Workshop on Opportunities and Challenges for Sustainable Production and Protection of the Potato Crop in Vietnam and elsewhere in Asia
Dalat, Vietnam, 25-28 November 2008

Executive summary

The FAO Regional Workshop on Opportunities and Challenges for Sustainable Production and Protection of the Potato Crop in Viet Nam and elsewhere in Asia (WOCSPPPCVA), co-organized by the Potato Vegetable and Flower Centre and the FAO Vegetable IPM Programme, was held in Da Lat city from 25-28 November 2008. Thirty-one participants, most of them senior IPM trainers, from seven countries (Bangladesh, China, Indonesia, Nepal, Philippines, Thailand and Vietnam) participated. Seven resource persons from national & international research institutions with key technical potato production and protection experience shared their knowledge with participants at the workshop. Also representatives from the private sector and key FAO staff and consultants participated in the workshop.

The workshop activities included (i) country presentations, (ii) classroom lectures and laboratory/field practical training by resource persons, (iii) field visits to observe on-going disease management investigations (iv) discussions to identify training needs and opportunities to strengthen existing and developing new potato FFS training curricula.

In general, the WOCSPPPCVA has enabled participants to:

- *Understand the importance of potato as food staple and cash crop;*
- *Gain in-depth knowledge of potato production and protection principles,*
- *Master the concepts and principles of integrated potato crop management;*
- *Be able to identify opportunities and challenges for the integration of potato in farming systems;*
- *Identify main potato disease pathogens in the field;*
- *Experience how to develop IPM for potato, particularly with regards to potential role that farmers themselves can play in this process;*
- *Establish networking among participants, including resource persons and industry, involved in potato production;*
- *Generate ideas for strengthening existing –and development new-Potato IPM-FFS training curricula.*

Evaluation by participants of the WOCSPPPCVA at the end of the training indicated that the course was well organized, highly informative and successful. Participants not only have learned a lot about potato crop production and protection but have also enjoyed and made many useful contacts for future consultation and collaboration within the IPM community.

Section 1 Background

Potato (*Solanum tuberosum*) originated in the highlands of Peru, South America, where it has been grown and consumed for more than 8,000 years. Potato is a main source of carbohydrates. A single medium-sized potato contains about half the daily adult requirement of vitamin C. Other staples such as rice and wheat have none. Potato is very low in fat, with just five percent of the fat content of wheat, and one-fourth the calories of bread. Boiled, it has more protein than maize, and nearly twice the calcium.

Today, potato is the third most important food crop in the world, with annual production approaching 300 million tons. More than one-third of the global potato output now comes from developing countries, predominantly in Asia. With the rising prices of rice and other staples in the world, potatoes have the potential and could be an alternative source of carbohydrates. However, there are still a lot of problems related to the production of potatoes that need to be addressed to realize the potential of the crop particularly in Asia.

Despite of the promotion of the True Potato Seed (TPS) technology in recent years, the most preferred potato propagation method among Asian smallholder farmers is planting tubers. However, since many potato diseases during the cropping season and in the harvested crops originate from inoculum in seed tubers, clean seed production is crucial. Potatoes can suffer from a range of pests (like leafminers) and diseases ranging from scab (which causes superficial damage on tubers) to late blight (which can destroy the whole crop foliage), the latter potentially resulting in total yield loss. Smallholder farmers spray their potato crops regularly with toxic pesticides, often on calendar basis, as to prevent and control such potato insect pests and diseases. Increasingly, fungal pathogens show resistance to fungicides as a result of the indiscriminate use of pesticides. Such applications are often to no avail and at considerable costs to the farmer and the environment.

To promote the sustainable production and protection of the potato crop, it is of paramount importance that farmers are able to implement ecologically-sound pest and disease prevention and management strategies. Of particular importance is the proper and timely diagnosis of potato diseases. For these reasons and also in commemoration of the International Year of the Potato-2008, FAO and the Potato Vegetable and Flower Center proposed to co-organize a Workshop on Opportunities and Challenges for Promotion and Sustainable Production and Protection of the Potato Crop in Vietnam and elsewhere in Asia.

Objectives

The overall objective of the training was to provide participants with new concepts on opportunities and challenges on sustainable potato production and protection with focus on principles and tools for disease diagnosis, prevention and management. In particular, the workshop aimed to:

- Provide introductory/overview sessions on the importance of potato as a major food staple and cash crop for smallholder farmers in Asia;
- Provide an overview on potato production and protection and identify opportunities and challenges for promotion of the potato crop in farming systems in Vietnam and elsewhere in Asia;
- Provide hands on training in the diagnosis and epidemiology of potato diseases and their integrated management options in the field;
- Generate ideas for additional methodologies and Structured Learning Exercises to train farmers on diagnosis, prevention and management of potato diseases within the context of FFS and follow-up training activities.

Expected outputs

The participants would:

- Understand the importance of potato as food staple and cash crop;
- Be able to identify opportunities and challenges for the integration of potato in farming systems;
- Understand the main potato production/protection issues;
- Master the concepts and principles of integrated crop management;
- Master the botany of potato and practices, harvest and post harvest techniques related to its production;
- Identify main potato disease pathogens in the field;
- Experience how to develop IPM for potato, particularly with regards to potential role that farmers themselves can play in this process.

The complete list of activities undertaken during the Workshop on Opportunities and Challenges for Sustainable Production and Protection of the Potato Crop in Vietnam and elsewhere in Asia is provided in **Appendix 2**

Participants:

A total of 44 people were invited to participate in the WOCSPPPCVA including:

- 25 participants, mostly senior IPM trainers, from seven member countries of the FAO Regional IPM Programme (including 13 from Viet Nam),
- three (3) researchers from the PVFC Da Lat city, Viet Nam,
- three (3) representatives from private industry (PepsiCo Vietnam),
- seven (7) resource persons, from various national and international research institutions
- one (1) project manager working in a CARD training programme and
- four (4) representatives from UN-FAO IPM Programme in South & South East Asia.

Participants and resource persons came from Vietnam, Thailand, China, Indonesia, Bangladesh, Nepal, Philippines, Norway, India, The Netherlands and Australia. A full list of participants is provided in **Appendix 3**.

Section 2 Opening Ceremony and training programme overview

The "Regional Workshop on Opportunities and Challenges for Promotion and Sustainable Production and Protection of the Potato Crop in Vietnam and elsewhere in Asia" (RTPPP) was officially opened when Mr. Jan Willem Ketelaar (Chief Technical Advisor for the UN-FAO IPM Programme in South and Southeast Asia) and Dr. Pham Xuan Tung (Director, Potato, Vegetable and Fruit Center, Vietnam) gave brief speeches welcoming participants and explaining the rationale behind this training event. Participants were requested to share their experiences and to learn from one another and resource people during the WOCSPPPCVA. Participants were also asked to keep in mind the need to utilize the knowledge and skills learned during the training once participants had returned to their home countries.

During the training program overview the participants were introduced to the workshop content i.e., review of current status of potato production and protection, including IPM training work, in each country (**Section 4**), technical presentations (**Section 5**), field visits, practical classroom exercises, group discussions and presentations of field and classroom work (**Section 6**). During the technical presentations and practical activities references to internet and hard copy resources were made, details of these are included in **Appendix 5**. The objectives of the training were also outlined so that participants were aware of their role in ensuring the success of the training. These objectives are detailed in **Appendix 1.**

Following the opening ceremony Ms. Alma Linda Morales-Abubakar, FAO Regional Programme Development Officer, facilitated the introduction of the participants whereby each person stated their field of work, country of origin and potato IPM experience. Introductory presentations were then given by Mr Jan Willem Ketelaar and Dr Kaiyun Xie to provide participants an overview of FAO's potato work in Asia, and potato production in the region (**Section 3**).

Section 3 Introductory Presentations

3.1 Overview of FAO Potato IPM.work in the Asia region

Jan Willem Ketelaar CTA, FAO IPM Bangkok, Thailand

Potatoes are predominantly grown by smallholder farmers in Asia, mostly under temperate climatic conditions in highland production areas. Potato is both an important tuber vegetable for local food security as well as a good cash crop for farmers. Production and storage is constrained by a plethora of pest and disease problems, most notably bacterial wilt, late blight, golden cyst nematodes and potato tuber moth. Access to healthy potato tuber seeds and credit is still problematic for most small-scale producers. Substantial investment in research and development, primarily led by the International Potato Institute (CIP), has led to the development of effective Potato Integrated Pest Management (IPM) strategies. In order for farmers to master these IPM strategies locally on their own farms, substantial investments in farmer education are needed.

FAO's support for Potato IPM farmer education

Recognizing the importance and potential of potato for local food security and more profitable farming systems, FAO is actively supporting farmer education initiatives in Asia. The FAO Regional Vegetable IPM Programme, based at the FAO Regional Office for Asia and Pacific in Bangkok, and its national IPM programme counterparts across Asia, are implementing farmer education programmes in countries and production systems as culturally and ecologically diverse as Indonesia, Nepal, Vietnam and China. All farmer education training is based on the innovative Farmers Field School approach. Potato growers, in groups of about 25 farmers, cultivate a potato crop from seed to harvest and meet on a weekly basis to learn about healthy and profitable potato production and storage. Participatory group discussions, led by experienced facilitators, and active experimentation by potato farmers is crucial for knowledge and skill development. Thousands of farmers across Asia have benefited from participation in season-long FFSs and, as a result, are now growing healthier and more profitable potato crops.

Innovations and Future Opportunities and Challenges

In order to allow more smallholder farmers to capture the benefits of potato IPM training, much more investment in applied R&D and educational programmes is needed. FAO, through its Asia Regional IPM Programme, is supporting action-oriented research and development initiatives, most notably on late blight and leafminer management as well as the promotion of biofumigation for control of soilborne diseases. The Programme has also actively supported the development of potato IPM training materials. In a joint effort, CIP and FAO published in 2006 an ecological guide for Potato Integrated Crop Management "All about potatoes" and an associated FFS training manual "Farmer Field School for Potato Integrated Pest Management", the latter full with innovative structured learning exercises which can be employed in training of trainer courses and Farmers Field Schools. These publications can be downloaded from the following websites: www.cipotato.org and www.vegetableipmasia.org .

Most importantly, more attention and investment is needed to ensure that more Asian farmers reap the benefits of good quality potato IPM education. There particularly also appears good scope for promotion of potato production as part of rice-based cropping systems in the subtropical lowlands. As to commemorate the International Year of the Potato-2008, the FAO Regional Vegetable IPM Programme, and its associated national IPM programmes across Asia, will put extra emphasis on potato IPM promotion and training this year as to honor its commitment to support farmer education for healthy and profitable potato production in Asia. This Regional Potato Workshop, convened here in Dalat, Vietnam, marks the start of a renewed commitment of the FAO Regional IPM Programme and its national IPM programme partners towards the promotion of sustainable potato production and protection in the Asia region.

3.2 An Overview of Potato Production in the Asia Pacific Region: Markets, Development and Constraints. Dr Kaiyun Xie and Fernando N Ezeta, International Potato Center, CIP-ESEAP

In the past 40 years, the production of potato crops has experienced a stable increase in developing countries, and since 2004 the amount of potatoes produced has exceeded that of developing countries. Led by China and India with an annual increase of about 3%, Asia and Pacific region contributes 80% of the total potato production in developing countries. Due to the diversified agro-ecosystems, potato cropping practices are quite diverse, even in different regions within the same country. Potato can be planted one season each year or all year round.

Without competition from other crops and with the high economic benefit, potato production in winter fallow paddy fields has been increasing in recent years in the Asia-Pacific region, especially in China. Due to the continuous increase of population, a decrease in the amount of arable land, and the fragile agro-ecologies, food shortage, possible famine and extreme poverty exist widely in this region. Potato has many functions as it is a high value vegetable, an important food and cash crop, an animal feed and it has played an important role for food security, poverty elimination, and employment.

Though the potato consumption per capita is still much lower than in European and North American countries, it has been increasing continuously in the past decades. Most of the potatoes (about 90%) are consumed fresh and there is a large potential for potato processing industry in this region.

The potato average yields are very low in most Asia-Pacific countries. Low quality of seed potatoes, low investment in potato, and frequent diseases and pests are the main reasons for the low yield. Improved seed potatoes, use of IPM methods, and implementation of better cultivation can increase the potato yield and reduce the yield gap.

The main strategies for research and development in the Asia-Pacific region should be: 1) to promote the sustainable use of biodiversity and release new varieties with high resistance to diseases and pests; 2) to increase yield stability to reduce temporal and chronic hunger among poor communities by using improved seeds and new varieties; 3) to improve the access to safe and nutritious food by eating more nutrient enriched potatoes; 4) to link small-scale farmers to the diversified markets; 5) to increase the sustainable intensification of potato-based farming systems, and 6) to build strong and stable partnerships to maximize the consumption of potatoes.

Section 4 Country Presentations

One representative from each country made a presentation on IPM activities in relation to potato production and protection in their respective country so as to provide other participants a broad understanding of the situation in the region. Each presentation included an overview of potato production and protection their country (topography, area under potato cultivation, major insect and disease problems and their management as well as future opportunities for IPM initiatives with respect to potato crops. Summaries of these country presentations are included below.

