NATIONAL PLANT PROTECTION CENTRE

ANNUAL REPORT

2014-2015

ROYAL GOVERNMENT OF BHUTAN

MINISTRY OF AGRICULTURE AND FORESTS

DEPARTMENT OF AGRICULTURE

FOREWORD

The publication of annual report provides an ideal platform to capture both completed and ongoing activities of the National Plant Protection Centre (NPPC). In the annual report, we are able to update and disseminate information that is required regularly by the agriculture development Centre and farmers.

In this report, we are pleased to highlight some of the commendable achievements made during 2015 season. Most of these achievements are outputs of the consistent effort made by various sections of the NPPC.

Followings are some of the commendable progress made during 2015 season;

a. Pheromone traps and lures to manage pod borer in the chili growing areas of Punakha Dzongkhag.
b. Super bag trial with promising result to manage storage pest in southern Dzongkhag.
c. New generation herbicides screening trials to manage Potamogeton distinctus, weed species in paddy
d. Pheromone traps to manage Red Palm Weevil in Areca nut plantation
e. HLB diagnosis through PCR analysis
f. Electric fencing progress and coverage
g. Pest surveillance capacity building

However, these notable achievements do not include number of progress made in other areas of the NPPC's activities. Most of the field trials concerning pest, disease and weed management are ongoing and are expected to generate useful results. In addition to the above notable achievements, we are also pleased to update the progress and achievement of Integrated Pest Management program since its inception in 1992-93. This status report of Integrated Pest Management not only reflect on the past lapses and improvement made, but such analysis guide us in future to streamline and emphasize on key areas of plant protection program. The other important content of this report highlights the strategy developed to reduce pesticide use, its implication, and integration of alternative tactics to overcome pest issues in agricultural crops.

Being the apex body for pest, disease and weed management that provides services to farmers and other stakeholders through research, extension and coordination, we continue to serve our clients with dedication and hard work and take pride in our strive to become a premier institution in the country for excellence in Integrated Pest Management.

Yeshey Dema
Program Director

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The NPPC's Vision, Mission and Goals are:

Vision

Strives to become a premier national institution for excellence in Integrated Pest Management

Mission

i. To generate pest management technologies that is environment friendly and safe for human health
ii. To disseminate pest management technologies for effective adoption by farmers
iii. To reduce crop losses to pest organisms to economically acceptable level

Goal

The goal of the pest management program is to contribute towards achieving the national goal of Poverty Reduction & Food Security through effective management and delivery of plant protection services.

1. PLANT PROTECTION PROGRAM PROFILE

The National Plant Protection Centre (NPPC) is the apex body and referral centre to provide direction, guidance and oversee the development and implementation of pest management program in the country. The centre is also a repository of pest, disease, weeds and plant protection products information system. The other important mandates of the NPPC are:

a. To develop and manage pest, disease, weeds, and vertebrate pests database through surveillance system
b. To undertake Pest Risk Analysis (PRA) especially for quarantine purpose
c. To conduct research and development to generate appropriate technologies that will reduce losses of crops to pest, disease, weeds and vertebrate pest
d. To provide guidance and coordinate vertebrate pests management activities
e. To provide laboratory diagnostic and advisory services
f. To develop collaborative activities with regional & international institutions and centres

For the coordination and implementation of above mandates, the centre has five technical divisions and one program management division (Figure 1).

1.1 Entomology Division:

Entomology Division deals with overall insect pest research and development of IPM technology. Specifically, the division is engaged in conducting adaptive field trials for major insect pests, collect referral insect pest specimens, train extension officials, develop extension materials, and provide advisory services to farmers and other stakeholders. Currently, the division is conducting research on the effectiveness of different traps for fruits flies, chili pod borer, armyworm, super bags for storage pests and beetles collection for species inventory.

1.2 Pathology Division:

Plant Pathology Division is responsible for conducting research on major diseases of economic and staple crops, and implements development activities for disease management in collaboration with extension agents, farmers and other relevant stakeholders. The other main functions of the division are diagnostic and advisory services for the management of plant diseases, training extension agents and farmers, and development of extension materials. The current research activities of the division are studying effectiveness of soil solarization using black and white plastic sheets to control cabbage club root disease, evaluation of released Bhutanese rice varieties for blast disease resistance, evaluation of effect of altitude and weather parameters (temperature, wind, rainfall, solar radiation) on citrus HLB disease, studying effectiveness of Sulphur spray to control citrus powdery mildew disease, and studying effectiveness of cultural practices for the management of chili blight disease. Besides, the division is also engaged in field visits to troubleshoot field plant disease problems.

1.3 Weeds and Vertebrate Pests Division:

The task of the Weeds & Vertebrate Pest Division is to develop management measures on weeds and vertebrate pests in agricultural crops. The division conducts on-farm trial and survey major weeds, train extension agents, collect weed species for herbarium, and develop extension materials. Currently, the division is conducting trials on efficacy of new generation weedicides against Potamageton distinctus spp. and other rice weed species. The electric fencing program including procurement of materials, capacity development of extension staff and impact assessment of electric fencing for vertebrate pest management in the country is coordinated by this division.

1.4 Pest Surveillance Division:

This division is responsible for planning, coordination and administration of overall national pest surveillance program. The division designs new surveys and refines survey techniques and tools based on farming system: provide training and technical support, which includes provisions of surveillance and monitoring tools in the field. The national repository of survey data is maintained and communicated for research, development and advisory services. The division is also mandated to develop national survey protocol, inspection guide, and survey calendar and information sheet to support the surveyors. Currently, the division is engaged in assessing the reliability and efficiency of newly introduced ePest surveillance system gadget in field.

