	Seeds are treated with rhizobium culture before sowing. Select a high yielding variety.	
	Insects	Those sowing early will probably escape most pest infestation. Those who planted later will encounter higher infestation.
	Hairy caterpillar *Spilosoma obliqua*	The larvae of this moth have long hairs which can cause irritation to those working in lentil fields. Damage is removal of leaf tissue, and before flowering, the crop can tolerate 25% leaf loss without suffering yield loss. Spray **neem** or **sulphur** when greater than 20% leaf loss.
	Aphid *Aphis craccivora*	Aphids remove plant sap and can produce sooty mold giving a black appearance to foliage. When abundant spray **neem** or **acetamiprid**.
	Pod borer *Heliocoverpa armigera*	This is the most serious insect pest as the worms feed on flowers and pods. When flowering begins look twice a week in the field in five locations. Look carefully at the flowers for one minute in each location. Another monitoring method install five pheromone traps/ropani using *Helicoverpa armigera*

Crop	Pest	IPM practices
		- lure in a funnel trap during the early growth phase and continue through the green pod stage. Check the traps daily and begin control when an average of one moth per trap is found, spray **chlorantraniliprole** (Coragen SC) or **neem**. If **NPV** (Nuclear Polyhedrosis Virus) for *Heliocoverpa* or *Bacillus thuringiensis* var. *kurstaki* are available and are registered one can be sprayed instead.
	DISEASES	If sowing a recently harvested flooded rice field, there is no need for action beyond seed disinfection. If sowing a non-flooded upland field, treat the seed with a dilute slurry of molasses mixed with *Trichoderma sp., Pseudomonas fluorescens* and *Bacillus subtilis*. Let the seeds dry before sowing in the field.
	Bacterial wilt *Ralstonia* sp.	*Pseudomonas fluorescens* and *Bacillus subtilis* microbial agents as a seed treatment should provide protection in upland fields.
	Root rot *Fusarium oxysporum*	*Trichoderma* should provide protection in upland fields against damping off fungi but no disease is expected following puddled rice.
	Blight *Stemphylium botryosum*	This disease is a defoliating fungal disease of lentil and is seed borne. It prefers high temperatures and a minimum of eight hours of leaf wetness for optimal disease development. Crop rotation is a control method. If prevalent then spray **mancozeb** two to three times at 7 d intervals
	Grey mould *Botrytis*	Clouds of *Botrytis* spores become visible when the crop is disturbed, and appear as a velvety growth covering rotting stems and pods. A fungicide such as **mancozeb** should be applied before canopy closure for best results. If conducive (warm and wet) conditions continue, follow up sprays may be necessary 14 days later.
TOMATO	Seeds need to be sterilized to remove pathogens. Use Somguard or household bleach (a 1:10 dilution of a 5.25% sodium hypochlorite solution. Compost also needs to be thoroughly decomposed and Silrich a biocomplex (*Trichoderma reesei, Aspergillus awamori, Cellulomonas uda, Pseudomonas putida*) can do the job in a month. The seeds are treated with another set of bio-fertilizers (mix one kg seed in molasses slurry of five ml and one g of Biohume (*Ampelomyces quisqualis, Fusarium prolifiratum, Trichoderma viride, T. harzianum, Pseudomonas fluorescens,* and *Bacillus subtilis*). Seedlings are raised in forest top soil or	

Crop	Pest	IPM practices

solarized soil and neem seed powder. Graft tomato seedlings onto resistant eggplant rootstock and place in poly bags.

Field cultural practices: stake, mulch, hand weed and continually clip off older leaves at the base of plants. Remove any leaves showing disease and rogue and burn any virus infected plants. Fertilizers (per ropani): one t well decomposed FYM. 500 g each: Nitrofix (*Azopspirillum*), P Sol-B (*Bacillus megaterium*), K Sol-B (*Frateria aurantia*), Zn Sol-B (*Thiobacillus thio-oxidans*), S Sol-B (*Thiobacillus ferro-oxidans*), Mn Sol-B (*Corynebacterium*), VAM (solubilizing P, Bo, Mo, Fe, Cu). Then 625 g each of bio-pesticides *Trichoderma viride* as well as *Paecilomyces lilacinus* or *Bacillus firmis* to control damping off, bacterial blight, and nematodes. Amend all bioagents into 50 kg FYM and store for 15 days in a cool dry place. At transplanting, apply to the root zone of each transplant.