4.1 Bangladesh

The area of Bangladesh is 147,570 km2 with about 140 million population. The major crops are rice, wheat, jute, tea, tobacco, sugarcane, potato, pulse, vegetable, etc. The potato growing area in Bangladesh is third highest after rice and wheat, and the total production of potato is second highest after rice. Potato is mainly used as a fresh vegetable. It grows all over the country but especially in the central and north & north western parts of the country. Prior to 2007, about 0.4 million hectares of land were under potato cultivation which provided a total production of about 6 million tons with an average yield of 14.5 ton/ha. In 2007-2008 Bangladesh increased the total yield harvested to about 9 million tons from 0.5 million hectares of land.

High yielding variety seed potato was imported first in 1960 and potato research started in 1977 with the establishment of a research center named “Tuber Crop Research Center (TCRC)”, based in Joydevpur, Gazipur. So far 50 potato diseases have been identified. Among these, late blight, bacterial wilt, common scab, and viral diseases are the most serious. Farmers practice calendar sprays for fungal disease control. Research has shown potato seed treatment with 3% boric acid solution is an effective way to manage scab disease.

The challenges to overcome when promoting potato crops include:

- the production of high quality seed potatoes,
- the degeneration of seed potato due to viral diseases,
- a lack of proper storage facilities,
- imbalanced fertilizer use,
- effective pest and disease management,
- limited knowledge on modern cultivation practices.

The opportunities for promoting potato crops include:

- improving the production of existing varieties to maximise yield potential,
- increased acceptance of -and demand for- potato among consumers,
- promotion of the use of TPS and tissue culture,
- production of more good quality seed,
- dissemination of technologies through FFS/IPM clubs,
- establishing more potato based industry, and
- establishing cold storage facilities (to encourage farmers to produce potatoes and ensure price stability).

Based on training materials developed by FAO, a curriculum and a field guide has been developed to guide the implementation of season-long (20 weekly sessions) potato Integrated Crop Management (ICM) FFS. Ten pilot FFS in potato ICM are being conducted by the ICM/Agricultural Extension Component (AEC) in different potato growing areas (AEC is one of the 3 components of the DANIDA supported Agricultural Sector Program Support phase 2 (ASPS-2) in Bangladesh).

4.2 China

Potato Production in Luliang County in Yunnan

The major crops in Luliang County are tobacco, mulberry, rice, corn, vegetables, and potato. Of them, potato occupies the largest acreage and it is one of the most important cash crops in the county. The annual potato planting area is about 33,300 ha and potato can be planted in three seasons. In recent years, late blight is one of the most important constraints for potato production and it is very serious especially in autumn potatoes. In autumn 2006, a total acreage of 6,667 ha of potatoes (worth 50 million RMB or USD 725,000) was lost due to late blight infection. In 2007 and 2008, the following methods were used to control late blight in the county: 1) intensive extension of late blight resistant varieties, such as Cooperation 88; 2) strict selection of clean seed potatoes and systematic isolation/destruction of the primary infection source; 3) extension of agronomic control methods, such as high ridges and intercropping with corn; and 4) timely use of fungicides, such as Infilito.

Potato Production and Potato Diseases in Guangxi

Potato is one of the important food and cash crops in Guangxi and its production has increased rapidly in recent years. The potato planting area in Guangxi was about 20,000 to 40,000ha before 2003 and this had increased to 132,000 ha by 2007. With the increase of the acreage of potato, all kinds of potato pests and diseases became increasingly more serious, especially late blight and virus diseases. The major potato diseases in Guangxi are early blight, late blight, viruses, bacterial wilt, soft rot, and common scab. In 2007, 15,806 ha of potatoes were infected by late blight, 9,086 ha by viruses, 1,080 ha by bacterial wilt and 540 ha by early blight. The presence of viral diseases has increased rapidly since 2006.

Investigations by the Guangxi Provincial Plant Protection Station and Agricultural University show there were five major virus diseases in 2007. These include PLRV, PVX, PVY, PVA, and PVS. These viruses infected potato plants individually or combined and the infection rate could reach 70% in some locations.

The seriousness of late blight and viral diseases are the main constraints for the potato industry in Guangxi. To solve the problems, the Guangxi Plant Protection Station has increased the extension of disease control technologies and guided farmers to implement IPM technologies. The key components of the IPM technologies include: 1) use of disease-free seed potatoes; 2) selection of disease resistant varieties; 3) disinfection of seed potatoes; 4) field sanitation and removing diseased plants in the field, and 5) timely and proper use of fungicides.

4.3 Indonesia

Indonesia is a big country made up of thousands of islands. Indonesia produces almost 1million tonnes of potato annually on a land area of 60,000 ha. Potatoes are grown under highland conditions in several provinces and the largest production areas are in West and Central Java and North Sumatra.

The population of Indonesia is around 140 million, requiring at least need 50-70 tonnes of staple food annually. Currently, rice is still the dominant food staple crop in Indonesia. During the last five years, Indonesia imported rice from several neighboring countries. The government of Indonesia has several programmes to diversify staple food from rice-based to alternative carbohydrate sources. In this case, potatoes have great potential, especially for food security among consumers in urban areas.

Indonesia is a tropical country with many pests and diseases. The major pests in Indonesia include leafminer, whitefly, thrips, mites, aphids, root knot nematode and potato cyst nematodes (PCN). Meanwhile, the major diseases are late blight, early blight and bacterial wilt. For controlling late blight, farmers occasionally apply fungicides. The government has given some recommendations such as growing resistant varieties and using certified seed tuber.

The Integrated Crop Management (ICM) Programme in Indonesia.
To control PCN farmers are encouraged to rotate potato crops with bunching onion and pea. Farmers are also encouraged to make use of trap crops such as *Tagetes erecta* for *Crotalaria striata* management .
Other major pests and diseases are controlled using chemicals. Botanical pesticides are applied alternatively with synthetic chemical pesticides. There are some proposed programmes for improving potato production in Indonesia:

- Introducing advanced clones from CIP
- Use of late blight and virus resistant varieties
- Hybridization and gene transfer integrating resistance to late blight genes
- Use of heat tolerant clones
- Strengthening ICM
- High quality seed production

Farmer field schools on potato IPM have been implemented since 2002 and the government has a standard curricula, based on curriculum and training materials development with support from FAO and CIP. From 2006-2010, there is an ACIAR-funded project that aims to improve FFS curricula for clean seed production and expand the IPM training work. The project began with a baseline survey that included taking soil and plant samples for analysis, interviewing farmers and analyzing and interpreting results. The main findings of the survey are:

- Disease incidence (late blight, wilt are of major importance)
- Pest infestation (PLM and other insects have a major impact)
- Seed quality, PCN, soil acidity, crop nutrition are important issues
- More efficient use of inputs and varieties is important

Following these results the Potato IPM FFS curricula has been updated and training of trainers and FFS activities have been implemented in ten districts in Indonesia since 2006.

4.4 Nepal

Nepal is a small landlocked country with a significant proportion of mountainous areas. The total population of Nepal is 26.42 million. Total land area is 147,181 km^2 with altitude ranging from 100 m in the Terai (plains areas) to 8,848 m in the Himalayas. With this wide topographic variation in Nepal comes equally variable agro-climate regions (including tropical, temperate and alpine regions) that provide opportunities to grow a wide range of crop species such as cereals, vegetables, potato, oil seeds, pulses and other crops.

Agriculture makes a major contribution to the Nepalese economy amounting to 38.8% of GDP and supports 65.6% of the economically-active population. Potato crops make up a major part of Nepalese agriculture. It is ranked number five after paddy, maize, wheat, and millet in terms of area distribution, fourth in respect to production and however potato is the highest yielding crop in terms of volume. Potato is a staple food crop for cold and high mountainous regions and one of the major cash crops for poor farmers of mid-hill and plain terai. Trends show that area under potato production has doubled from 1986/87 to 2006/07 and total yield production increased around five fold. Most recent statistics in 2006/07 show potatoes were grown on 153,534 ha, annual production of 1,943 metric tonnes, and an average yield of 12.7 t/ha. The cropping patterns, time of planting, choice of potato varieties, and occurrence of insect pests and disease depends mostly on the seasons along with topographic variation.

Limiting factors that result in low productivity include attack by insect pests and diseases, poor agronomic practices and the use of poor quality seed tubers. Major disease of potato crops include late blight (*Phytophthora infestans),* early blight (*Alternaria solani),* Black scarf (*Rhizoctonia solani*), wart (*Synchytrium endobioticum*), Bacterial wilt (*Ralstonia solanacearum*), common scab (*Streptomyces scabies*), and viral diseases (PLRV, PVX, PVY). Insects attacking potato crops in Nepal include aphids (*Myzus persicae*), potato tuber moth (*Phthorimaea operculella*), cutworms (*Agrotis* spp), and red ants (*Dorylus orientalis*). To manage these problems farmers are applying high doses of toxic pesticides at regular intervals. This causes increased cost of production, depletion of natural enemies, health hazards and environmental pollution. To curb these practices potato IPM farmers and farmer association alumni are considering the best options for farmer empowerment to reduce pesticide application, proper insect and disease management, proper agronomic practices.

The National IPM Programme along with the Plant Protection Directorate are apex organisations for conducting IPM FFS in many crops like rice, vegetables, potatoes, etc. Farmer and science, post harvest (rice and maize) as post-FFS activities, capacity building of official and farmer facilitators, networking and coordination of IPM programmes with other institutions. The IPM Trainers Association of Nepal (TITAN) is also working in various IPM programmes like capacity building, curriculum development, training of facilitators, conducting farmer field research and assisting in technical backstopping to the National IPM Programme (NIPM). Till now a total of 180 FFS in potato have been conducted in Nepal and this has produced very outstanding results.

4.5 Philippines

Potato is among the most important crops in the Philippines. It is consumed as a snack food but mainly potato is cooked as vegetables. Potato consumption closely follows rice, the primary staple food for Filipinos. It is a source of livelihood with 80% of production sold fresh in the market and only 20% consumed by producers.

The major potato growing areas in the country are concentrated in the Cordillera Administrative Region (CAR) in the northern Philippines (Benguet Province, Mountain Province and Ifugao Province), Davao Region and Northern Mindanao (Bukidnon) in the southern part of the country. The increase in the production of potatoes in the Philippines is brought about by increased land area and improvements to management technologies such as integrated pest management (IPM). In the Cordillera Region, the production increased by 120,000 metric tonnes in 2007 from 50,000 metric tonnes in 2004. Through IPM, CAR was able to contain leaf miner outbreaks in 2002-2004. Average yield of potato ranges 18-20 tons/hectare (BAS). However, in some areas in the Cordillera it could reach to 25 tonnes per hectare.

Most common varieties planted by farmers are: Granola (table potato) and the Igorota or PO3. PO3 was developed in NPRTC-Benguet State University in collaboration with CIP.

Programs/ Projects/Research in the Philippines related to Potato Crops

1. KASAKALIKASAN PROGRAM – this is the National IPM Program in the Philippines and is an improvement on the traditional IPM concept that emphasizes the economic threshold level of injury or the use of chemical as the last resort of controlling pest and diseases. The IPM-KASAKALIKASAN focuses on farmer training for the total management of the crop to obtain the optimum yield. The acronym KASAKALIKASAN stands for bountiful harvest in farming with nature or environment. The National IPM Program was first implemented in rice, vegetables and cotton and was then expanded to other commodities.

Through KASAKALIKASAN various FFS, including student field schools, have been conducted. Although the use of chemicals has not been totally eliminated, there has been a great reduction in their application, often from 18 applications per potato growing season to 0-3 applications. Often yields were the same in these studies.

2. Seed Potato Project. 2002: an interagency project of NPRTC-BSU, BPI, DA, LGU and farmer organizations.

3. Various Research initiatives

- Bacterial Wilt (BW), *R. solanacearum*

Research findings (J. Perez, et. al), ANAP, Research Journal;2004), HARRDC
On farm verification of the application of lime (20 Cao t/ha), Urea (40 kgs N/ha) and combination 1: lime + Urea (20 Cao t/ha + 40 kgs N/ha), and combination 2: lime + Urea (20 Cao t/ha + 20 kgs N/ha) reduced the population of BW by 80-100 % **.**

- Potato Cyst Nematode (PCN)

Research findings (T. Mangili, et. al), ANAP, Research Journal;2004), HARRDC
Harvesting of potato tubers at 70 to 80 DAP reduced PCN population by almost two-fold.
Cabbage-Carrots-Cabbage crop rotation scheme reduced PCN population by 65 to 77 % in three cropping seasons.

Opportunities and challenges of potato production in the Philippines:

- Access to markets and fair prices
- Access to land to expand production areas, especially in southern Philippines
- Access to expert knowledge and technology
- Existing institutes or colleges in the growing areas
- Availability of facilities and research centers

Other concerns or needs in relation to potato production in the Philippines:

- Training needs of Extension Workers/facilitators
  Advocacy materials/training Manuals for Extension Workers
  Refresher and technical courses for trainers and facilitators
- The need for technologies/research on the development of an Organic Approach in Potato Production, especially for the management of pest and diseases as many consumers are now becoming much more health conscious and there is growing demand for organic products.

4.6 Thailand

Thailand is a small country, located in South-East Asia with a total land area of 512,000 km^2 and a population of 62 million people. The total agricultural area is 26,900,000 ha. Economic crops include rice, para rubber, fruit and vegetables.

Potatoes are grown, primarily under contract farming, on an area totaling 7,651 ha in the northern and northeastern provinces including Chiangmai, Chiangrai, Lampoon, Lampang, Tak, Sakon Nhakon and Loei province. Average yield of potato production is 15 ton/ha. Most potato production is done in lowlands during the winter season, and in the highlands during rainy season.