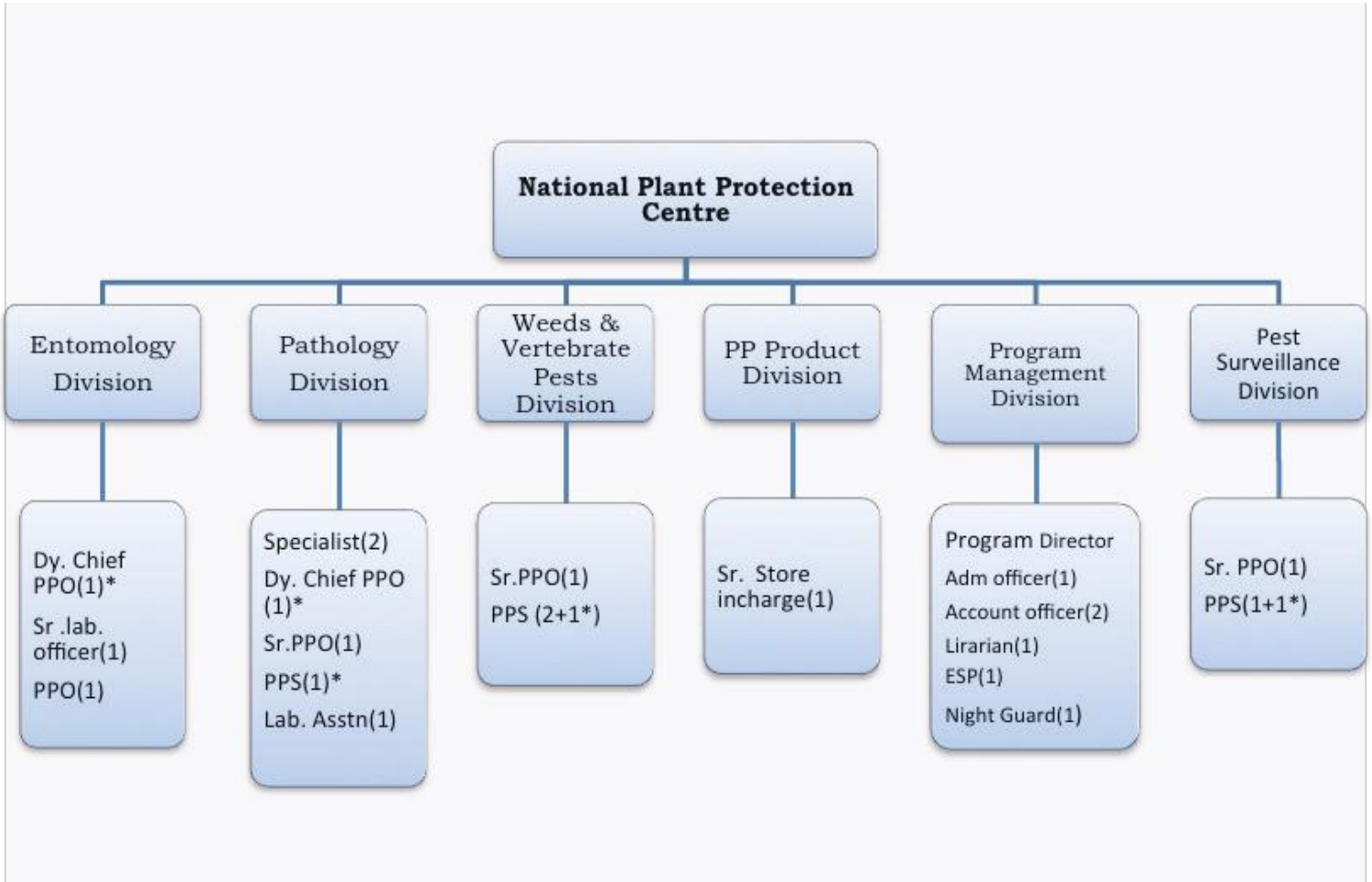
1.5 Plant Protection Product Management Division:

This division is responsible for plant protection product indenting, procurement, and distribution. It provides advisory services on safe handling and application of pesticides to farmers and other stakeholders.

1.6 Program Management Division:

The Program Management Division is responsible for overall administration, facilitation, monitoring and evaluation of plant protection program. It provides accounting and budgeting services besides normal day to day management of the centre and its resources.

ORGANISATIONAL SET UP



*Note: *Indicates staff on study leave and extra ordinary leave.*

Figure 1: Organizational Structure

HIGHLIGHT OF ACTIVITIES

2. INSECT PEST MANAGEMENT PROGRAM

2.1 Chili Pod Borer Management with Pheromone Lures

Site: Kabjisa gewog- Punakha Dzongkhag

Introduction: Chili is the main cash crop grown by farmers of Wokuna and Damchi villages of Kabji gewog in Punakha Dzongkhag. It is one of the main sources of cash income for the farmers. However, Chili pod borer, Helicoverpa armigera, is an important pest causing 40-50 % yield losses; thus constraining the overall production and quality of chili.

To find solution to this important constraint, the NPPC in collaboration with the Punakha Dzongkhag Agriculture sector had conducted pheromone traps and lures trials in these areas from the past few years. The trials have generated good results, especially in reducing pod borer population and losses of the crop. The technology is cost effective, easy to manage and environmentally friendly. It is becoming more acceptable technique to manage the pest.

Figure 2: Trial Sites for Pheromone Traps and Lures

The success of this technology has resulted in the reduction of pesticides use against this pest over the past years. Currently, the technology is promoted through training and demonstration programs. A day long farmers training on chili pod borer biology and use of pheromones and lures against chili

pod borer was conducted on 31st March, 2015 at Kabjisa gewog. The farmers were taught to identify the pest, its life cycle, infestation symptoms, and use of pheromones in managing the population. The installation techniques of pheromones and their maintenance were demonstrated following the theory session.

Figure 3: Moths in Pheromone Traps

The pheromone traps were set up in six famers' field in different locations and weekly inspection of the traps was carried out to study the time of emergence of moths in the locality to forecast the outbreak. The farmers accompanied the NPPC technical team in inspecting the traps to make them aware of presence of moths and show them how to service the traps in their field.

2.2 Army Worm monitoring using pheromone traps

To monitor the pest and population build-up of the pest, the NPPC procured pheromone lures and traps specifically designed for this species, Mythimna separata (Walker). Pheromone lures and traps can be used both for population monitoring of a specific pest and for mass trapping purpose.