During the period of seedling establishment stress apply Biohume 6%SL with five ml of water. First top dressing, in one month use 250 g/ropani of the same bio-fertilizers and repeat at fruit development stage.

Insects – the main pest is the fruitworm

Pest	IPM practices
Tomato fruitworm *Heliothis armigera*	Place five pheromone traps per ropani using *Helicoverpa armigera* - lure in a funnel trap during the early growth phase and continue through the fruiting stage. Spray **chlorantraniliprole** (Coragen SC) or **neem** when threshold of one moth per trap is exceeded. If **NPV** (Nuclear Polyhedrosis Virus) for *Heliocoverpa* or *Bacillus thuringiensis* var. *kurstaki* are available and registered, one of these products can be sprayed instead.
White flies **Bemesia tabaci**	In other countries placing white plastic sheets on both sides of a crop row will repel them due to the reflection of sunlight. Perhaps a plastic house or tunnel will have the same effect. Spray *Verticillium lecani* or **neem** when first observed at > 1/plant
Leaf miner **Liriomyza trifolii**	Infestation has to be high to cause yield loss. When greater than one tunnel per plant, spray **neem** or if registered **spinosad**.

Diseases – Graft tomato onto wild eggplant rootstock

Pest	IPM practices
Damping off fungi *Fusarium*, etc	Plant on ridges if fields normally wet. Control should occur through the applications of *Trichoderma*.

Crop	Pest	IPM practices
	Early blight *Alternaria solani*	Crop rotation and destroy plant residues. Remove lower leaves of plants. Staking and mulching. Using a plastic house or tunnel. Spray mancozeb when infestation is increasing.
	Late blight *Phytophthora infestans*	Control is the same as for early blight
	Tomato mosaic virus (TMV)	The virus is mechanically transmitted usually by workers. TMV damages the leaves, flowers, and fruit and causes stunting of the plant. The virus almost never kills plants but lowers the quality and quantity of the crop. Selecting healthy seeds and seedlings is a preventative measure. Workers should wash their hands in strong soap and tools boiled in water for five minutes to decontaminate. Bleach does not work here. If virus appears, remove the plants and destroy.
	Bacterial wilt *Ralstonia solanacearum*	The grafting onto resistant eggplant rootstock and incorporating *Pseudomonas fluorescens, Paecilomyces lilacinus*, and *Bacillus firmis* biocontrol agents into the compost at planting. If wilted plants appear, remove and destroy
	Nematodes	Graft tomato seedlings onto nematode resistant wild eggplants for control of bacterial blight and nematodes and provide tolerance during water logging. *Pseudomonas fluorescens, Paecilomyces lilacinus,* and *Bacillus subtilis* have been shown to impart resistance against nematodes.
CRUCIFERS	For cauliflower, earth up one month after transplanting; this helps in larger curd development. Hand weed, plastic mulch, clip off the diseased and dead leaves from the plant. Curd covered and tied with leaves improves flavors and attractiveness. Blanching is important in cauliflower to get good quality curd. The duration of blanching should not exceed three to five days in hot weathers and eight to 10days in cool weather. For the bio-fertilizers and seed sanitation, follow the schedule for tomato but the doses are different so consult someone knowledgeable.	
	Insects	Crop monitoring should have a sample size of 20 plants each sampling date. Weekly sampling is advised. When spraying, be sure to get good coverage and use a sticker-spreader on waxy leaves.
	Cabbage butterfly	The larvae defoliate and in severe infestations, all that is left are the stems and larger veins. Row covers prevent egg