The major diseases are: late blight, early blight, fusarium wilt and bacterial wilt. Management techniques used to address the problems are crop rotation, use of certified seeds, and biological control. Virus test kits are used to identify virus infections.
Given that potato production in Thailand is predominantly a private sector activity, there has been limited public sector extension activity so far. Potato farmer field schools have so far not been implemented in Thailand. However, there are FFS in rice and vegetable, and some potato growers have been trained in rice or/and vegetable FFS.

4.7 Vietnam: Potato production and IPM Programme in Thai Binh province

In Vietnam, potato belongs to the vegetable group. Potato is important for local consumption and as a cash crop. Potato is used as vegetable and animal feed.

In recent years, the province has intensified support for the development of vegetable production, including potato. At the same time Thai Binh has mobilized contributions from different sources including international organizations and private sector for the development of crop production, processing, post harvest as well as market access resulting into considerable improvements of potato production.

The annual production area of vegetable is about 35,000 ha, the highest production area being 51,000 ha (4,395 ha potatoes) in 2003 and that occupied 30% of crop cultivation area. Forty-seven cold stores are currently in operation for the preservation of potato seed.

The potato production area has gradually increased during the last five years as shown in the table below:

Year	2001	2002	2003	2004	2005	2006	2007
Area (ha)	5,250	3,946	4,395	6,276	4,744	7,000	8,000
Productivity (total yield output in tons)	67,366	53,232	59,051	95,821	83,808	112,000	128,000

The table and processing varieties used in Thai Binh include**:**

- Viet Duc (Mariella), imported from Germany
- Solara from Germany
- Diamant from Netherlands
- Atlantic
- KT3
- Hong Ha 7 and
- P3

Main pest and diseases include:

- Late blight, Bacterial Wilt, Viruses
- *Spodoptera* spp.
- Cut worm
- Aphids and
- Mite (white)

IPM activities in Thai Binh:

IPM FFS commenced in Thai Binh in 1996. Since then 236 FFSs have been organized on vegetable including 12 FFS on potato crops, between 2006 and 2008. Further follow-up FFS activities were organized by IPM-FFS alumni. There are ten IPM farmer groups actively working on potato activities such as field studies on topics such as balanced fertilizer application, variety evaluation, plant densities and pest and disease management.

IPM in Thai Binh has received the support of different international organizations such as FAO, DANIDA, Bread for the World, and World Bank. It is Thai Binh’s strategy to develop vegetable and potato production from year 2009 to 2020 according to the requirement of the national food safety programme and the national food security programme. The main activities under these programmes are:

- Mark out/map areas for production (using results from residue tests to select target areas)
- Build infrastructure such as the irrigation system, roads, wholesale market
- Capacity building for producers who apply FFS approach
- Generating policy support

Section 5 Technical Presentations

Many technical presentations were delivered by specialist resource persons and some of the country participants. Besides well-illustrated power point presentations, in some cases handouts were also provided. Several presentations were also supplemented with field visits and practical hands-on exercises. Overall, a wide range of topics and experiences were covered. Taken together, they provide full coverage of the crucial aspects of potato production and protection, i.e., concepts, principles and related theories, practical constraints and issues emphasizing diseases and their management, and the envisaged future prospects. All technical presentations (as well as all the country presentations) will be compiled on CD and given to all the participants for use as reference materials after returning to their home countries. Summary versions of these presentations are provided below.

5.1 Potato and its Production in Vietnam

Dr Pham Xuan Tung. Potato Vegetable and Flower Centre, Da Lat City, Viet Nam

Annually, Viet Nam produces about 420,000t of potato on 35,000 ha of land in three distinct regions: Red river Delta (66%), Northern Highland (29%) and Lam Dong province, central Viet Nam (5%). Average yield per hectare is 12t. Potatoes are produced during the winter in the northern regions while production can continue year-round in Lam Dong province.

Viet Nam can produce up to 80% of the total amount of potatoes consumed domestically (521,000t) and 85% (445,000t) of the total amount of potatoes is consumed fresh. Projections show that by 2010 Viet Nam will require a total of 781,000t of potatoes annually either for fresh consumption, processing, seed or export.

Currently in Viet Nam there are 70 cold storage facilities with a total capacity of 2,615t predominantly used for seed tuber storage. There are three major potato processing companies in Viet Nam including PepsiCo International, An Lac Co. Ltd. and VitaFood Co. Ltd. Constraints for development of the processing industry include:

- High raw material input
- Low quality of variety and production technology
- Lack of in-country supply chain
- Small growers/small scale production leading to high cost of production, trading and freight

Statistics on the volume of potatoes exported from Viet Nam show 40,150t was exported to Russia between 1986 and 1990. Currently a few hundreds tons are exported to China, Singapore, Laos and Cambodia annually by private enterprises.

Production of potatoes in the Red River Delta (9 provinces) reaches a total 22,200 ha with an annual volume of 281,000t (average yield = 14t/ha). There are several advantages for production in this region that include:

- Concentrated production from November – January for harvest in late January and February
- Land availability
- Lower cost of labour, land and irrigation

Disadvantages include:

- One production season each year
- Low yield potential due to the short growing season of less than 90 days and low light intensity during the tuber bulking period (December-January) and
- Lower quality (lower dry matter)

In the northern Highlands and at mid elevations issues include:

- Scattered production in thinly populated areas (small household production or subsistence)
- Under-developed infrastructure and education (low level of education and technical training)
- Long distances and poor roads for transportation
- Single growing season
  - November – January for mid elevations
  - April – June for highlands

In Da Lat and surrounding Lam Dong province, the current land area dedicated to potato production is 1,200ha that yields 19,200t annually (average 16t/ha).

The advantages for this region include:
- Favourable climatic conditions
- Year round production
- High yield potential and product quality
- Land availability for expansion
- Closer to HCMC with better roads
- Larger households and
- More progressive and experienced growers.

Disadvantages for Lam Dong province include:
- Higher labour and land costs
- Higher cost for irrigation during the dry season
- Higher cost for pest and disease control during the rainy season

There is potential for increased production in the Central Plateau region of Viet Nam as here the climate is considered suitable for potato production. There are large tracts of land available and infrastructure for roads is improving as well as extension services. The government in these provinces is also interested in diversifying into higher value cash crops.

In summary:
- The existing 35,000 ha will remain unless demand for potatoes increases,
- Most potatoes are produced for fresh consumption and there is a need to develop a potato processing industry,
- Potato production is expected to increase 1.5 times while processing has the potential to increase eight fold by 2010 due to new market trends
- The Red River Delta area will remain the main potato producing area in Viet Nam due to the large amount of land available during winter fallow. However large investment is required in terms of quality and infrastructure.

5.2 Biology of the Potato Plant

Dr Pham Xuan Tung. Potato, Vegetable and Flower Centre, Da Lat City, Viet Nam

Dr Tung presented an overview of the origin, physical and growth characteristics of the potato plant, *Solanum tuberosum* (L). Potato is a member of the solanaceae plant family with origins being traced back to the Andes in Bolivia and Peru. Potato was first introduced to Vietnam in the late 19th century by French colonialists and is now grown extensively in the Red River Delta region surrounding Hanoi.

Potato plants share anatomical features common to most solanaceous plants including roots, stems, shoots, flowers. However there are two other features, stolons and tubers, that are of particular importance as these are the sources of food that we desire from this plant. As potato is a tuber crop, the root environment is very important. The optimum soil conditions include loose, fertile, deep soil with good drainage.

Stems, leaves and other foliage are given a special name when referring to the potato crop, *halms*. Halm growth is influenced by factors including soil fertility, plant genotype, light and temperature. The number or density of halms can influence the number and size of potatoes. This is important when farming for seed potatoes or for ware potatoes.

Along with halms, potatoes also have underground, or secondary stems known as *stolons*. Stolons tend to grow horizontally and the length of stolons is influenced by cultivar genetics and environmental factors. Stolons are important to us as under the right conditions stolons swell to store starch. These storage sinks are technically called tubers but we know them as potatoes. Temperature, nitrogenous fertilisers and farming practices influence tuber growth.

A potato tuber may be used for food or as seed (tuber seed) for a new crop because there are submerged points around the tuber where new shoots can emerge from. These points are known as eyes. Eyes enter a resting period (called dormancy) after harvest which may differ in length (from 1-2 months, or up to 6 months) and is a cultivar determined characteristic. Some diploid varieties of *S. phureja* may not have a dormancy period or have just a very short one. The seed tuber "sprouts" when new shoots arise from the eyes. After planting into the field, sprouts emerge into new plants. There are optimum conditions for sprouting and best sprouts for planting in relation to the so called physiological age of the tuber seed and plant growth and tuber yield one may expect from the following crop.

Potato plants may also be produced from true botanical seeds (true potato seeds – TPS). However, true seeds normally give rise to plants of diverse genetic variation – segragation – the extent of segregation depends on the parental genetic background. The important factor to remember when using seed tubers is to use high quality seed so you can assure minimal disease and pest contamination, improve growth and increase yield under the correct growing conditions.

5.3 Group Discussion on Problems Faced in Potato Crops in the Region

A short group discussion was held to identify what participants felt were the major constraints to potato production within their countries, and the learning opportunities to be discussed during this workshop that could help to overcome these constraints. During this discussion participants were asked to group issues into the problems in relation to potato cultivation, crop protection, variety and storage.

Cultivation	**Crop Protection**	**Variety**	**Storage**
-Minimum tillage techniques -Conservation agriculture -The best methods for potato sowing and hilling up -Best practices for fertiliser/nutrient management -Machinery in potato cultivation/production -Ratio of N:P:K to produce high yield/quality/pest resistance -Plant densities for different soil types -Number of stems/m^2 to improve yield -Seed quantity/ha	-Late Blight and viruses -Botanical pesticide alternatives? -Resistant/tolerant varieties -Chemical use for late blight and bacterial wilt -Indigenous knowledge of late blight and bacterial wilt management? - Nematode management -Use of EM (effective microorganisms) -Organic potato farming experiences? -Effect of N on bacterial wilt and late blight	-High starch content -Late blight and bacteria wilt resistant varieties -Lowland adapted varieties (hotter climate)? -Suitable varieties available for TPS (true potato seed) production?	-Potato Tuber Moth (PTM) -Availability of suitable seed tuber storage facilities, especially at farm level -Managing general storage pests and diseases

5.4 IPM in Potato, Concepts and Principles

Dr Ngo Thi Xuyen, Pathogen Division, Plant Protection Department, Agronomy Faculty, Hanoi University of Agriculture.

The majority of potato crops are grown in the Red River Delta and northern mountainous regions as well as around Da Lat City in Vietnam. Integrated pest management in potatoes is similar to that of other crops: understanding the components and maintaining a balance within an ecosystem and the environment to produce high yields. This implies biological control is a major player while chemical insecticides are utilized as a last resort so that the balance of the agro-ecological system is maintained for as long as possible. Economic and damage thresholds are used to determine when management actions should be taken.

In principle, IPM practitioners try to manipulate factors in the agro-ecosystem to make the environment unfavorable for weeds, insects, and plant pathogens while producing optimal crop yields. IPM researchers also concentrate on monitoring insect and disease populations in their crops and develop decision-making tools that included the cost of pest damage and diseases control practices when making management decisions. Several simple formulas can be used to determine the economic threshold for pest management.

The first IPM FFS activities began in Vietnam in the 1990's and focused on rice crops. Since then the National IPM programme has undertaken 15 programmes or projects involving the participation of over 1 million farmers. Potato FFS in Vietnam aim to:

- understand the biology and ecology of potato pests/diseases
- determine which management method is best for location-specific situation, and
- accurate and comprehensive sampling of pest/disease to allow evaluation of treatments.

Research at the Agro-biology Institute at Hanoi University of Agriculture (HUA) has been conducting a project "Biotechnology production for potato resistant to virus diseases". HUA has also conducted studies on potato seed storage conditions investigating temperature, plastic storage bags and transmission of viruses by insect vectors. Other work includes in vitro techniques to culture virus free potato stock, true seed production, hydroponics for producing seed potatoes and drip irrigations systems. Through the use of biotechnology, in collaboration with Inner Force Research, HUA has been able to produce disease-free seeds and assist potato growers to increase the total land used to produce potatoes to 200,000 ha. HUA has also established a network with the Agrobiological Institute, Cornell University and the College of Agriculture and Life Science to continue researching potato varieties resistant to Late Blight.

5.5 Foliar Diseases in Potato

Dr Arne Hermansen. Bioforske, Norway

The three major fungal diseases effecting potato production in Asia include:
Late Blight (*Phytophthera infestans*), Early Blight (*Alternaria solani*), and Fusarium Wilt (*Fusarium* spp.). The factors influencing the development of disease include interactions between the plant, the environment and the pathogen. Late blight symptoms may be seen on the leaves, stems and tubers of potatoes, full descriptions can be found on the Global Initiative for Late Blight website at http://gilb.cip.cgiar.org.

Late blight is most commonly seen in potato crops during winter in northern Vietnam (that is when potatoes are grown there) while symptoms can be found all year round in Lam Dong province. Fungicides are often applied more than once a week to control late blight. However crop losses can reach up to 100% in cases of severe infection.

Late blight can infect several members of the Solanaceace family. The infective propagule of late blight is the sporangia, including zoospores. Sporangia are produced mostly on leaves and the spores can drop to the soil and infect potato tubers. Oospores are also sometimes produced which can survive long periods in the soil. The inoculum that begins an infection usually come from seed tubers, plant residues left in the field or blown or splashed from an alternative host or "weed plant" left over from a previous crop.