Figure 4: Setting Armyworm Traps

The first outbreak of army worm in Bhutan was reported from Shengana in Punakha Dzongkhag in 2013. Following the incidence, army worm monitoring were conducted in pest prone areas. Last year, traps were set up in various places in Shengana to study the fluctuation in population level and forecast the outbreak.

To monitor the pest in critical crop growing period, ten sets of pheromone traps with monitoring sheet each were distributed to all twenty Dzongkhags in the country.

Figure 5: Armyworm Moths Captured by Traps

These activities not only help in pest monitoring but also assist in forecasting and

early intervention to control the pest. In the last cropping year, armyworm outbreaks were reported as shown in Table 3. The army worm affected areas in 2015 will be used as pilot site for evaluating effectiveness of pheromones traps and lures during the coming season.

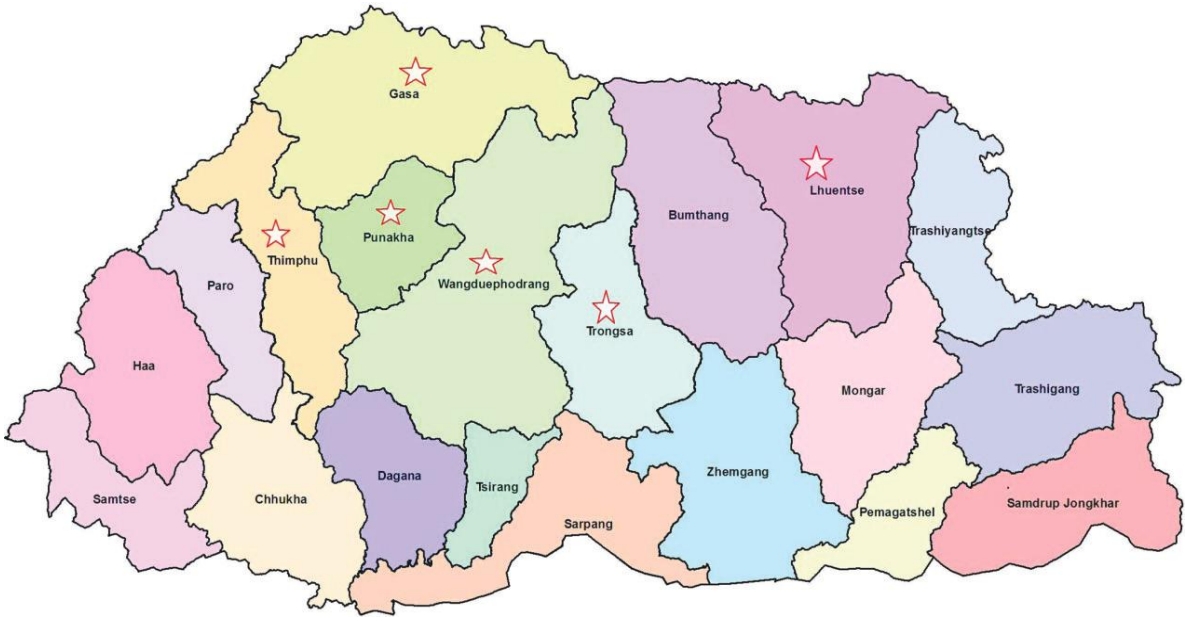


Figure 6: Armyworm Outbreaks in Various Districts

2.3 Army Worm Outbreak Reported In 2014 Season :

Table 1: Armyworm Outbreak Report

District	Gewog	Crop	Date of Incidence	Action Taken
Punakha	Barp, Chhubu, Dzomi, Goenshari, Guma, Kbaisa, Lingbukha, Shengana, Talo, Toepisa, Toedwang	Paddy nursery, maize	5th April-6th May 2015	Advisory services rendered
Thimphu	(Tendrelthang paddy nursery)	Paddy nursery	13th May 2015	Chemical spray
Wangdi	Thetsho	Paddy nursery	4th May 2015	Advisory services rendered
Lhuentse	Menji Gangzor Khoma	Paddy nursery Maize	13th May 2015	Advisory services rendered
Gasa	Khamae	Paddy		Advisory services rendered

Most of army worm outbreaks were reported from the paddy nursery and maize at early vegetative stage in the mid and high altitude areas. Only fewer cases were reported from the southern belt. These vulnerable places will be installed with army worm traps in the coming season. Such intervention is required to reduce the use of pesticides to control army worm. Besides adverse effects on environment

and health risk, use of pesticides to control army worm leads to development of pest resistance. Other cultural methods such as field sanitation and management of irrigation water are made aware to the famers as vital alternative management options.

2.4 Evaluation of Super Bag to Manage Storage Insect Pest
Sites: Tsirang and Sarpang Dzongkhag

Introduction: Grain Pro super bag works on the principle "Hermetic storage" where the flow of oxygen and water from outer environment is completely checked. This prevents damage and proliferation of storage pests and helps in reducing grain losses without using any insecticide. It helps in preserving the quality, germination and vigor of the seeds. In south East Asia, use of super bag has prevented infestation of grains by storage pests in rice, maize, coffee, etc.

Field Evaluation: The NPPC carried out field evaluation of super bag in collaboration with the agriculture sector of Tsirang Dzongkhag with an objective to evaluate the effectiveness of super bag in reducing maize grain losses to storage pests and compare its effectiveness with other traditional storage techniques. Simultaneously, two days farmers training were conducted for two chiwogs of Mendrelgang gewog in Tsirang. Four farmers from two chiwog were selected and trial was set up in their storage facility right after the grains have been harvested and dried. Data collection, sampling and inspection were carried out every after 3 weeks till the end of storage period (5-6 months).

Figure 7: Grain Stored in Super Bag

Result: At the end of storage season the grains were inspected visually. It was found that there was no pest infestation in grains stored in super grain bag compared to grains stored in jute bag that had high infestation of pests.