Crop	Pest	IPM practices
	Pieris rapae	laying by the moth. The cabbage butterfly has many natural enemies so it is necessary to conserve them. Sample 30 plants counting the larvae and when one larva/plant is found, apply *Bacillus thuringiensis* var. *kurstaki* (Btk) as the preferred insecticide but if it is not available **neem** or **chlorantraniliprole** (Coragen SC).
	Tobacco caterpillar *Spodoptera litura*	This is another leaf defoliator. Set up five pheromone traps per *katha* specific for *Spodoptera* where the action threshold is a total of four to five moths from the five traps. An alternative threshold is one larvae in two plants. When the threshold is exceeded, spray Nuclear Polyhedrosis Virus of *Spodoptera litura,* (*Spodo*-NPV) or *Bacillus thuringiensis* var. *kurstaki* (Btk). If these are not available, spray **neem** or **chlorantraniliprole** (Coragen SC)
	Diamond-back moth *Plutella xyllostella*	Destroy crop residue after harvest. The larva is smaller than the other two defoliators. Again set up five pheromone traps/katha using *Plutella xyllostella* – lure in a water trap. The action threshold is one moth per trap occurs or one to two larvae per plant. If the threshold is exceeded spray *Bacillus thuringiensis* var. *kurstaki* (Btk) or a **neem** product.
	Cabbage aphid **Brevicoryne brassicae**	Deformation of leaves, and appearance of sooty – mold. Infestations are established by winged aphids migrating from other fields. Early planting will escape much infestation. To sample cross the field and pull leaves from 20 plants and if 20% of the leaves are infested, then spray *Verticillium lecanii* bio-pesticide or a **neem** product which will protect parasites and predators of the aphid.
	Diseases. Sterilize the seed by following the bio-fertilizers and bio-pesticides for tomato and many of disease pathogens will be held in check.	
	Damping off fungi *Fusarium, Pythium*	It is a common fungal disease in the nursery beds. Plant on beds for drainage. Shoots near the soil get infected and plant topples down. Treat the seed with *Bacillus subtilis* and the amended Trichoderma should control these soil fungi.
	Black rot bacteria *Xanthomonas campestris*	Brown to black V-shave lesions develops from leaf margin. The bacteria spread and cause most damage in wet, warm weather so begin the seedbed under a tunnel. Crop rotation and sanitation are needed. If symptoms occur on 10% of

Crop	Pest	IPM practices
		plants spray **copper oxychloride**. High dosages can cause black spots to appear on the leaves.
	Downy mildew *Peronospora parasitica*	The appearance of purplish-brown spots on the lower side of the leaves of this fungal disease. Sanitation and crop rotation helps in reducing the infection of downy mildew which is soil borne. If symptoms appear on 5% of plants spray **copper oxychloride** or **mancozeb**.
	Club root *Plasmodiophora brassicae*	Root knots/ nodules formation, yellowing, plant wilts and dies. Rogue diseased plants. This is a soil borne protozoan so destroy crop residue and use crop rotation. Adding lime or calcium carbonate to the soil will minimize the disease. If 10% of plants show symptoms then spray a soil drench of *Bacillus subtilis.* The spores can remain in the field for years so do not plant crucifers in the field for five years.
	NEMATODES	*Pseudomonas fluorescens, Paecilomyces lilacinus,* and *Bacillus firmus* have been shown to impart resistance against nematodes as soil amendments with the planting compost.
CUCURBITS	Squash/gourds/pumpkin	
	INSECTS	
	Red pumpkin beetle *Aulacophora foveicollis*	Beetles feed on leaves and grubs feed on roots and underground stems. The maximum damage is done when the crop is in the cotyledon stage. The action threshold is two to three beetles/plant; when reached spray a **neem** product or **spinosad**.
	Fruit flies *Bactrocera cucurbitae*	Fly maggot develops inside the fruit and fungi and bacteria lead to decaying of the fruit. The cucurbit fruit flies were prevalent in the field throughout the year. Removing and destroying infested fruits is very important to reduce infestation in the area. Install five pheromone traps/ropani using "US-Cuelure + mashed ripe pumpkin + soapy water in a bottle trap" for mass trapping of males and also to monitor the fruit flies from the date of planting and continue till the date of final harvest. The combination of mass trapping and infested fruit reduction precludes the need for pesticides.
	Epilachna beetle	Both the adult and grub stages of this large ladybeetle feed