Spores can be produced under mild climatic conditions, optimally 90% RH and 3-260C. Germination of spores occurs when leaf surfaces are wet for a period as short as two hours and between temperatures of 12-26^{0}C and 2-25^{0}C for zoospores. The temperature for optimal growth of mycelium in the plant is between 18-22^{0}C. Studies conducted in 2003 showed that only the "mating type A1' strain of Late Blight exists in Vietnam. Isolates identified in northern Vietnam had intermediate resistance to Metalaxyl while most isolates were resistant in southern Vietnam. Mating type A2 was identified in Lam Dong province in 2007. This means that generative reproduction and formulation of oospores is now much more likely, which poses additional challenges for durable variety resistance management and prevention and management of late blight.

Late blight may be managed by using an integrated approach including reducing the initial population of inoculum in the field. This may be achieved by using only healthy seed, removal and destruction of volunteer plants, covering plants on cull piles and rotating crops.

Aggressiveness tests showed there is a low chance of late blight collected from tomatoes infecting potato leaves while there is a high chance that late blight collected from potatoes will infect tomato plants.

A key factor to managing potato late blight is the use of resistant varieties. Cultural control methods such as the location and orientation of the field as well as the time of irrigation can also reduce late blight infections. The use of the most appropriate fungicide spray is also important. Timing the application of these fungicides should be done according to "forecasts" if they are available. To reduce the chance of potato tuber infection, leaves should be removed before harvesting, tubers should be mature, and conditions should be dry so that tuber surfaces are dry when they are put into storage.

Conclusions from potato field trials in Vietnam (carried out by Bioforsk under the FAO project in 2005-2007) showed that there was a potential to reduce the input of fungicides and obtain good late blight control if modern (currently not available in Vietnam) fungicides were used and mainly in the most resistant cultivars. Use of simple forecasting rules (misty days or rain as triggers for sprays) had a potential for better timing of sprays, and the development of a simple decision support system for late blight prevention/management should be further explored.

Symptoms of early blight (*Alternaria solani*) include dark brown circular lesions with dark brown concentric ridges on older leaves. These lesions often become angular and olive-green spores are produced. Tubers may also show signs of infection after several months in storage. These lesions are dark, sunken, irregularly shaped and often surrounded by a raised violet border. The underlying flesh is dry, leathery and usually brown. In advanced decay the tissue is often water soaked and yellow to greenish yellow.

As with early blight, late blight can persist in soil, on plant debris, infected tubers or other solanaceous hosts. The optimum temperature for sporulation is 20^{0}C and spores are often produced after heavy dews. Spores may be carried by wind or water and spore dispersal is often facilitated by alternating wet and dry periods. Infection occurs through wounds in plant tissue. Symptoms are often not seen until later in the crop life. However, unhealthy or stressed plants are more susceptible to infection. Crop rotations, minimizing wounds to plants and planting resistant cultivars are ways to reduce the severity of early blight outbreaks. Well timed application of fungicides can also minimize losses due to early blight. Removing foliage prior to harvesting and minimising damage during harvesting can reduce post harvest losses.

Grey mould (*Botrytis cinerea*) is considered a weak pathogen normally not worth management action. Infections start when leaves fall onto leaves at times of high humidity. Grey mould survives as sclerotia and mycelium in plant residues and alternate hosts. Conidia can be easily spread by wind.

Symptoms of Fusarium wilt (*Fusarium* spp) include stunted growth, uneven chlorosis, wilting of lower leaves, yellowing then browning of inter-veinal areas first observed lower in the stem moving to the top of the plant. Vascular bundles in stems and tubers turn brown. Symptoms are often observed at high temperatures and low soil moisture. Inoculum is often found in soil and on plant residues left after harvest and infection usually occurs via wound sites. Planting crops in areas without a disease history, rotation and seed treatment with fungicides can help.

Introduction to: "Learning to Control Potato Late Blight - a Facilitators Guide"
This guide, produced by CIP based on recent IPM-FFS work in Equador, was introduced as it is relevant to IPM facilitators. The guide can be downloaded from the following website: CIP: Learning to Control Potato Blight - a Facilitators Guide The guide aims to introduce a relatively simple decision support system for late blight management. It should be remembered that the learning activities presented in this guide should be adapted to the local agro-ecological systems. This resource contains five modules and within each module there are several practical exercises. The five modules covered include:
1. Knowing *Phytophthera infestans* and the symptoms of late blight.
2. Learning more about *Phytophthera infestans*.
3. Controlling late blight by using resistant potato cultivars.
4. Controlling potato late blight with fungicides.
5. Visiting the potato plot to control late blight.

5.6 Tuber Diseases in Potato (mainly caused by fungi)
Dr Arne Hermansen. Bioforsk, Norway
There is a long list of pathogens infecting potato tubers. This list can be broken down into scabs and scurfs (common scab, powdery scab, black scurf, silver scurf and black dot), and other diseases including pink rot (*Phytophthora* spp), southern blight, wart and *Fusarium* spp. dry rot.

Common scab (*Streptomyces* spp) lesions can be spots or net-like structures across the surface of the potato tuber. The scab lesions might be raised, sunken or superficial. There are different symptoms because some can be more or less aggressive, depending on the plant cultivars, development stage and environmental factors. Common scab is common world-wide and is caused by a group of soil-borne bacteria a bit like fungi, most species are saprophytic. There are ten pathogenic species in the *Streptomyces* genera, these are distributed across the world. Host plants include potato, raddish, sweet potatoes and infective propagules can transferred by water and seed potatoes. Dr Hermansen described the life cycle of *Streptomyces* spp and factors that are important for common scab to infect tubers.

Management methods include the use of healthy seeds, resistant cultivars, crop rotation, avoid raising the soil pH above 6 and maintain high soil humidity when stolon tips are swelling as most *Streptomyces* spp do not compete well against other soil-borne microbes at high moisture.

A discussion following Dr Hermansen's presentation revealed *Streptomyces* spp. outbreaks are common in northern Vietnam where soils have low pH. For example in Hai Duong province, 100ha showed 70% of tubers were infected. However this problem was only apparent for one season and farmers selected a different variety the following year which resulted in no recurrence of the problem.

Powdery Scab (*Spongospora subterranea*)
Raised scabs on surface of potato craters containing spore balls (small resting spores) can be observed at 100x magnification. Symptoms can be variable, depending on environmental conditions and race of pathogen. Symptoms may appear like wart, or root knot nematode. Management includes disease free tubers, crop rotation, resistant cultivars, avoid fertilising with contaminated manures, effective drainage of fields and avoiding excess irrigation .

Black Scurf (*Rhizoctonia solani* and *Thanatephorus cucumeris*)
Symptoms are black sclerotia, cracking, surface blemishes/necrosis. Potato size distribution can be effected by this pathogen and the infected tuber surface areas can vary from small to large

spots or whole surface. Symptoms may be seen above ground on stems or branches can be stunted. Pathogen can survive on organic matter in the soil, via sclerotia and mycelium. Most important infection source is infected tubers, soil moisture affects disease development, and deep planting of tubers should be avoided. Management includes crop rotation, use of healthy seed tubers and resistant cultivars, seed treatment with fungicides, avoid late harvest of mature tubers.

Silver Scurf (*Helminthosporium solani*) and Black Dot (*Colletotrichum coccodes*) can cause discolouration and reduces marketability. These pathogens can also cause an increase in water loss and shrinkage. Black dot can affect other parts of the plant which also reduce yield. These pathogens are slow growing and can produce conidia between 2-27^{0}C at high humidity. Seed tubers are an important inoculum source and infection can occur through lenticels and directly through the periderm during the growing season, and also post harvest. Silver scurf and black dot can be managed through crop rotation, the use of healthy seed tubers and resistant cultivars, seed treatments with fungicides, reducing plant stress, good drainage, dry and cold storage facilities.

Pink rot (*Phytophthora erythroseptica*) usually appears late in the season. Flesh turns pink 15 minutes after it is cut open and exposed and has a rubber texture. The potato produces an amonium smell and vinegar flavour. This is a soil-borne oomycetes that has an optimum development temperature of 24-28^{0}C. Management methods can include crop rotation, the use of healthy seed tubers, well drained fields and avoiding excess irrigation, reducing the likelihood of wounding during harvesting, the use of systemic fungicides applied to furrows.

Southern blight (*Sclerotium rolfsii*) symptoms include a white mat of mycelium that develops to a tan, brown or black colour. Symptoms on stems include discoloured lesions that wilt and can cause plant death. Symptoms on tubers include yellow – tan sunken lesions where tissue becomes soft and collapsed.

Wart (*Synchytrium endobioticum*) is a quarantine issue. However it is reported from most growing regions. The pathogen is an obligate parasite with long living resting spores. About 20 races are reported and temperatures of 12-24^{0}C are favourable for infection. Strict quarantine is recommended for this pathogen.

Fusarium dry rot (*Fusarium* spp.) may be caused by the same pathogens causing *Fusarium* wilt. Tubers are more susceptible the longer they are in storage. Control methods include the use of resistant cultivars, the avoidance of wounds during harvest, proper sanitation and fungicide treatment of seed tubers.

5.7 Harvest and Post Harvest Diseases in Potato

Dr Ngo Thi Xuyen. Pathogen Division, Plant Protection Department, Agronomy Faculty, Hanoi University of Agriculture

As part of this presentation Dr Xuyen showed images of a large range of pathogens including *Fusarium* spp. wilts, nematodes (*C. elegans, M. incognita, M. arenaria, M. javanica, M. hapla, Ditylenchus destructor, Globodera rosochiensis*), bacterial wilt (*Rolstonia solanacearum*) stem rots (*Sclerotia sclerotiorum* and *S. rolfsii), Rhizoctonia* spp, scabs, *Verticillium* spp, scurfs, silver rot, soft rot (*Erwinia carotovora*). The complex associations between root-knot nematodes and soil-borne fungal/bacterial diseases that can cause damage to most vegetables where also discussed, as was the importance of crop rotations with non-host crops.

During this presentation life cycles of nematodes were discussed stressing the importance of infections on crop residue in the field and development of disease symptoms when storage conditions are inappropriate. It was noted that due to a lack of optimum storage facilities there are many storage diseases found in Vietnam and nematodes are a considerable issue. Management includes soil solarisation, ensuring the seeds are disease-free prior to storage by using an appropriate diagnostic technique.

A range of laboratory diagnostic equipment was also shown during this presentation highlighting the experience students and researchers at Hanoi Agricultural University have in potato disease diagnosis and management. SEM images showed a range of nematodes and nematophagous fungi (nematode trapping and digesting species) that can be utilized in biological control programmes and by farmers. A range of species within the genera *Hirsutella, Arthrobotrys, Trichoderma, Paecilomyces, Gliocladium* and *Dactylella* were described.

Images of antagonistic microorganisms were also shown, these included *Bacilis subtilis* inhibiting the growth of *R. solani* and *F. oxysporum* as well as *Pseudomonas fluorescens.* Experiments that showed soil solarisation using plastic film and the use of *Tagetes* spp that produce root toxins were also discussed.

5.8 Bacterial Diseases of Potato

Dr Pham Xuan Tung. Potato, Vegetable and Flower Centre, Da Lat city, Viet Nam

The major bacterial disease in potato crop is considered to be Bacteria Wilt (BW) (*Ralstonia (Pseudomonas) solanacearum)* characterized by the partial or complete wilting of plants. This bacterium is gram-negative and has huge variability in characteristics. BW is pathogenic to over 40 plant genera and is more prevalent in warm and humid climates. Infection by BW can be confirmed by the “vascular ooze (or flow) test”.

There are four races of BW:

1	Prevalent in mid and lower elevations of the tropics. Wide host range of over 30 plant families including potato and tomato.
2	Bananas, *Heliconias*, plantains. May affect potato upon artificial inoculation.
3	Potato race. More prevalent at higher elevations and latitudes. Occasionally infect tomatoes.
4	Mulberry. Weakly virulent to potato and eggplant.

Biotypes (biovars) can be classified according to the oxidation of carbohydrates (disaccharides and hexose alcohols)

Biovar	Carbohydrates utilized	Host range
I	None	wide host range belonging to large number of families
II	Only the disaccharides lactose, maltose, cellobiose	attacts only members of *Solanaceae*
III	Disaccharides and hexose alchohols (manitol, sorbitol and dulcitol)	wide host range belonging to large number of families
IV	Only the alchohols	only members of *Solanaceae* and *Zingiberaceae*
V	Maltose, lactose, cellobiose and manitol (not dulcitol and sorbitol)	Attacks only mulberry

The mechanism for pathogenicity for BW is the occlusion of xylem vessels by extra-cellular polysaccharides (EPS) produced by the bacterium. In potatoes this mechanism is not fully understood. Research so far shows there is:

- No evidence of any pre-existing or induced resistance,
- No inhibitors to bacterial growth
- No agglutination of bacterial cells by plant lectins
- No attachment and envelopment of bacterial cells to host cell walls
- No association between or with phytoalexins or other phenolic compounds

Therefore, the nature of resistance is not yet clear. Several mechanisms might be involved in the ability to resist wilt.

There is a very strong host – pathogen – environment interaction and the H-P-E interaction is the consequence of the differential adaptation of particular host genotypes and pathogen genotypes to environments, i.e., both the host and the pathogen genotypes interact strongly with changes to the environmental changes especially the ambient temperature.