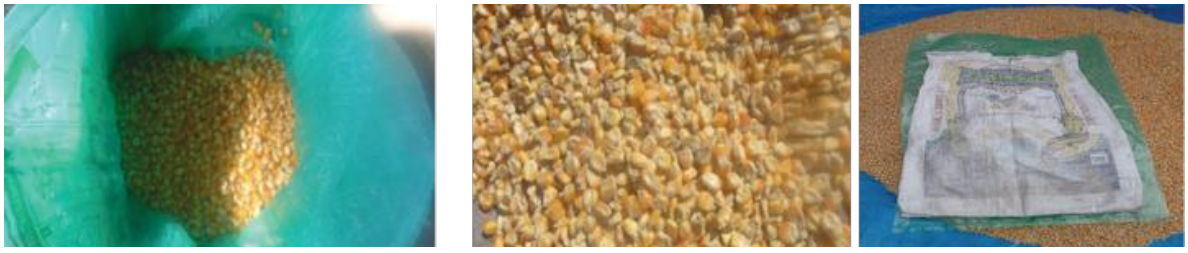


Figure 8 Super bag use for maize grain storage

To promote the use of super grain bags in Sarpang Dzongkhag, 20 numbers of super grain bags were distributed to Sarpang Dzongkhag Agriculture Officer this season. Dzongkhag Agriculture Sector will provide detail feedback after comparing effectiveness of storing grain in super bag and also using traditional storage method. Based on feedback received, the NPPC will promote the technology to other areas.

2.5 Fruit Fly Area-Wide Management in Tsirang Dzongkhag

Introduction: A species of fruit flies like Bactrocera dorsalis, Bactrocera tau, Bactrocera curcubitae, Bactrocera zonata, Bactrocera tuberculata and Bactrocera minax have been recorded in Bhutan. However, no fruit fly species falling under the genus Ceratitis , Anastrepha, Rhagoletis have been recorded till now in Bhutan. Bactrocera minax in citrus is currently of economic importance. This does not mean that the other species of fruit flies are not important. B. dorsalis, B. curcubitae, B.tau and B. zonata are major economically important pest in some countries, and they have potential to cause economic loss of crops in Bhutan if introduced and detected particularly in the warmer regions of the country.

Figure 9: Citrus Fruit Fly

Citrus Fruit Fly Survey: Survey was conducted in collaboration with the Dzongkhag Agriculture sector in two gewogs where the farmers have carried out protein baiting for the control of fruit fly and in another two gewog where the orchards are managed without protein baiting.

Figure 10: Sign of Citrus Fruit Infested by citrus Fruit Fly

Methodology: From each gewog, five orchards were randomly selected to study fruit fly infestation. From each orchard ten trees were randomly selected, and ten fruits from each selected trees were observed for the infestation. Infested and non-infested fruits were recorded in the format with the farmer's details. Altogether 20 orchards, 200 trees and 2000 fruits were observed for fruit fly infestation from four gewog.

2.6 Fruit Fly Area-Wide Management Training

Introduction: Fruit fly is a pest of economic importance in citrus and many other fruit crops and vegetables. Given its widespread habitat and host range, it is one of the most difficult pests to manage. Citrus fruits infested by this pest are rendered unfit to consume. The use of the chemical pesticide is neither economical nor safe to health and environment: Integrated approach such as picking of dropped fruits, use of pheromone traps and bait spray are used to minimize losses to this pest.

Training and Awareness: The NPPC in collaboration with Tsirang Dzongkhag Agriculture sector, conducted the Chinese citrus fruit fly area-wide management training in Kilkorthang and Dunglagang gewog from 21- 22 April, 2014. This training was a continuation of the similar program implemented by the NPPC as part of the ACIAR citrus project implemented since 2013. More than 91 farmers were trained on Chinese fruit fly biology, management strategies such as protein baiting, timely collection and destruction of dropped fruits, pit digging and safe use of pesticides based on need.

Figure 11: Farmers Training at Tsirang

Figure 12: Infested fruit collection and dumping

2.7 Red Palm Weevil Management

Introduction: Commonly known as betel nut, areca nut (Areca catechu) is a tropical crop cultivated as one of the main cash crop that provides high income for the farmers. It is widely grown in the sub-tropical southern Dzongkhags of Sarpang, Samdrup Jongkhar and Samtse.

The Red Palm Weevil (RPW) *(Rhyncophorus ferrugineus)*: Adult Red Palm Weevils are large beetles. The weevils have a long, slender rostrum or "snout" which the female uses to penetrate areca nut tissue and create access wounds in which eggs are deposited. The RPW adult collected from Bhutan are predominately reddish-brown. Larvae are legless grubs with the body color uniformly pale yellow with a brown head. The grubs are the most destructive stage of the weevil as they penetrate deep in the lower part of the stem causing damage to the internal tissues. When the infestation is severe, the whole tree falls and dies. Larvae feed within the soft tissues of the meristem or leaf bases creating frass filled

mines, enlarging and penetrating deep within the upper trunk areas as the larvae mature. Mature larvae construct a pupa chamber or cocoon made up of coarse arecanut fibers in which they pupate and occupy until they emerge as adult. The cocoons can be found within the damaged tissue of the arecanut trees.

		
RPW adults	*RPW Larva*	*RPW Cocoon*

Damage symptoms: RPW is widely considered to be the most damaging insect pest of arecanut and usually attack weak trees. RPW larvae feed within the apical growing point of the arecanut creating extensive damage to tissues and weakening the structure of the trunk. Arecanut damaged by RPW may exhibit the following symptoms:

a. Presence of tunnels on the trunk or base of plants.
b. Frass accumulating at points of injury or at the base of offshoots may also appear in infested trees
c. Oozing of viscous fluids from tunnels.
d. Appearance of chewed plant material (Frass) at the external entrances of feeding tunnels and a highly distinctive "fermented" odor.
e. Empty pupa cases and the bodies of dead adult RPW in and around heavily infested arecanut.
f. Breaking of the trunk, or toppling of the arecanut crown.
g. Dieback in the apical (newest, uppermost, or center) leaves in the canopy can be observed.