Crop	Pest	IPM practices
	Henosepilachna vigintioctopunctata	on the leaf surfaces and skeletonize the leaves which present a lace like appearance. When two larvae or adults occur per plant, spray **neem** product or **spinosad**.
	Aphids *Aphis gossypii*	The wingless female melon aphid has an ovoid body is a rather small aphid that ranges in color from yellowish green to greenish black. The adults and nymphs of the cotton aphid feed on the underside of leaves or on the growing tips of shoots in small colonies, sucking juices from the plant. They also transmit cucumber mosaic virus. If there is one colony per plant, spray a **neem** product or spray the bio-pesticide *Verticillium lecanii*.
	White flies *Bemisia tabaci*	White flies colonize the underside of leaves; adults and eggs are commonly found on the lower surface of younger leaves and the scale-like nymphal stages on somewhat older leaves. Desiccation of plants occurs with moderate-to-heavy populations and the production of honeydew gives rise to sooty mold. In other countries, placing white plastic sheets on both sides of a crop row will repel them due to the reflection of sunlight. Perhaps a plastic house or tunnel will have the same effect. A soil drench of **imidacloprid** or **thiamethoxam** at planting effectively controls white flies by systemic action. If the infestation is building up apply, **buprofezin** which does not affect bees.
	DISEASES	Sterilize the seed (see tomato)
	Powdery mildew *Erysiphe cichoracearum*	Leaves and shoots develop grayish white powder spots. Spores are wind borne. The disease is prevalent when there are warm days and cool nights. When symptoms appear, spray a **sulphur** compound or **neem oil**.
	Downy mildew *Pseudoperonospora cubensis*	Downy mildew first appears as small, pale green to yellow, angular spots delimited by leaf veins that give the foliage a mottled appearance. Eventually the spots coalesce and the leaf will turn brown. It is also air borne and early planting can escape high infection. Use drip irrigation to minimize leaf wetness. When infection begins spreading, spray **mancozeb**.
	Cucumber mosaic virus	This virus is transmitted by aphids. Leaves molt with yellow and green color and in severe condition the upper part of

Crop	Pest	IPM practices
		the plant curls. In other countries placing white plastic sheets on both sides of a crop row will repel them due to the reflection of sunlight. Perhaps a plastic house or tunnel will have the same effect. Spray **neem oil** to interrupt the transmission of the virus during feeding by the aphid. Neem will also control the aphid.
	Cucurbit chlorotic yellows virus	Whiteflies build up rapidly but placing white plastic sheets on both sides of a crop row will repel them due to the reflection of sunlight. Perhaps a plastic house or tunnel will have the same effect. This virus is transmitted by whiteflies. Covering the rows with plastic tunnels may prevent whiteflies from seeing the crop. Spray **neem oil** to interrupt the transmission of the virus during feeding by the whiteflies. Neem will also control the aphid.
EGGPLANT		
	INSECTS	It is important to use selective insecticides so as not to kill natural enemies particularly of the fruit borer. Seedlings grown under a net tunnel will prevent early season insects from finding the crop
	Eggplant fruit and shoot borer *Leucinodes orbonalis*	This is a major constraint in growing eggplants. The moth lays eggs in the stem and fruit and the young larvae bore inside resulting in great damage and loss in fruit quality. Avoid growing eggplant seedlings near fields with standing crops. Avoid monoculture as the moth feeds mainly on eggplants. The symptoms first appear in immature shoots i.e. wilting. Soon after observing wilted shoot, remove and destroy them. Destroy infested shoots and fruit at regular intervals until final harvest. Spray **chlorantraniliprole** following the directions on the label.
	Leafhopper *Amrasca biguttula biguttula*	The leafhopper removes plant sap but as they feed they also inject toxic saliva into the plant tissues, which leads to yellowing. When the yellow appears on most plants spray a neem product. Yellow sticky traps can be placed to control flying hoppers.
	White fly *Bemisia tabaci*	Both the adults and nymphs suck the plant sap and reduce plant vigor. In severe infestations, the leaves turn yellow and drop off. There is no virus transmission for eggplant. When