From an evolutionary point of view: there is no true gene for resistance *sensu* Flor; (*Melampsora lini* – flax pathosystem), other genes pleiotropically confer the "*resistance"* and thus there is no true resistance but tolerance to wilt or pseudo- resistance.

Many attempts at breeding potatoes for resistance have been made, initially by the University of Wisconsin using *Solanum phureja* – BR clones series. However, researchers found resistance breaks down rapidly under hot conditions. They concluded any resistance appears to be most unstable.
The International Potato Centre also investigated resistance using a conventional strategy and wide genetic background for resistance coupled with wide adaptation, especially to hot environments and following up with recurrent selection and progeny testing. This resulted in several varieties exhibiting resistance to BW however, a modern approach, employing Biotechnology, was needed.

CIP was able to develop a general type of resistance through *Agrobacterium*-mediated transfer of a gene from the silk moth, *Hyalophora cercopia*, that encodes for production of cecropin, a general anti-bactericidal compound. The advantage of using Biotechnology includes a general resistance to bacterial diseases and the quick development of resistant materials. However there remains a general consensus against the use of genetically modified organisms in crop production, particularly in food crops.

Control measures for BW include:

- the use of disease free potato seeds, such as those produced *in vitro* (tissue culture).
- True seeds may also be used
- Crop rotation in 3-5 year cycles
- Soil disinfection or fumigation
- Disease-free irrigation water
- Assured sanitation for utensils and during field operations
- Rouging of volunteers
- Rouging of diseased plants
- Avoid root damage, including the need to control nematodes

Soft Rot or Black leg (*Erwinia carotovora*) is also another important bacterial pathogen of potato crops damaging the stems, stolons and tubers of plants. Stem symptoms include a dark-brown discolouration inside of stems while flesh quickly turns brown when tubers are cut.

Soft Rot (*Erwinia spp*) are soil-borne pathogens that infect a wide range of host plants in warm and cool climates. All *Erwinia* spp require high (in excess) soil humidity for spread and infection. *Erwinia* species*:*

- Are endemic in the soil (irrespective of whether the tubers are harvested from black leg infected plants or black leg free plants, a high proportion of them carry *Erwinia carotovora* – 80 % var *carotovora*; 20 % var *atroceptica*)
- Can survive on larvae of several species of flies and on plant debris and in rhizospheres
- More related to soil temperature than soil moisture
- Can survive temperature up to $40^{o}C$
- Diminish when soil temperatures decrease to near freezing point

Dispersal of *Erwinia* spp. occurs through*:*

- black leg plants in the field
- seed tubers (visible symptoms or latent infection)
- working tools/machinery
- weed hosts
- insects/animals

- irrigation water
- run-off water
- rain splash
- wind-dispersed aerosols

Management methods for soft rot include:

- use of clean seed
- apply proper rotation, especially bare fallow
- use clean water for irrigation
- control insects
- use of clean working tools/machinery
- never harvest potatoes when it rains or soil is wet
- store seed well (good ventilation and dry)

Discussions:
Many more tubers are infected by late blight then by soft rot in storage.
Insects can carry soft rot but the most important thing about insects is that they are able to cause primary feeding damage and only then *Erwinia* can enter the plants
Use of clean water for irrigation, how do we do this? This is difficult to do but must come from clean source, preferably from ground well water. Ensuring crop residues do not enter water sources in also very important to reduce the spread of diseased plant material.

5.9 Virus Diseases of Potato in Asia
Dr Prabhat Kumar. Asian Institute of Technology, Thailand
After its introduction from Europe in 16 and 17Th century, the potato steadily increased its acreage and reach into the food system in Asia. However, in the last three or four decades; many countries in Asia, led by China and India, witnessed tremendous increase in potato cultivation area and production. In the recent few years more potatoes are now produced in the developing world compared to the developed world.

Potato viruses are among the chief potato production constraints and as many as 12 various viral diseases are reported. Potato Virus X, Y, A, and Potato Leaf Roll Virus are commonly found in many Asian countries. Green peach aphids are often associated with vectoring many of these viruses. As potato is propagated vegetatively, the consequences of virus diseases at farmer field is enormous, e.g., overall deterioration of varietal performance, yield losses, etc. In addition, newer virus and other diseases like Zebra stripe and other phytoplasma diseases, etc. are being reported from various parts of Asia and Oceania.

Management of these viruses is directly linked to availability of good and clean seeds, phyto-sanitary measures and vector management. Farmer’s education using Farmers Field School focusing on these management aspects could add directly to the sustainable production and protection of potato in Asia, where majority of farmers are smallholders. Correct and robust diagnosis of virus, cleaner and healthy seed production at farmer’s level are equally important aspects. The hand-held virus diagnosis stripes could further help to identify presence or absence of a virus in farmers’ training situation at overall low-cost. Similarly, incorporation of recent scientific findings and development of a robust training curricula to address virus diseases would be of paramount importance for IPM-FFS programmes in Asia.

5.10 New Technology in Seed Production
Dr Kaiyun Xie. International Potato Center, Beijing Liaison Office
There are two kinds of seed potato production systems in the world, formal system and informal. The former one exists in developed countries with high quality and high price. The latter one is very common in the developing countries with relatively low quality and low price. The technologies used in the formal seed system comprise of meristem culture, virus detection, and different seed production technology (pre-basic, basic, and certified). Of them, all kinds of

mini-tuber production technologies are the key factors for the success of the system. Mini-tubers can be produced from all kinds of media or from media-free methods, such as hydroponics and aeroponics. The supervision system plays an important role in this system. For the informal system, positive selection (to select and mark the healthy plants in the field during the beginning of blooming, then harvesting these plants separately) is the most efficient way to improve the seed quality.

5.11 Diseases Caused by Nematodes

Valeriana P. Justo. National Crop Protection Center, University of the Philippines, Los Baños

Description, classification, distribution, and host range. Nematodes, microscopic animals also known as roundworms, threadworms or eelworms, are either plant parasitic or non-plant parasitic (saprophytes). These animals belong to Class Nematoda. They occur in a wide variety of habitats, mostly in soil and water. The common plant-parasitic nematodes in potatoes are *Globodera rostochiensis* and *G. pallida,* potato cyst nematode or golden nematode or potato root eelworms; *Meloidogyne incognita, M. javonica* and *M. hapla*, root knot nematodes; *Nacobbus aberrans*, false root knot nematode; and *Pratylenchus* species, root lesion nematode. Potato cyst nematode originated from the Andean highlands of South America and is distributed throughout Europe, northern temperate countries and high elevations (2,000msl) in tropical latitudes. Root knot nematodes, the most widely spread nematodes in the world are found in cold areas (0-15^{o}C) and in the tropics (above 40^{o}C). Potato cyst nematodes attack potato, tomato, eggplant, and more than 100 solanaceous weed species while root knot nematodes attack more than 170 plant species including 17 weed species.

Morphology, reproduction and life cycle. Second juvenile stage of nematodes have stylets, the key feature of plant-parasitic nematodes. The stylet, a hard, narrow and mobile mouth spear, is used to perforate root cells and absorb food. The muscles attached to the posterior knobs move the stylet backward and forward to perforate plant cells. The median bulb pumps and forces food into the intestine that serves as the storage organ filled with globules. The alimentary canal has the mouth esophagus, intestine and anus.

The life cycle of potato cyst nematode is 6-10 weeks. The larvae called juveniles are protected by egg shell and cyst wall. The second stage juveniles hatch from the egg shell which ruptures due to stimuli produced from subtances exuded by the potato roots. The juveniles puncture, penetrate into the roots, feed and develop and undergo two molts. Availability of food supply determines the sex of nematodes. More males develop at low food supply and more females at abundant food supply. At favorable food supply, population increases 50-fold. Females (cysts) are sedentary, attached within the root surface and body swells. The cyst ruptures the root cells, head and neck remain attached, buried inside the roots. They get their food supply for development from the syncitia or enlarged cells caused by the saliva excreted by the juveniles during feeding. Females die, white cuticle turns brown hard cysts (.5-1mm). Each cyst may contain 600 eggs and remain viable for 20 years. Root knot nematode has shorter life cycle, 3-4 weeks at ideal conditions and doubles at unfavorable conditions. It is simple and direct, from egg to juveniles and to adult. Juveniles undergo four larval stages. A female lays more than 500 eggs/egg mass enclosed in a gelatinous matrix. Eggs remain dormant for a few months.

Damage, signs and symptoms. Plant parasitic nematodes cause indirect damage to plants. Feeding lesions serve as entry points for bacterial and fungal infection. Damage due to feeding causes the above ground parts to become yellowish, wilt at severe infection and stunted. Formation of root galls in the primary and secondary roots may become enlarged and obvious at severe infection. Disease due root knot nematode damage is favored by relatively warm temperature and light sandy soils.

Host-nematode relationship. The host-nematode relationship is controlled by resistance and tolerance of potato variety and pathogenecity of the nematode. Environmental factors such as soil fertility and other growth conditions alter the host-nematode interrelationships. Resistance is determined by the relationship between the initial nematode population density before planting and final nematode population density at the end of growing season. The variety is susceptible if nematode multiplication rate is greater than 1 and resistant if less than 1. The processes that determine the mechanism of resistance are reduced hatching due to failure of the roots to stimulate emergence of second stage juveniles and the restriction or inhibition of formation of transfer cells or syncytia. Resistance may break down due to natural selection or genetic adaptation by continuous planting of resistant variety under conditions of high nematode population density. Tolerant varieties have the ability to yield despite nematode infestation and are able to compensate for nematode damage. Pathotypes in *Globodera* spp. are physiological races that can be distinguished by their ability to multiply on so-called differential potato plants. *Globodera* have different genes for resistance, some pathotypes may be infested while others are not.

Integrated nematode management. Once established in the field, cyst and root knot nematodes are difficult to eradicate. Successful method of control combines prevention of spread and keeping nematode populations below damaging levels in infested areas. (1). Strict quarantine regulations prevent the introduction of infected plant materials from one country to another or locally from one farm to another by farm tools, boots, feet, and planting materials. (2). Plant resistant varieties if available. (3) Use clean and healthy seeds. (4) Practice crop rotation – rice or other cereals reduces nematode population by 30%; usual rotation is 5-6 years non-host plant. (5) Grow resistant crops such *as Tagetes* , *Crotolaria*, *Cosmos* and *Asparagus* that are not affected by nematodes but prevent multiplication of plant parasitic nematodes. (6) Use biofumigation by incorporating brassica crops as green manure 2 weeks before planting. (7) Fallow after plowing to expose the nematodes to drying and eliminate potential host plants. (8) Apply animal manure – organic matter decomposition produces toxic metabolites, heat and acidic condition that kill plant parasitic nematodes. Organic matter also favors growth of nematode trapping fungi. (9) Apply biological control agents such as nematode trapping fungi – *Paecilomyces lilacinus, Arthrobotrys, Catenaria, Dactylaria, Penecillium, Aspergillus niger, P. oxalicum* and *Metarhizium anisopliae.*

Extraction of nematodes from the soil. Nematode population in the soil can be determined through extraction from the soil samples. Nematode population counts is necessary in conducting bioassay or studies such as the effect of soil treatments, environmental factors, biological control agents, crops planted and varietal trials. Extraction can be done by using a Baerman funnel, whitehead tray or simply a bottle. Soil samples are taken from the root zone of ten plants. Soil samples are well mixed. A small amount of the soil is poured in a glass or funnel of water lined with a tissue paper. After 24 hours, collect the water and allow the nematodes to settle at the bottom. Pipette the water at the bottom, transfer water to a petri plate and count under a dissecting microscope. The simplest method is done by putting the soil sample in a bottle, adding water enough to moisten the soil, and shaking vigorously. Then, add more water near top and collect the cysts that will float using a very thin pointed piece of wood or bamboo stick. Pour the upper portion into a layer of absorbing paper and examine cysts under a microscope.

5.12 Biofumigation for Soil-Borne Disease Management in Potatoes

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Definition. Biofumigation is the suppression of pests and diseases by biocides released from brassica rotation and green manure crops. Brassica tissues have glucosinolates (GSL) that when acted upon by the enzyme myrosinase produces isothiocyanates (ITC). The amount and type of GSL varies among species of brassica. *Brassica juncea* (Indian mustard, Chinese mustard) has 20-50umole/g; *Raphanus sativus* (oil radish and radish) has ~ 30umole/g; *Sinapsis alba* (white mustard) has 20-30umole/g; *Brassica napus* and *Brassica campestris* (rapeseed and turnip) have 5-20umole/g and *Brassica oleracea* (cabbage, wongbok, cauliflower, pechay and chaism) have < 15umole/g.

Best-bet brassicas. In commercial farms in Australia, Indian mustard is planted as green manure crop to suppress bacterial wilt and root knot nematode in potatoes and other solanaceous crops. Biofumigation done in Philippine small-scale vegetable production utilizes Chinese mustard, cauliflower, broccoli and radish residue after harvest. Cabbage and wombok can also be used.

Tissue incorporation. In large-scale production, green manure crops are grown and mulched with a tractor before flowering. The soil is irrigated and then covered with plastic mulch. The tissues are allowed to decompose for at least two weeks before planting potatoes. In small-scale vegetable production, $5kg/m^2$ of brassica tissues are pulverized, chopped into small pieces and incorporated or well mixed into the soil manually during land preparation. The soil is irrigated and left for two weeks to decompose. Seedlings are transplanted two weeks after incorporation.