Figure 14: Arecanut Infested with RPW

2.7.1 RPW Incidence at Chuzagang

The team from the NPPC made field visit to the RPW affected arecanut orchards at Chuzagang gewog of Sarpang Dzongkhag. The team was accompanied by the concerned extension officer of the gewog. The followings are the observations and field activities carried out by the NPPC team.

a. Visited the severely infested arecanut orchards
b. Cut the infested arecanut trees for detection of red palm weevil larvae.
c. Most of the arecanut trees observed were affected by bud rot disease.
d. Observed RPW larva in some of the cut down trees.
e. Observed that the infested trees by RPW and infected trees by bud rot disease showed similar symptoms(yellowing and die back at the crown)
f. Collected the RPW and brought to the Entomology laboratory in the centre for rearing.

Figure 15: RPW Infestation Investigation at Chuzagang

2.7.2 Use of Pheromone Traps

Pheromone traps for the RPW were installed in six locations in the gewog. The traps are made of buckets which have been specifically designed for the RPW; these buckets contain a pheromone lure that attracts adult RPW. The adult weevils are trapped by drowning in the trap and this allows observation of population in the locality and as well as for the mass trapping the infested areas. They were hanged at 2-2.5 meters above the ground level.

Red palm weevil lure

Red palm weevil pheromone trap

2.7.3 Recommendations:

To prevent occurrence and control of RPW, following suggestion were provided;

1. *Phytosanitation*
   a. Avoid injuries on stems of arecanut as the wounds may serve as oviposition sites for the weevil.
   b. Wounding should be prevented, but if it is done wounding sites must be treated immediately with sand or resin
   c. Dig and turn the soil deeply around arecanut trees in the month of April-May
   d. Chipping, burning, and burying infested material deeply can reduce the RPW infestation
   e. The entire heavily affected tree should be destroyed immediately; however the slightly infested trees and others should be treated by spraying systemic insecticide.

2. Quarantine

   a. Taking into account that a major mode of RPW spread is via infested planting material (nursery palms and offshoots) quarantine plays key role in preventing the weevil spread

3. *Survey*

a. Monitoring whole arecanut regularly using pheromone traps and other means is important

4. Pheromone traps

a. Mass trapping to reduce RPW densities. Pheromones lures are loaded into bucket traps along with arecanut material and granular insecticides. RPW adults are attracted by the pheromones and the plant material and fly into buckets. Once inside the bucket trap, the insecticide kills the weevils before they can escape.

5. Chemical control

a. Trunk injection of Dimethoate 30% EC in the ratio of 2 ml per litre of water is recommended.

2.8 Survey of Predatory Coccinellid Beetles in Bhutan

Introduction: The main objective of survey is to build an information base on the prevalence of various beetle species across different agro-ecosystem in the country. This information will be used as an initiation point for major research. This survey is done in collaboration with National Biodiversity Centre. The survey sites are shown in the map below.

2.8.1 Survey updates

a. Initial Survey of Predatory Coccinellid Beetles in the country started in December, 2014 under BTFEC funded project.

b. Till date six Dzongkhag have been covered (Punakha , Wangdi, Chukha, Tsirang, Sarpang, Dagana)

2.8.2 Laboratory activities

a. Collected adult Coccinellid Beetles from various habitats were brought to the entomology laboratory of the National Plant Protection Centre, Semtokha.
b. The specimens were sorted out and pinned.
c. Each specimen was tagged with the information about host plants, locality, date, geo-coordinate and elevation of the areas.
d. To protect the pinned specimens from the other insect pests, naphthalene balls were placed in the insect collection boxes.

Figure 16: Pinned and Labeled Beetle Collection

e. The specimens were pinned and put in the insect collection boxes and are placed in the insect referral collection room in entomology section of the NPPC.

These specimens will be handed over to the National Biodiversity Centre, Serbithang for further identification works.

2.9 Pink rice stem borer population monitoring

Introduction: The NPPC is studying the effectiveness of pheromone lures and traps to control the pink stem borer in paddy. The pink stem borer outbreak from Bjapcho Gewog of Chukha Dzongkhag was reported in 2013.

Figure 17: Pink Stem Borer Trap Installed in Paddy Field

Materials and Methods: The trapping of pink stem borer in paddy was initiated in collaboration with Dzongkhag Agriculture Sector in Bajpcho Gewog. The NPPC distributed 10 sets of pheromone traps for trapping pink stem borer in the paddy field at Bjapcho geog in 2015 season. The trapped moths were collected and sent to NPPC for pining and preservation with proper label indicating location and date of collection for future reference. The assessment will be continued in the coming season.

3. DISEASE MANAGEMENT PROGRAM

3.1 Rice Blast Assessment

Introduction: The rice blast disease resistance assessment of released Bhutanese rice varieties and IRRI isogenic lines continued in its second year at Kabjisa Gewog in two sites that are known to be blast disease hotspot areas.

Materials and Methods: The methodology was described in the last publication. The assessment result is shown in the annexure VI

Result and Discussion: Five out of total of 30 entries showed differential reactions at two different sites, suggesting difference in blast pathogen population structures. All released Bhutanese varieties, except No. 11 at Rimchu site, remained resistant to blast disease, which is good for the farmers for they can cultivate these varieties without fear of blast disease infection. The isogenic entries that show resistant reactions in both the sites may be selected as parents for resistant breeding of new varieties.

Figure 18 Blast disease lesions on CO39 Isogenic line

3.2 Cardamom Disease Assessment

Introduction: The cardamom diseases at Suntalakha have been known as early as 1990s. The diseases are leaf blight and wilt caused by the fungi Colletotrichum and Fusarium Spp. There are also sporadic incidences of virus infection.

Figure 19: Virus infected cardamon clump

Field Observation and Advisory Services: The cardamom plantation does not have adequate shade trees and many parts of the plantation are exposed to direct sunlight that normally scorches the plants. The extension agent has been advised to encourage plantation owners to maintain proper shade and propagate materials only from healthy clumps or seed. Proper cardamom plantation must at least maintain 20-30 percent of area under shade. This is because cardamom plants are shade loving and sensitive to direct solar radiation.