Crop	Pest	IPM practices
		damage symptoms from feeding become evident spray, a neem product. Yellow sticky traps can be placed to capture adults. If white flies become a large problem, then the farmer may place white plastic sheeting on both sides of the row to repel them
	Aphid *Aphis gossypii*	The wingless female melon aphid has an ovoid body is a rather small aphid that ranges in color from yellowish green to greenish black. The adults and nymphs of the cotton aphid feed on the underside of leaves or on the growing tips of shoots in small colonies, sucking juices from the plant. If there is one colony per plant, spray a **neem** product or *Verticillum lecanii*
	Epilachna Beetle *Henosepilachna vigintioctopunctata*	Both the adult and grub stages of this large ladybeetle feed on the leaf surfaces and skeletonize the leaves which present a lace like appearance. When two larvae or adults occur per plant, spray **neem** product or spinosad.
	DISEASES	Graft eggplant onto resistant wild eggplant. Crop rotation is beneficial with a non-solanaceous crop.
	Damping off fungi *Fusarium*, etc	Plant on ridges if fields normally wet. Control should occur through the applications of Trichoderma.
	Anthracnose *Colletotrichum* species	This disease first appears as small, variously colored, circular spots (those on watermelon are angular) on the older leaves, though it eventually spreads to younger leaves, stems, pods and fruit. The spots enlarge and merge. It is soil borne. Remove leaves when spots appear. Mulch and drip irrigate. It is transmitted on seeds to sterilize seed first. If the damage is spreading, spray **mancozeb**.
	Verticillium wilt *Verticillium sp.*	The soil borne fungus enters the plant through natural openings and wounds in the roots caused by nematodes. It then grows up into the stem where it blocks the supply of nutrients and water to the leaves. This disease should be suppressed by the microbial agents amended with the planting soil. There are no effective fungicides for control.
	Bacterial wilt	The grafting onto resistant eggplant rootstock and incorporating *Pseudomonas fluorescens, Paecilomyces lilacinus*,

Crop	Pest	IPM practices
	Ralstonia solanacearum	and *Bacillus firmis* biocontrol agents into the compost at planting. If wilted plants appear, remove and destroy
	NEMATODES	Graft tomato seedlings onto nematode resistant wild eggplants for control of bacterial blight and nematodes and provide tolerance during water logging.

APPENDIX IV. TOXICITY TABLE FOR PESTICIDES PERMITTED TO USE UNDER KISAN IN NEPAL

Active Ingredient	Class	EPA Reg	Registered in Nepal	Acute toxicity		Chronic toxicity	Ground water	Non-targets								
				WHO	EPA			Fish	Bee	Bird	Amphib-ian	Earth-worm	Mol-lusk	Crus-tacea	Aquatic-invert	Plankton
Insecticides/acaricides																
acetamiprid	chloro-nicotinyl	GUP	Yes	none	III	none	Potential	NAT	MT	PNT				PNT	PNT	
buprofezin	IGR	GUP	Yes	U	III	cancer possible	Not detected		PNT		RNT				HT	
chlorantraniliprole	anthranilic diamide	GUP	Yes	Not listed	IV	none	Potential	ST	NT	PNT				HT	HT	
imidacloprid	chloro-nicotinyl	GUP	Yes	II	II & III	none	Potential	NAT	HT	HT					VHT	
sulphur	inorganic	GUP	Yes	U	III	none	Not detected	ST	PNT	PNT	PNT	PNT	PNT	PNT	PNT	
thiamethoxam	neonicotinoid	GUP	Yes	Not listed	III	III	Not likely	no data	PNT	HT	PNT		PNT	PNT	PNT	PNT
Bio-insecticides/acaricide																
azadirachtin	botanical	GUP	Yes	Not listed	III	endocrine suspect	Not detected	ST	MT	PNT	MT		ST	VHT	HT	
Beauvaria bassiana	microbial	GUP	Yes	Not listed	III			No reason to suspect toxicities/pollution								
Metarhizium anisopliae	microbial	GUP	Yes	Not listed	III			No reason to suspect toxicities/pollution								
Fungicides																
carbendazim	benzimideazol	GUP	Yes	U	III	cancer-possible, endocrine suspect	Not detected	MT	NAT	ST	ST			ST		HT
mancozeb	dithio-carbamate	GUP	Yes	U	III	Cancer-possible	Not detected	MT	MT	ST	HT					NAT
metalaxyl (+ mancozeb)	benzanoid	GUP	Yes	III	III	none	Potential	ST	PNT	PNT	PNT	PNT	PNT	PNT	PNT	ST
sulfur	inorganic	GUP	Yes	U	III	none	Not detected	ST	PNT	PNT	PNT	PNT	PNT	PNT	PNT	
Bio-fungicides																
azadirachtin	botanical	GUP	Yes	NH	III	endocrine suspect	Not detected	ST	MT	PNT	MT		ST	VHT	HT	
Pseudomonas fluorescens	microbial	GUP	Yes	NH	III			No reason to suspect toxicities/pollution								
Trichoderma viride	microbial	GUP	Yes	NH	III			No reason to suspect toxicities/pollution								
Bactericides																
copper oxychloride 50%WP	inorganic	GUP	Yes	III	III	none	Not detected	ST	PNT			HT				VHT
Streptomycin sulphate	microbial	GUP	Yes	NH	III			No reason to suspect toxicities/pollution								
Tetracycline hydrochloride	microbial	GUP	Yes	NH	III			No reason to suspect toxicities/pollution								
Bio-nematicides																
azadirachtin (neem	botanical	GUP	Yes	NH	III	endocrine	Not	ST	MT	PNT	MT		ST	VHT	HT	