Conditions for effective biofumigation. Brassica tissues should be well pulverized or chopped to maximize the release of ITCs. Pulverizing is much better than chopping. Maceration at cell-level is required for optimal release of ITCs. Water in plants is insufficient to maximize the release of ITCs. Adding water is important to maximize hydrolysis, carry ITCs into the soil and possibly reduce volatile loss. Isothiocyanates require thorough mixing for even distribution and uniform wetting of the soil. Movement of ITCs in the soil is limited to 7.5-10cm. Biofumigation is more effective in lighter soils or sandy soils. Isothiocyanates are adsorbed by organic matter and clay.

Advantages of using biofumigation for suppression of pests and diseases. Bacterial wilt, one of the most difficult diseases to control can be suppressed by biofumigation by as much as 50-70%. Several soil-borne diseases, soldier fly, plant parasitic nematodes and many weed species can also be effectively controlled by biofumigation (Kirkegaard and Mettheissen 2004). It does not affect useful microorganisms in the soil such as *Thichoderma* and *Bacillus*. Biofumigation can be easily integrated into disease management strategies. Organic matter added to the soil upon decomposition of brassica tissues improves soil physical, chemical and biological properties such as aeration, cation exchange capacity, fertility, and pH. Organic matter also enhances the growth of useful microorganisms in the soil that competes with the soil-borne pathogens. Nutrients from additional organic matter provide better nutrition to crops planted thereby, making the plant more tolerant to pests and diseases. Biofumigation reduces dependency to pesticides and ensures improved quality of produce and increases yield. Other impacts include utilization of left-overs that helps waste disposal. If soil-borne diseases especially bacterial wilt is controlled in the lower area of the slopes, then there will be no need to search for other areas on which to plant and further encroachment in the upper areas of the mountains will be avoided, thus forests are conserved.

5.13 Physiological Disorders of Potato Plant

Dr Pham Xuan Tung. Potato, Vegetable and Flower Centre, Da Lat City, Viet Nam

Potato plants can be considered a starch factory. To manufacture quantities of starch it will need adequate supply of raw materials. Environmental factors such as light, temperature, moisture, nutrients, etc may be considered the raw materials. To keep the potato plant healthy and producing high yield, each of these input factors should be kept at an optimum level. Impairment in any one of them will result in physiological disorders.

Disorders caused by unfavorable climatic conditions:

Unfavorable temperature conditions can affect plant growth and tuberisation. Potato is a cool climate plant. Heat stress often causes growth abnormalities such as curled leaves with yellowing patches, abnormal plant growth, increased respiration, reduced dry matter accumulation, low tuber set and abnormal tuber development due to impaired partitioning of assimilates to tubers, and phytohormone production. All of these impairments reduce yield and quality. Under heat stress conditions, stolons may grow profusely, there may be more stolons than tubers; tuber bulking is reduced, the tubers tend to be small and develop new shoots known as second growths, there may be a tendency of the tubers to give rise to sister tubers - bulbing from the main tuber. Heat necrosis is may occur inside the tuber and this may include symptoms such as hollow heart. To lessen the negative effect of heat stress during the season heat tolerant varieties should be selected and plants grown in the correct season. Application of additional Ca and N during periods of heat stress can reduce these symptoms. Lack of moisture can induce similar symptoms including stunted growth, reduced tuber set, malformed tubers, and reduced yield.

Nutrition Imbalances

There are several essential macro- and micro-elements that affect normal growth and development of a potato plant. Important macro-elements include N, P, K, Ca, Mg. Essential micro-elements may be Mn, B, Zn, S, Fe. When N is lacking, leaves turn yellow and plants are stunted. The optimum rate is between 150-400 (Universtiy of Nebraska website). Nitrogen deficiency can affect both above and below ground plant parts. Phosphorus is the second most important nutrient. When P is deficient, leaves look burnt, some time develop a dark brown reddish colour. Potassium deficiency results in yellow necrotic patches on leaves between veins of the older leaves, there may be leaf necrosi. Calcium deficiency often results in distorted young leaves which are irrigularly shaped, blossom end rots, malformed useless tubers. Magnesium deficiency results in imterveinal yellowing of leaves which are usually smaller, leaving a pointed arrow shape on the leaf blades. Deficiencies in manganese, iron, zinc, boron all cause similar symptoms. Soil conditions may influence the exhibition of nutrient deficiency symptoms. The bottom line is to adjust your fertilizer management to improve the quality and quantity of your tuber yield.

Discussions:

Under very hot conditions heat stress can affect tubers in storage. Brown spot is also an issue.

Virus symptoms can be easily confused with nutrient deficiency symptoms, ELISA -or other more practical- diagnostic test kits should be used to determine the cause of symptoms.

Black and Hollow heart can be influenced by moisture conditions and irregular application of fertilisers.

5.14 Potato in Rice Based Cropping Systems in China

Dr Xingyao Xiong. Hunnan Agriculture University

China is the biggest country in the world in terms of the population. Now the total population is over 1.3 billion and the annual requirement for food is over 560 million tonnes. However, the total annual output of food was about 500 million tonnes since 1990's. To ensure the food security in China, additional 60 million tonnes of food must be increased. The total arable land is about 1.8 billion mu (120 million ha) and will likely further decrease in the coming 20 years according to the prediction from experts. Thus, the increase of food output can not rely on the increase of arable land. The yields of major food crops (rice, wheat and corn) are much higher than the world averages and these have almost reached the potential yield by using modern breeding achievement, such as release of the super hybrid rice. This means the potential is limited for yield/ha increase of major food crops. In South China, about 300 million mu (20 million ha) of rice fields in winter fallow season are not utilized efficiently and 2/3 of them are empty during winter periods. It will be very meaningful for the food security if we can produce more food from these empty fields during the winter season.

In the past 50 years, there have been a number of experiments on wheat and corn in winter season but little progress has been made due to the climatic problems, such as light and temperature. In the beginning of the 21st century, the technological system for winter potato has markedly improved due to selection of new varieties, change of the cropping system, rotation with suitable crops, and improvement of crop management. Now the system has been extended in seven provinces in South China and huge social, economic and ecological benefits have been realized.

The Ministry of Agriculture has paid important attention to winter potatoes and over 3.33 million ha are planned to be planted in the coming 10 to 15 years. Furthermore, the rotation of rice and potato, will be efficient to control pests and diseases, to improve soil fertility, to increase yields, and to reduce production costs. Thus, the potential for winter potato will be remarkable. As remarked by Academician Yuan Longping, the father of hybrid rice, the combination of super hybrid rice with winter potato will be a huge contribution to food security in China.

Section 6 Field Visits and Practical Components:

6.1 Field collection of potato diseases

Participants visited a farmer's field outside the research center. Potato plants showing symptoms of diseases or abnormalities in growth and color were collected and placed in plastic bags. Dr. Hermansen and Dr. Kumar also showed samples of potato plants with symptoms of fungal diseases and viral infection. Samples were brought to the laboratory for examination.

6.2 Laboratory examination of potato diseases

Fungal diseases

The common fungal disease in the field was potato late blight. Black/greyish lesions on the leaves were the common symptoms of potato leaf blight. White mycelial growth was seen on lesions underneath the leaves when kept overnight in a plastic bag. Microscopic sporangia were seen under the microscope. Potato tubers with leaf blight infection were also examined. There was discoloration on the surface.

Bacterial diseases

Bacterial infection such as soft rot in one of the tuber was a secondary infection. Bacterial ooze was seen from the infected tuber. Unpleasant odor of the ooze was a characteristic sign of bacterial infection.

Nematode and diseases

Potato plants infected with root knot nematode were pulled out. Galls or enlargement of the secondary root were characteristic symptoms of nematode infection. Second juvenile larvae of root knot and potato cyst nematode were examined under the microscope. Juveniles appear as eelworm–like microscopic larvae. Cysts of female potato cyst nematode and root knot nematode were also examined. Cysts could be seen with the naked eye but when examined under the microscope the juvenile or small worms or larvae inside the cyst could be seen.

Viral diseases

Potato plants with necrotic leaves or uneven yellowing of the leaves, profuse growth of the leaflets were observed in the field. These were plants infected with potato virus Y or X or A or S. Dr. Prabhat Kumar explained to the participants that it was difficult to determine whether the symptoms were caused by either of the potato viruses- PTVY, PTVX, PTVA or PTVS or a combination thereof. In the field, participants also observed curling of leaves and stunted growth of plants due to viral diseases such potato leaf curl virus and mosaic viruses.

6.3 Field Visit to observe potato varieties grown with and without fungicide application, biofumigation and seed tuber treatment (Solarisation, Calcium hyperchlorite and control)

Several activities were prepared for demonstration and field visit during the workshop. The first activity demonstrated the effect fungicides can have on cultivars resistant and susceptible to potato late blight. Within this activity, three potato varieties with varying degrees of resistance (high, medium, low) to late blight were planted three weeks before the worksop. Mancozeb at one rate was applied to the plots, and some plots were kept untreated. The lessons learned from this activity conclude that although all varieties showed symptoms of late blight, the incidence of late blight disease among the three varieties varied according to their reported susceptibility to late blight. Furthermore, application of the fungicide Mancozeb reduced the incidence of late blight symptoms in all varieties.

A final field visit was made to evaluate a second field trial planted as a demonstration prior to the workshop. In this planting two seed tuber treatments were included, soil solarisation and soaking seed tubers in Calcium Hyperchlorite. While in the field participants collected data on the number of infected and deceased plants, as well as estimating the incidence and severity of infection for individual plants. The results from this study indicate that a similar number of plants were infected however the severity of plant infection among treatments was variable.

Both of these techniques can be adapted to assess many different things, according to your research needs

Summary discussion from field visit:

- Making a demonstration plot is difficult if too many factors are involved (sprayed and unsprayed, biofumigation and variety)
- Highest rate of infection observed in experimental plots were observed closest to infection source (residual crop neighboring the trial).
- Some differences were seen among cultivars, most resistant cultivars had infections indicating that resistant cultivars are not immune but the incidence and severity of symptoms is much less compared to other varieties.
- Treatments with fungicides had some effect but still plants in all plots show disease symptoms, inoculum pressure was very high, environment was very favourable for disease development.
- No effect can be expected from the use of biofumigation against late blight because it is a soil treatment.
- It is important to follow experiments throughout the crop cycle as results can change over time, sequential data collection should be done to allow analysis during the entire season, also extent of infection can change over time. Count how many plants/plot, measure severity by counting number of leaves infected on each plant.

6.4 Potato in Asian Kitchens – Cooking competition

A highlight of the Regional Potato Workshop was a cooking contest to celebrate the 'potato in Asian kitchen'. Information regarding the cooking contest was sent to the country teams prior to the workshop and they were asked to bring the needed spices, condiments, etc. from their own end and other needed ingredients including fresh potatoes were organized from Da lat. A number of Asian dishes were prepared by the participants and this created lot of interest among local organizers and participants alike.

Once dishes were prepared, each country displayed their creation along with their national flag. Followed this each dish was introduced by the participants and served to each participant so they could enjoy the exotic flavors. The dishes range from the Potato Soup from China to 'yum potato' from Thailand. Towards the end of the show, the participants and guest unanimously recognised the Bangladeshi's 'aaloo puri " (fried potato bread) as the best dish of the evening. As a token of appreciation a Chinese cookery book "How Chinese Eat Potato" was given away by its Author Dr Xie from CIP-China.

Section 7 Curriculum Development Needs: Learning Opportunities from participant countries, and opportunities for future.

At the conclusion of the WOCSPPPCVA participants were divided into country groups to identify what was learned during this workshop, where opportunities for the future knowledge development lie, what technical support do these learning initiatives require and what opportunities exist in each country to promote sustainable potato production and protection. This knowledge will assist FAO IPM to tailor activities within each country and improve the programme delivery. These responses are summarised below while full responses, according to country, are included in **Appendix 4**.

1. What was learned during the WOCSPPPCVA? How can you integrate the points that were learned into existing FFS curricula?