3.3 Club Root Disease Assessment

Introduction: Club root disease caused by Plasmodophora brassica is a serious disease of cruciferous crops. In cabbage, it causes serious stunting and yellowing of leaves when infection occurs in the early stage of crop growth. The affected plants are rendered nonmarketable and often whole cabbage field is lost if affected by this disease. Raising soil temperature through soil solarization is recommended to reduce the disease incidence as the causal agent of the disease is known to be a soil born and sensitive to high soil temperature. To study the effectiveness of high soil temperature, trial with different color (white and black) plastic sheets were set up to cover the soil surface and raise the soil temperature.

Material and Methods: The two sites with club root disease problem at Dogar and Naja gewogs under Paro Dzongkhag were selected for the trial.

In both sites, field was ploughed thoroughly a few days before transplanting. The trial was designed as Randomized Complete Block Designed (RCBD) with three replications for each treatment. The trial plots were covered with different color (black and white) plastic sheets, leaving the control plot uncovered. After two weeks of transplanting the cabbage seedlings were topdressed with urea.

Figure 20: Bed preparation

Result and Discussion: The trial plots were regularly monitored. There was intensive growth of weeds on plots covered with white plastic sheet. Some cabbage plants showed foliar wilting symptom of club root disease, but there was no gall formation on the roots. The stem and tap-root barks were rotten on those wilted plants. The infected plant samples were collected and examined in the laboratory. The root rotting was due to attack of carrot fly larvae.

Isolation of fungus

Microscopic Observation

Infected root under isolation

3.4 Detection and Diagnosis of HLB

Introduction: Due to variable results obtained from the PCR analysis of citrus leaf samples collected from NSC Bhur nurseries in the fall 2014, more leaf samples were collected in 2015 from the same nursery blocks to re-confirm the test results. Laboratory protocols were modified and improved to eliminate any possible errors. Duplicate samples were taken to Australia to cross-check the results obtained at the NPPC.

Materials and Methods: Samples were collected in the month of January and June 2015. Samples collected in June 2015 were processed in duplicates at the laboratory in the NPPC and Australia. For all samples, RT-PCR test was performed in the NPPC as well in Elizabeth Macarthur Institute of Agriculture (EMAI), NSW department of Primary Industry (DPI), and in the molecular laboratory of Western Sydney University, Australia.

Some samples that showed positive reaction by RT-PCR were further re-confirmed with conventional PCR. Some samples with uncertain reaction with RT-PCR results were also included in the conventional PCR analysis. Two samples collected from RDC Mithun, Tsirang were also included for the tests.

Results: Specific PCR tests performed repeatedly by using both real-time and conventional PCR indicated the citrus plants in the nursery of NSC, Bhur are infected with HLB. Test was repeated with more samples over a period of six months to re-confirm the results. Sample showing positive results for HLB are listed in annexure VII. Both RT-PCR and conventional PCR also showed positive results for HLB in the two composite samples collected from lemon trees from evaluation trial block (across the guest house) in RDC Mithun in Tsirang. To further reconfirm, all these samples are processed and sent for sequencing for final confirmation and to identity HLB bacterium strain.

Technical Recommendation Based on PCR Findings:

a. Although the PCR results indicated that samples from the grafted seedlings blocks and the mother blocks of NSC Bhur positive reaction, it is possible that other plants in propagation houses could be infected as well. This implies that the whole nursery is infected. Similarly, it is important to understand that when a sample is negative, it does not mean that the plant or the area is negative or free of HLB. HLB infection is not uniform within a plant and detection can be marked by many factors in addition to its non-uniform distribution. Hence, proper nursery standards and periodic testings' are integral part of nursery operations.
b. With the detection of HLB in the listed samples, technically all plants in NSC Bhur are not fit for plantation or sale and should be destroyed.
c. Detection of HLB in the samples from the mother block in NSC Bhur is another evidence of the complexity of the disease. If one look at the plants in the mother block in NSC Bhur, the plants do not appear symptomatic at all and yet samples collected in January and June 2015 both tested positive in all repeated tests. This is one main reason that planting material should not be selected based on symptom exhibition. e.g., it is wrong to practice collection

of bud wood from Mendrelgang area in Tsirang because there are no symptoms of HLB in Mendregang or Dorokha for that matter.

d. For the plants in the RDC Mithun, it is advisable to remove the whole block. Testing for HLB from other blocks need to be done on quarterly basis.
e. It is important that plants from Wengkhar be tested for HLB. Many planting materials are traced back to Wengkhar.

3.5 Chili Blight Management

Introduction: Chili is the main cash crop for the people of Kashi gewog. Almost all the Chiwog at Kashi grow chilies and approximately 80-90 acres are being cultivated with chili this year. Chili blight disease is the main production constraint in this gewog.

Chili Blight Disease Management: In 2015 season, farmers in this gewog were supplied with fungicides (Copper Oxychloride and Ridomil) to treat chili seeds to control chili blight diseases. About 200 packets of Copper Oxychoride and 200 packets of Ridomil were supplied to 55 households of Kashi, Bjaktey,Komathrang, Gendep, Chegip and Boelangdra villages.

Seed Treatment and Nursery Raising: To see the effectiveness of fungicide to control chili blight disease, a field trial was conducted at Bjaktey Village. Chili seeds were treated with Copper Oxychloride at the rate of 2.5gms per kg of Chili seeds. Seeds were soaked overnight before sowing in the nursery bed. Seeds were sown evenly and the nursery beds mulched with local organic materials. Regular monitoring of chili blight disease occurrence in the nursery was done. It was observed that treated chili seeds were healthy without any sign of the blight disease in the nursery.

a: Seed Treatment with fungicide (copper oxychloride)	b: Chili bed preparation	c: Sowing seeds	d: Sowing treated chili seeds	e: Healthy chili plants in the nursery

Field Preparation for the Transplantation: After two months of the chili in the nursery, chili plants were transplanted in the field that was left fallow for one year, mainly to examine effect of fallow period on the chili blight disease occurrence. Only healthy seedlings were selected and transplanted on the raised bed with a minimum spacing of 30cm between the plants. After transplantation, mulching was done with FYM to reduce inoculums splash from the soil to foliar parts.