Active Ingredient	Class	EPA Reg	Registered in Nepal	Acute toxicity		Chronic toxicity	Ground water	Non-targets								
				WHO	EPA			Fish	Bee	Bird	Amphib-ian	Earth-worm	Mol-lusk	Crus-tacea	Aquatic-invert	Plankton
cake)						suspect	detected									
Pseudomonas fluorescens	microbial	GUP	Yes	NH	III			No reason to suspect toxicities/pollution								

KEY: EPA Reg = Registered by Environmental Protection Agency (EPA); RUP = Restricted Use Pesticide;
Non-target toxicity classification: NAT = Not Acutely Toxic; PNT = Practically Non-Toxic; ST = Slightly Toxic; MT = Moderately Toxic; HT = Highly Toxic; VHT = Very Highly Toxic.

APPENDIX V. TOXICITY LIST OF PESTICIDES PERMITED FOR USE AGAINST LIVESTOCK ECTOPARASITES IN NEPAL

Active Ingredient	Class	Comment	EPA Regis-tered	Regis-tered in Nepal	Acute toxicity		Chronic toxicity Issues	Ground water	Non-targets								
					WHO	EPA			Fish	Bee	Bird	Amphib-ian	Earth worm	Mol-lusk	Crus-tacea	Aquat invert	Plankton
Insecticides/acaricides can be allowed																	
cypermethrin 5% EC	pyrethroid	Solid formulation is tox class III but liquid is a II, need to register in Nepal. Chronic toxicity not a problem as farmers will contact on a few times a year The low concentration is permitted, RUP applies to crops so is not relevant to animals	RUP	Yes	II	III	Cancer-possible	Not detected	HT	HT	PNT			MT	VHT	VHT	VHT
malathion EC	OP	Only EC formulation is EPA tox class III	GUP	Yes	III	III	Cancer-possible	Potential	MT	HT	MT	HT	ST	VHT	MT	VHT	HT
Insecticides/acaricides not approved																	
deltamethrin	pyrethroid	Too toxic,	RUP	Yes	II	II		Not detected	HT	MT		VHT		NA T	VHT	VHT	VHT

KEY: EPA Reg = Registered by Environmental Protection Agency (EPA); RUP = Restricted Use Pesticide; OP = organophosphate
Non-targets = Environmental toxicity classification: NAT = Not Acutely Toxic; PNT = Practically Non-Toxic; ST = Slightly Toxic; MT = Moderately Toxic; HT = Highly Toxic; VHT = Very Highly Toxic;