- Greater understanding of potato production including disease identification and management through exchange of information from other coutnries
- Methods to identify diseases spread by nematodes and management techniques
- Difference between symptoms caused by potato diseases and nutrient deficiencies

- Methods to produce healthy seed potatoes, especially aeroponics, minimum tillage and covering with rice straw
- Biofumigation techniques to manage soil-borne diseases
- Methods to incorporate what was learned during workshop into FFS curricula

2. What are the additional learning needs?
- Further incorporation of activities on plant disease, nutrient deficiency, nematode management, biofumigation and potato seed production techniques into FFS curricula
- Biopesticides useful in potato production
- Learning materials that will assist the development of FFS curricula eg. Lowel Black's "Vegetable Diseases: a practical guide"
- Techniques to manage potato insect pests
- Technical support from training and research experts to assist in country learning
- Knowledge of marketing techniques to promote potato production and consumption
- Soil nutrient management knowledge and equipment to help identify and differentiate symptoms caused by disease and nutrient deficiencies
- Methods to develop forecasting system for late blight
- Understanding of the influence of climate change on potato production, now and in the future

3. What technical support do you need to facilitate this learning?
- Virus detection kits such as ELISA
- Technical support from potato production experts
- Field guides and resource materials for FFS curriculum development
- Financial support to prepare resource materials in local languages
- Late blight resistant varieties for incorporation in FFS

4. What are the opportunities in your country to promote the potato?
- Government and NGO support to increase field activities, especially in seed potato production
- Cold storage facilities, especially for seed potatoes
- Government and private sector support for potato processing industry
- Development of stronger market demand for potato consumption
- Stronger linkages between farmers producing potatoes and markets for distribution
- Access to improved potato varieties
- Better understanding of how climate change will affect potato production
- Methods to ensure sufficient potato seed production when dealing with natural disasters such as drought and floods

Section 8 Workshop evaluation

In order to help improve future training courses and workshops, including those to be held on potato production and protection, an evaluation of the current WOCSPPPCVA was conducted by obtaining feedback from participants on its strength and weaknesses. The main findings as highlighted below are:

Participants Evaluation of **training facilities** (answers expressed as % - based on the number of responses received)

Facilities	Excellent	Very good	Good	Fair	Poor
Meeting room	5	32	59	4	
Accommodation	50	18	32		
Food	42	20	33	5	

Other comments:
- Meeting room was too small

- Traveling by bus to Da Lat was tiresome, airplane would be better

Participants Evaluation of **training content** (answers expressed as % - based on the number of responses received)

Training content	Excellent	Very good	Good	Fair	Poor
Overview of FAOs work on the potato crop	41	27	32		
An overview of production in the Asia-Pacific Region: Markets Development and Constraints	29	43	29		
Country reports	14	45	41		
Potato and its production in Vietnam	29	33	38		
Botany of the Potato	32	37	32		
Technical aspects of potato production	19	33	43		
IPM in potato: concepts and principles	23	9	50	5	
Foliage diseases of potato	32	23	41	18	
Tuber diseases caused mainly by fungus	45	9	41	5	
Harvest and post-harvest disease of potato	18	23	45	5	
Wilt diseases	32	26	37	14	
Virus, Vectors and zebra strip disease	32	18	45	5	
Seed potato production	23	50	27	5	
Diseases caused by nematodes	33	29	38		
Biofumigation for management of soil-borne pathogens	45	20	30	5	
Physiological disorders	41	23	36		
Potato in rice-based cropping systems in the sub-tropical lowlands	33	62	5		
Curriculum development needs in country	29	35	35		
Potato party & cooking contest	64	18	18		
Field work	15	35	40	10	

Other Comments

- Should have more specified reports
- Potato party was excellent
- More time for field activities

Participants Evaluation of **workshop organisation** (answers expressed as % - based on the number of responses received)

	Excellent	Very good	Good	Fair	Poor
Process	41	27	32		
Scheduling of Activities	36	32	32		
Facilitation	32	41	27		
Comments	Excellent, well managed potato party				

Suggestions for future workshops:

- More practical participatory classroom and field exercises
- Longer workshop
- More regular workshops to share experiences ad learn about new topics
- PVF centre good location for future activities
- Field visit to FFS to interact with farmer
- Larger room
- Group dynamic exercises
- More time for each speaker
- Color printing for presentations as black and white cannot see symptoms
- Information about and tour to cultural attraction in country

- Workshop in China to demonstrate potato production in rice-based cropping systems in the sub-tropical lowlands
- Greater preparation for field activities, should not be too complicated

Section 9 Closing remarks

Mr. Jan Ketelaar and Dr Pham Xuan Tung delivered the closing address for the WOCSPPPCVA urging participants to promote sustainable potato production and protection in their home countries with farmers, government departments and the community in general. Participants were reminded that although there has been a lot of research conducted on potato production and protection there are lots of opportunities to promote the potato crop among farmers through relevant and participatory extension activities including FFS and pilot studies together with farmers. Participants were reminded to consider current curricula and consider ways in which what was learned during the WOCSPPPCVA could be incorporated into and strengthen current field school curricula. Many new friendships were fostered during the WOCSPPPCVA and participants were also encouraged to maintain and build on these networks to facilitate knowledge exchange among the participants, and with other researchers, to help everyone improve their understanding of potato production and protection. Finally, all participants, organizers and resource people were thanked for their outstanding contribution in making this a successful training event, and all participants were welcomed to enjoy the evening’s dinner party before the WOCSPPPCVA was declared closed.

Section 10 Acknowledgements

Sincere thanks are due to the collaborating institutions and many people (too many for individual mentioning) who have contributed to the success of the WOCSPPPCVA, in particular:

- All country participants for their country presentations and active participation and cooperation in all the training activities carried out in the WOCSPPPCVA,
- The Director, staff and researchers at the Potato, Vegetable and Flower Centre in Da Lat city, Viet Nam for their coordination of equipment, preparation of field activities and assistance in providing facilities and other resources during the WOCSPPPCVA,
- The PPD –and its National IPM Program- for allowing the workshop to be hosted in Vietnam,
- All resource persons for freely sharing their knowledge and experiences via formal presentation or during discussion with participants,
- The CTA and PDO, FAO Vegetable IPM Programme and the staff at FAO RAP (Bangkok) for all support necessary in making the WOCSPPPCVA feasible, and
- The organizing and management team for planning the WOCSPPPCVA, and together with other support helpers, for ensuring that all the WOCSPPPCVA expectations are met, including the smooth day-to-day operational execution of the training and related miscellaneous activities.

Appendix 1 Concept Paper

Workshop on Opportunities and Challenges for Promotion and Sustainable Production and Protection of the Potato Crop in Vietnam and elsewhere in Asia (Dalat, Vietnam, 25-28 November 2008)

Background

Potato (*Solanum tuberosum*) originated in the highlands of Peru, South America, where it has been grown and consumed for more than 8,000 years. Potato is a main source of carbohydrates. A single medium-sized potato contains about half the daily adult requirement of vitamin C. Other staples such as rice and wheat have none. Potato is very low in fat, with just five percent of the fat content of wheat, and one-fourth the calories of bread. Boiled, it has more protein than maize, and nearly twice the calcium.

Today, potato is the third most important food crop in the world, with annual production approaching 300 million tons. More than one-third of the global potato output now comes from developing countries, predominantly in Asia. With the rising prices of rice and other staples in the world, potatoes have the potential and could be an alternative source of carbohydrates. However, there are still a lot of problems related to the production of potatoes that need to be addressed to realize the potential of the crop particularly in Asia.

Despite of the promotion of the True Potato Seed (TPS) technology in recent years, the most preferred potato propagation method among Asian smallholder farmers is planting tubers. However, since many potato diseases during the cropping season and in the harvested crops originate from inoculum in seed tubers, clean seed production is crucial. Potatoes can suffer from a range of pests (like leafminers) and diseases ranging from scab (which causes superficial damage on tubers) to late blight (which can destroy the whole crop foliage), the latter potentially resulting in total yield loss. Smallholder farmers spray their potato crops regularly with toxic pesticides, often on calendar basis, as to prevent and control such potato insect pests and diseases. Increasingly, fungal pathogens show resistance to fungicides as a result of the indiscriminate use of pesticides. Such applications are often to no avail and at considerable costs to the farmer and the environment.

To promote the sustainable production and protection of the potato crop, it is of paramount importance that farmers are able to implement ecologically-sound pest and disease prevention and management strategies. Of particular importance is the proper and timely diagnosis of potato diseases. For these reasons and also in commemoration of the International Year of the Potato-2008, FAO proposes to organize a Workshop on Opportunities and Challenges for Promotion and Sustainable Production and Protection of the Potato Crop in Vietnam and elsewhere in Asia.

Objectives

The overall objective of the training is to provide participants with new concepts on opportunities and challenges on sustainable potato production and protection with focus on principles and tools for disease diagnosis, prevention and management. In particular, the workshop aims to:

- Provide introductory/overview sessions on the importance of potato as a major food staple and cash crop for smallholder farmers in Asia;
- Provide an overview on potato production and protection and identify opportunities and challenges for promotion of the potato crop in farming systems in Vietnam and elsewhere in Asia;
- Provide hands on training in the diagnosis and epidemiology of potato diseases and their integrated management options in the field;

- Generate ideas for additional methodologies and Structured Learning Exercises to train farmers on diagnosis, prevention and management of potato diseases within the context of FFS and follow-up training activities.

Expected outputs

The participants will:

- Understand the importance of potato as food staple and cash crop;
- Be able to identify opportunities and challenges for the integration of potato in farming systems;
- Understand the main potato production/protection issues;
- Master the concepts and principles of integrated crop management;
- Master the botany of potato and practices, harvest and post harvest techniques related to its production;
- Identify main potato disease pathogens in the field;
- Experience how to develop IPM for potato, particularly with regards to potential role that farmers themselves can play in this process.

Program structure

Training methodology

Active participation will be essential during the programme. Emphasis will be on lectures, presentations, discussions and hands-on activities/practice. **The resource persons will not only give the lectures but also carry out the sessions using participatory approaches and make ample use of practical and field-based Structured Learning Exercises.**

Participants (about 34 persons)

Bangladesh (2); China (2); Indonesia (2); Nepal (2); Philippines (2); Thailand (2); and Vietnam (2 each from 5 key potato-growing provinces of Lam Dong, Hai Duong, Hai Phong, Thai Binh and Nam Dinh) From the Vietnam National IPM Team (PPD): 3 persons From FAO-programme staff and resource persons: 7 persons

Language requirement

The training programme will be organized and conducted in English. English language presentations will be simultaneously translated into Vietnamese and all presentations will be made available in both English and Vietnamese language.

Workshop facilitators/trainers

Dr. Arne Hermansen - BioForsk, Norway
Dr. Ngo Thi Xuyen – Hanoi Agriculture University, Vietnam
Dr. Pham Xuan Tung – Potato, Vegetable and Fruit Center, Vietnam
Ms. Valeriana Justo – National Crop Protection Center, Philippines
Dr. Kumar Prabhat – Asian Institute of Technology, Thailand
Mr. Le Tien Binh – Plant Protection Department, Vietnam
Mr. Ngo Tien Dung – Plant Protection Department, Vietnam
Mr Damien Cupitt – Vegetable IPM Consultant
Mr. Jan Willem Ketelaar – FAO Regional Vegetable IPM Programme, Bangkok
Ms. Alma Linda C. Morales-Abubakar – FAO Regional Vegetable IPM Programme, Bangkok

Place and duration

Potato, Vegetable and Flower Center (PVFC), Da Lat, Vietnam. The workshop will last for four days from 25-28 November 2008.

Appendix 2 Training Programme
Workshop on Opportunities and Challenges for Promotion and Sustainable Production and Protection of the Potato Crop in Vietnam and elsewhere in Asia
Dalat, Vietnam, 25-28 November 2008

Day 1, Tuesday, 25 November	
8:15 – 8:30	Opening Ceremonies • Welcome Remarks, Jan Willem Ketelaar, CTA, FAO Regional Vegetable IPM Programme • Welcome Remarks, Dr. Pham Xuan Tung, Deputy Director General, Institute of Agricultural Sciences of South Viet Nam (IAS) and Director of Potato, Vegetable and Flower Research Center (PVFC)
8:30 – 9:00	Overview of FAO's Work on the Potato Crop, Jan Willem Ketelaar An Overview of Potato Production in the Asia-Pacific Region: Markets, Development and Constraints, Dr. Kaiyun Xie, Liaison Scientist, CIP Beijing Liaison Office
9:00 – 9:30	Introduction of participants
9:30 – 9:45	Coffee break
9:45 – 12:00	Country Reports • Bangladesh • China • Indonesia
12:00 - 1:30	Lunch break
1:30 – 3:00	Country Reports (cont.) • Nepal • Philippines • Thailand
3:00 – 3:15	Coffee break
3:15 – 4:30	Potato and its Production in Vietnam, Dr. Pham Xuan Tung Potato IPM-FFS Experience in Vietnam, Mr. Bui Van Huyen, Vice Director, Thai Binh Plant Protection Sub Department
4:30 – 5:30	Field work: Collection of Plant Materials with Disease Symptoms
Day 2, Wednesday, 26 November	
8:00 – 9:15	Botany of Potato, Dr. Pham Xuan Tung
9:15 – 10:30	Technical Aspects of Potato Production, Dr. Pham Xuan Tung
10:30 – 10:45	Coffee break
10:45 – 12:15	IPM in Potato: Concepts and Principles, Dr. Ngo Thi Xuyen, Pathogen Division, Plant Protection Department, Agronomy Faculty, Hanoi University of Agriculture
12:15 – 1:45	Lunch break
1:45 – 3:30	Foliage Diseases Caused by Fungi (major focus on Late Blight), Dr. Arne Hermansen, Senior Late Blight Specialist, Bioforsk – NIAER, Norway
3:30 – 4:30	Field visit
4:30 – 5:00	Processing of field visit
Day 3, Thursday, 27 November	
8:00 – 8:45	Foliage Diseases Caused by Fungi (cont.), Dr. Arne Hermansen
8:45 – 9:30	Tuber Diseases Caused by Fungi and Common Scab Disease, Dr. Arne Hermansen
9:30 – 10:30	Harvest and Post Harvest Disease on Potato, Dr. Ngo Thi Xuyen
10:30 – 11:00	Visit to Laboratory/Cofee break
11:30 – 12:30	Wilt Diseases, Dr. Pham Xuan Tung
12:30 – 2:00	Lunch break
2:00 – 3:30	Virus and Vectors and Zebra Stripe Disease, Dr. Prabhat Kumar, Asian Institute of Technology, Thailand
3:30 – 3:45	Coffee break

3:45 – 5:00	Seed Potato Production, Dr. Kaiyun Xie
5:00 – onwards	Potato Party!!!
Day 4, Friday, 28 November	
8:00 – 9:30	Preparations for Field Visit
9:00 – 10:00	Field visit
10:00 – 10:15	Coffee break
10:15 – 11:15	Diseases caused by Nematodes, Ms. Valeriana Justo, University Researcher, National Crop Protection Center, Philippines
11:15 – 12:30	Biofumigation for management of soil-borne diseases, Ms. Valeriana Justo, NCPC, Los Banos, Philippines
12:30 – 1:45	Lunch break
1:45 – 2:45	Physiological Disorders, Dr. Pham Xuan Tung
2:45 – 3:00	Coffee break
3:00 – 4:15	Potato in Rice-based Cropping Systems in the Sub-tropical Lowlands, Dr. Xingyao Xiong, Professor , Hunan Agricultural University
4:15 – 5:00	Curriculum Development Needs in Countries
5:00 – 5:30	Evaluation and Closing Ceremonies

Note: Aspects of curriculum development will be included in each topic and not as a separate activity. All topics will utilize participatory approaches that should generate ideas for methodologies and structured learning exercises to train farmers on the production and protection of the potato crop within the context of FFS and follow-up training activities.