Three times spray of fungicides (Copper Oxychloride and Ridomil) was done after the transplantation. The first spray was done with the Ridomil @2g/litre 30 days after the transplantation. Second spray was done with Copper Oxychloride @2.5g/litre of water 14 days after the first spray of (Ridomil). And the third spray was done 14 days after the second spray with Copper Oxychloride @2.5 g/litre of water. Regular and timely monitoring was done throughout the season for the blight symptoms especially after the rainfall.

Harvesting (Yield): To see the treatment effects chili crop cut was done both for control and the fungicides treated plot. Chili fruits were harvested and weight was measured. Quality of chili fruit and plant were also checked.

Results:

Table 2: Results Obtained from the Treatment

Parameters	**Fungicides treated plot and raised bed with proper drainage**	**Control plot**
Weight of chili fruits per sample plot	5 kgs per plot ($6m^2$)	3 kgs per plot ($6m^2$)
Physical appearance of the plant	healthy	Plants dried up due to the disease
Physical appearance of the fruits	Healthy fruits	Fruits dried and shrunken with disease
Symptoms of blight disease	Few leaves affected	Many leaves affected with high disease severity

Conclusion: Fungicides treatment of both seeds and transplanted chili plants on the raised bed with proper drainage was effective in preventing blight disease occurrence.

4. WEED MANAGEMENT PROGRAM

4.1 New Generation Herbicide Efficacy Assessment

Introduction: The DuPont, an American company has developed a range of herbicides, falling under the class Sulfonylurea (Orthosulfamuron 50% WG, Metsulfuron Methyl 10% + Chlorimuron Ehtyl 10% WP and Ethoxysulfuron 15% WDG). These products were procured from India for field evaluation for the control of weeds in transplanted rice. These new generation herbicides have a low application rate and mammalian toxicity. They are supposed to be effective on a wide range of grasses and broadleaf weeds and were particularly chosen to be tested against Shochum (Potamogeton distinctus) in transplanted rice field.

Objectives: Herbicide screening trials were carried out mainly to study the efficacy of herbicides for controlling shochum (Potamogeton distinctus) in transplanted rice. The new generation herbicides used for the study were Orthosulfamuron 50% WG, Metsulfuron Methyl 10% + Chlorimuron Ehtyl 10% WP and Ethoxysulfuron 15% WDG

Materials and Methods: Field evaluations were conducted from June 2014 to November 2014 at three locations: L1-Kbesa, L2-Genekha and L3-Tendrelthang across Thimphu district. The fields were treated with the herbicides at 3-5 days after transplanting (DAT).

Weed samples were collected from 1m x 1m quadrant at 25 and 40 DAT. Data collected were for dry weight of weeds and rice yield at harvest. Data analysis was done by using SPSS. Weed control efficiency (WCE) was determined for all the treatments.

Results:

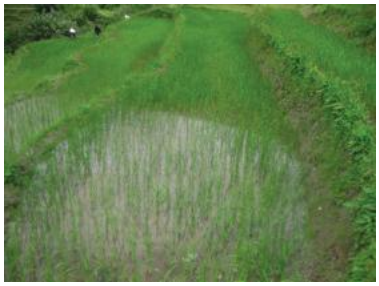
		
Control Plot	Treated field	Weed condition after treatment

Table 3: Mean weed dry matter, weed control efficiency and grain yield difference obtained with different herbicides across three locations

Location	Treatment	Mean weed dry matter ± s.e (g/m2)	Weed control efficiency (%)	Grain yield (t/ha)
1. (Kabesa)	Orthosulfamuron 50 % WG	5.06±1.35a	94.87	4.56a
	Ethoxysulfuron 15% WDG	6.87±1.40a	93.04	3.91a
	Control	86.23±17.59b	-	2.66b
2 (Genekha)	Metsulfuron Methyl 10% + Chlorimurion Ethyl 10% WP	4.97±1.43a	75.63	4.26a
	Orthosulfamuron 50 % WG	4.47±0.96a	78.08	3.15a
	Control	20.41±4.83b	-	1.66b
3(Tendrelthang)	Metsulfuron Methyl 10% + Chlorimurion Ethyl 10% WP	31.26±9.91a	73.95	4.38a
	Orthosulfamuron 50 % WG	20.50±5.36a	88.99	4.88a
	Ethoxysulfuron 15% WDG	11.47±3.78a	93.17	4.97a
	Control	113.71±23.20b	-	2.99b

For the mean weed dry matter; means followed by the same letter are not significantly different (t-test on Fisher's LSD test on log (x+1) transformed data; P < 0.05

Conclusion: All three herbicides tested were equally effective in controlling P. distinctus. The sulfonylurea herbicides are characterized by broad-spectrum weed control efficacy at low application rates, good crop selectivity, and very low acute and chronic animal toxicity. Therefore, these herbicides are promising in managing P. distinctus in transplanted rice.

4.2 HUMAN WILDLIFE CONFLICT MANAGEMENT PROGRAM

Introduction: A fabricated electric fencing system (EFS) was developed and introduced in the field to reduce crop damage by the wild animals. Dissemination of this technology had been done through audio-visual documentary, demonstration in the farmers' field and by building the capacity of relevant stakeholders and key farmers to install and manage the fencing system.

Consultation Meeting with Districts Agriculture Officers

The Centre conducted consultative meetings with DAOs and other relevant stakeholders to discuss roles and responsibilities among stakeholders based on implementation guidelines for EFS. During the consultation meeting, they were briefed on the content of the guideline and manual. A brief highlights on the possibilities of financial support from the BOiC were made by the BOiC officials during the consultation meeting and to find alternative financial sources to support the farmers.