Appendix 3 List of Participants, Resource Persons and Contact Details:

Participants	Name/Designation	Designation	Organisation	Email Address
Bangladesh	Mr. Md. Rezaul Islam Mr. Zahidul Alam	FFS Master Trainer, Danida FFS Master Trainer, Danida	Department of Agriculture Extension, Bangladesh Department of Agriculture Extension, Bangladesh	c/ohbijlmakers@gmail.com, dmsalam@accesstel.net
China	Mr. Xie Yiling Mr. Ruan Shiyou	Agronomist Senior Agronomist	Guangxi, Plant Protection Station, China Luliang County PPS, Yunnan, China	gxfz@vip.163.com zhbzhrshy@126.com
Indonesia	Ms. Mieke Ameriana Mr. Muhammad Asaad	Researcher Researcher	Indonesian Vegetables Research Inst, Bandung, Indonesia Assessment Institute for Agricultural Tech of South Sulawesi, Indonesia	mieke.ameriana@gmail.com asaad_bptpsulsel@yahoo.co.id
Nepal	Mr. Rajib Das Rajbhandari Mr.Rishi Ram Kunwar	Master IPM trainer/Plant Protection Officer IPM facilitator, Plant Protection Officer	TITAN, Government of Nepal Plant Protection Directorate, Government of Nepal	c/o Arjun.Thapa@fao.org c/o Arjun.Thapa@fao.org
Philippines	Ms.Mary Frances Buanzi Mr. Landis Teofilo	IPM Program Officer / Agriculture Extensionist of Mountainous provinces Provincial Program Coordinator of the High Value Commercial Crops Prog	Department of Agriculture, Office of Mountain Provinces, Bontac, Philippines Department of Agriculture, Powgau City, Philippines.	mfw_buanzi@yahoo.com pilolandes@yahoo.com
Thailand	Ms.Pasita Kaewlueamsai Mr.Panupong Singhkhum	Agriculture Extensionist Agriculture Extensionist	Chiangmai Pest Mgt Center, Changmai Thailand Phitsanulok Pest Mgt Center, Muang Phitsanulok, Thailand	pmc08@doae.go.th pong9_9@hotmail.com
Vietnam	Mr. Pham Nguyen Hanh Mr.Pham Dinh Hoa Mr. Tran Ngoc Chinh Ms. Bui Thi Bang Thanh Mr. Bui Van Huyen Mr. Phi Ngoc Hung Ms. Pham Thi Hoa Ms. Nguyen Hong Thuy Mr. Nguyen Duy Hai Mr. Tran Van Tuan Mr. Dang Ngoc Can Mr. Nguyen Van Huan	Director Master trainer IPM trainer IPM trainer Master trainer Master trainer IPM trainer IPM trainer Director IPM trainer Project manager Agro manager Agro manager	Hai Duong PPSD Hai Duong PPSD Nam Dinh PPSD Nam Dinh PPSD Thai Binh PPSD Thai Binh PPSD Hai Phong PPSD Hai Phong PPSD Lam Dong PPSD Lam Dong PPSD PepsiCo PepsiCo PepsiCo	ccphamnguyenhanh@yahoo.com tranngocchinh_bvtv@yahoo.com thanhoanh63n@yahoo.com thaibinh@gmail.com ppdhp2003@yahoo.com nguyenhongthuy@haiphong.gov.vn tuantdkt@gmail.com dang.ngoc.can@intl.pepsico.com nguyen.van.huan@intl.pepsico.com

	Mr. Nguyen Hong Hang	Dean of Agro-Forest Dev	Dalat University	
	Mr. Nguyen Van Ket	Agro executive	PVFC	haupvf@yahoo.com
	Ms. Nguyen Tuyet Hau		Agro executive, PVFC	
	Mr. Nguyen The Nhuan		Agro executive, PVFC	
	Ms. Pham Thi Lan		National IPM Coordinator, PPD	lanpham_pvf2006@yahoo.com
	Mr. Ngo Tien Dung		Vegetable IPM Coordinator, PPD	
	Mr. Le Tien Binh			binhipm@yahoo.com
Resource Persons	Mr Pham Xuan Tung	Director	Potato, vegetable & Fruit Center, Vietnam	tung.ctp@hcm.vnn.vn
	Ms Ngo Thi Xuyen	Professor	Hanoi Agriculture University, Vietnam	ntxuyen20012000@yahoo.com
	Mr Arne Hermansen	Late Blight Specialist	BioForsk, Norway	arne.hermansen@bioforsk.no
	Mr Prabhat Kumar	Senior research Scientist	AIT, Bangkok, Thailand	pkipm@ait.ac.th
	Ms Valeriana Justo	Researcher	National Crop Protection Centre, Los Banos College	vale.justo@yahoo.com.ph
	Mr Kaiyun Xie,	Liaison Scientist	CIP Beijing Liason Office	k.xie@cgiar.org
	Mr Xingyao Xiong	Professor,	Hunan Agricultural University	xiongxingyao@yahoo.cn
FAO Vegetable IPM Programme	Mr Jan Willem Ketelaar	CTA	FAO Regional Vegetable IPM programme	Johannes.Ketelaar@fao.org
	Ms.Dada Abubakar	Programme Officer	FAO Regional Vegetable IPM	AlmaLinda.Abubakar@fao.org
	Mr. Tran Van Hieu	Programme Assistant	FAO IPM office, Hanoi	tvhieuipm@vnn.vn
	Damien Cupitt	IPM Consultant	FAO consultant	damiencupitt@gmail.com

Appendix 4 Curriculum Development Needs in Country

Bangladesh:

1. What was learned during the WOCSPPPCVA? How can you integrate the points that were learned into existing FFS curricula?
    - Biofumigation
    - Difference among symptoms caused by viral disease and nutrient deficiencies
    - Collection and identification of disease samples
    - Seed plot techniques to produce healthy tubers, including aeroponics
    - Zebra stripe virus
    - Identification of golden cyst nematode
    - Management of root nematodes
    - Disease management
2. What are the additional learning needs?
    - Biopesticides
    - Further incorporation of nutrient deficiency and virus identification activities in FFS
    - Development of FFS curricula for potato
3. What technical support do you need to facilitate this learning?
    - Virus detection kits (ELISA)
    - Disease Diagnosis Manual (ACIAR, Vietnam)
    - "Vegetable diseases - A practical Guide". Dr Lowell Black
4. What are the opportunities in your country to promote the potato?
    - Seed production through NGO's or Government departments
    - Training of farmers through potato FFS, especially seed tuber production
    - Cold storage facilities for seed tubers
    - Change of dietary habits to encourage more potato consumption
    - Development and promotion of potato industry.

China:

1. What was learned during the WOCSPPPCVA? How can you integrate the points that were learned into existing FFS curricula?
    - Greater understanding of potato production including disease and pest management through exchange of information
    - Production techniques in other countries
    - Potato recipes
    - Ways to incorporate what was learned into FFS curricula
2. What are the additional learning needs?
    - More information about the seed potato and seed system
    - Control of potato insects
    - Learn more about the culture of the host country
3. What technical support do you need to facilitate this learning?
    - Potato experts from different fields to give the specific presentations
    - Prepare the textbook for the participants because of the limit of language
    - Copy the materials for workshop
    - Organize another similar workshop in China
4. What are the opportunities in your country to promote the potato?
    - Healthy seed potato production and sound seed system
    - Winter potato production in South China
    - Promote the potato processing industry
    - Improve the farmers' knowledge for potato production, including FFS method, IPM approach from FAO.

Indonesia:

1. What was learned during the WOCSPPPCVA? How can you integrate the points that were learned into existing FFS curricula?
- Pest and disease biology and management
- Seed production systems and techniques

2. What are the additional learning needs?
- Cost benefit analysis
- Knowledge of marketing aspects

3. What technical support do you need to facilitate this learning?
- Assistance to develop experimental field training activities with farmers

4. What are the opportunities in your country to promote the potato?
- Create a new market for both fresh and processed potatoes
- Linking farmers to markets
- Improvement in seed quality
- Promoting diversification to our communities

Nepal

1. What was learned during the WOCSPPPCVA? How can you integrate the points that were learned into existing FFS curricula?
- Management practices of the potato crop and production practices in regional countries
    - to assist the integration of these techniques into FFS
- Fungal diseases including late blight management and the importance of healthy seed
    - these methods can be incorporated into FFS studies
- Bacterial diseases including bacterial wilt and management techniques such as biofumigation
    - These methods can be incorporated into FFS and special topics
- Viral disease and healthy seed produced on farm or imported test kits
    - Incorporation and strengthening of FFS curricula
- Techniques to produce healthy seed eg rice straw in potato seed production
    - Can be incorporated as special topics and case studies

2. What are the additional learning needs?
- Greater understanding of insect pests
- Curriculum development for potato FFS

3. What technical support do you need to facilitate this learning?
- Virus testing kits
- Late blight resistant varieties from other countries
- Technical support on seed production at farmer level
- Field guides for potatoes production

4. What are the opportunities in your country to promote the potato?
- More potato FFS within National IPM programme and TITAN
- Promotion of potatoes to increase food security
- Promotion of better potato varieties

Philippines

1. What was learned during the WOCSPPPCVA? How can you integrate the points that were learned into existing FFS curricula?
- Techniques in seed production
- Integrated management techniques for disease including disease diagnostics
- Potato recipes

2. What are the additional learning needs?
- Participatory field exercises
- Soil management in respect to nutrient and diseases
- Role of effective microorganisms and organic approaches to potato production

3. What technical support do you need to facilitate this learning?
- Field guides and exercises for potato FFS
- ToT activities for potato crop

4. What are the opportunities in your country to promote the potato?
- Increased food security utilizing potato crops
- Imported healthy and high yielding potato varieties
- Processing techniques and facilities
- Stimulated market demand for poratoes

Thailand:

1. What was learned during the WOCSPPPCVA? How can you integrate the points that were learned into existing FFS curricula?
- Healthy seed tuber production
- Disease and nematode management pre and post harvest
- Potato IPM techniques
- Potato and rice based cropping systems

2. What are the additional learning needs?
- Greater understanding of seed potato production techniques
- Disease control strategies in farmers fields
- Insect management utilizing IPM techniques

3. What technical support do you need to facilitate this learning?
- Curriculum development for FFS

4. What are the opportunities in your country to promote the potato?
- Understanding and promotion of the benefits of potato production
- Stimulate consumer demand for potato crops

Vietnam

1. What was learned during the WOCSPPPCVA? How can you integrate the points that were learned into existing FFS curricula?
- Grow potato with minimum tillage in RRD to improve production,
- Need to develop exercises to train farmers/field study design/develop curriculum for community involvement in potato prduction – IPM activity.
- Simple method to identify nematodes in potato fields – help farmers determine problem in the field.
- Identify the symptoms of micro and macro nutrient deficiency eg farmers doing pot study

2. What are the additional learning needs?
- Need to forecast late blight
- More information about the seed potato and seed system

3. What technical support do you need to facilitate this learning?
- Potato experts from different fields to give the specific presentations
- Prepare the textbook for the participants in each language to help participants
- Copy the materials for workshop

4. What are the opportunities in your country to promote the potato?
- Opportunities for increasing production in VN, climate change problems eg floods.
- Shortages of water in winter means potato production increase in future.
- Food processing knowledge

Appendix 5 Resource Materials:

Abdul Khaleques. 2008. *Potato Evolution: The tuber that was once called 'the cursed food hidden in the earth' may save mankind from starvation* Asia News, May 23-29
http://asianews.net

Anonomous. 2008. When the Chips Turn Brown. The Economist, 02 August 2008

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manual for plant diseases in Vietnam. ACIAR Monograph No. 129,

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Dongyu. Qu. and Kaiyun. Xie. Eds 2008. How the Chinese Eat Potatoes? World Scientific Publishing Co. Pte Ltd.

Elisabeth Rosenthal 2008. The humble spud gets a closer look in the food crisis, Potato seen as an alternative to grains. IHT, 27 October 2008

Kirkegaard, J. and J. Mettheissen. 2004. Developing and refining the biofumigation concept. Agroindustria. Vol. 3 Num.4. pp 233-239

Manis K. Papademetriou Ed. 2008. Workshop to Commemorate the International Year of the Potato - 2008. FAO-RAP, Bangkok Thailand 6 May 2008.

Reader. John. An Earlier Blight, When the Spuds Died. IHT, 17 March 2008.

Stevenson, W,. Loria, Rosemary., Franc. G.D., Weingartner. D. P., Compendium on potato disease 2nd Edn. American Phytopathological Society 2001.