The meetings were conducted at NPPC for the West, Centre and South regions and in RDC Wengkhar for the East region. Essential equipment required for electric fencing systems were showcased to create

awareness. The audio-visual documentary, guidelines and technical manuals developed by NPPC and RDC- Wengkhar were distributed to each Gewog. The documentary tabs were also distributed to local cable operators for free shows to create awareness to farmers and general public.

Training of Trainers on Electric Fencing System

Introduction: The Training of trainers (ToT) on EFS has been conducted for the RNR officials who are directly involved in the implementation of electric fencing program to build their capacity to plan, coordinate and implement the EFS program.

In the training program, RNR extension officers of the Gewog are trained to coordinate the planning process, materials estimation, installation and management. Fences are installed during the training program particularly to demonstrate the technology and as well to directly benefit the most affected farmers. Direct beneficiaries are involved to assist the establishment as well as to adequately keep them informed on the required maintenance and aftercare services.

Most of these training programs were supported by the NPPC both in terms of financial and technical, except for a few by projects, RDCs and Dzongkhag. A significant progress has been made in terms of building the capacity of extension personnel as well as in terms of area coverage. Usually, the beneficiaries make contribution of local materials collection and labor inputs. Dzongkhag electricians are engaged to support the training as it requires electrical technical inputs as well as to assist farmers to rectify electrical issues latter.

Figure 21: ToT Participants with Program Director during Closing at Bjacho-Chukha

Training component: The primary objective was to train and educate on technical aspects on installation of EFS. The training program includes both theoretical and practical session. Participants were trained on all the technical aspects of EFS such as preparation of insulator, fence poles, earthing, fence corridor, pit digging, erection of post, installation of energizer, maintenance of fence, safety operations, etc.



In the fiscal year 2014-2015, a total of 226 participants including staff from MoAF and other relevant organizations were trained on EFS in seven Dzongkhags (Dagana, Paro, Chukha, Tsirang, Sarpang, Samdrup jongkhar and Tashigang). For participants see Annexure IX

4.3 Overall EFS Status

As of now, the EFS demonstration and capacity building were completed, albeit the coverage ratio merely justified, for 16 Dzongkhags (Thimphu, Haa, Punakha,Trongsa, Sarpang, Bumthang, Tashigang,Mongar, Lhuntse,Tashiyangtse, S/Jongkhar,Pemagastel, Zhemgang, Dagana,Wangdi, Tsirang) . A total of 362 km of fence length, covering more than 6472.60 acres of agricultural land, benefiting 3015 households have been established. The total cost incurred for EFS establishment was Nu. 7.328 Million. Detail coverage and the progress are given in Annexure VIII

5. PEST SURVEILLANCE & INTEGRATED PEST MANAGEMENT

5.1. The ePest Surveillance System

Reliable information is critical to initiate any plant protection research and development programs. Early detection of exotic pest is essential for contingency planning; and information on pest prevalence and its build-up is inevitable to critical decision making process to farming communities and to develop management practices. Surveillance report is required by agriculture trader to negotiate trade with ex-countries, where pest risk analysis (PRA) is mandatory by WTO and RTO. Further, the pest surveillance data is being maintained for repository, review and pest forecasting purposes.

Given its enormous importance, pest surveillance program is being emphasized as one of the integral components of plant protection program. Therefore, it is being streamlined from a paper-based to digital based monitoring system. This is to facilitate capturing real-time information, timely data processing, reliability and long-term storage. This new system will be able to capture entry of exotic pests into new areas; pest builds ups from minor to major; temporal and spatial distribution of pests.

5.1.1. Training Workshop

After the UAT sign-off on completing ePest surveillance system development, a training workshop was organized for the key implementers. The workshop program was designed based on relevancy to farming system. The workshop is expected to impart required skills and knowledge to the agriculture officers assigned for pest surveillance activities. Participants were selected from Gewog based on crop production, pest vulnerability, and internet access.

5.1.2. Objectives, Participants and Duration

The main objective of the training program was to build the capacity of the extension and research officers to implement newly developed digital based ePest surveillance system.

A week long training workshop was held at the National Plant Protection Centre (NPPC), Semtokha from 21-27 April, 2015. More than 43 participants from RNR Research and Development Centers (RDCs), Geog Extension Centres, NPPC, National Organic Program and Mountain Hazelnut Venture Pvt. Ltd. attended the program

Figure 22: E-Pest Surveillance Training Workshop Participants with Program Director and Resource Persons

5.1.3. Content of the Training-Workshop Session

The training-workshop covered the following areas of pest surveillance science and its applications.

Theory-Principle and Concept of Pest Surveillance

During theory sessions, presentations covered the following areas of pest surveillance science, practices and their applications;

Importance of Pest Surveillance

A detail presentation on the need and the importance of pest surveillance including its role in local, regional and global agriculture trading was made to the participants. The role of pest surveillance in pest outbreaks and epidemics, chemical safety, food safety, human health and environment were covered under the same topic.

Pest Surveillance System and Types

Under this presentation, important definitions, types of surveys/surveillance, their specific applications in the field and information usage were covered. Specific survey design and planning were presented in stepwise followed by discussions at the end. The participants were informed on the importance of each step to be followed for systematic planning and designing the surveillance activities before visiting the field based on their knowledge of presence or absence of pests in their locality. They could

learn what and where the lapses, difficulties, and other factors that challenged them from collecting correct and timely information in the earlier system.

Survey and Sampling Methods

This was one of the important technical session that participant were taught on how to design and apply sampling methods, use of sampling patterns, finding sampling unit and collection of data from the field. Estimation of sampling size and use of appropriate methods including the correct identification of pest species and inputting the information into the system was emphasized to build their confidence level.

The E-Pest Surveillance System

The participants were presented a brief history on the transition from paper-based system to digital system of pest surveillance, their comparative advantage, working modality, versatility of devices and reliability of data collection, processing and storage. A detail demonstration on the working module of the system was made and tested under real time during the session. Participants had a complete hands-on-practice during the session.

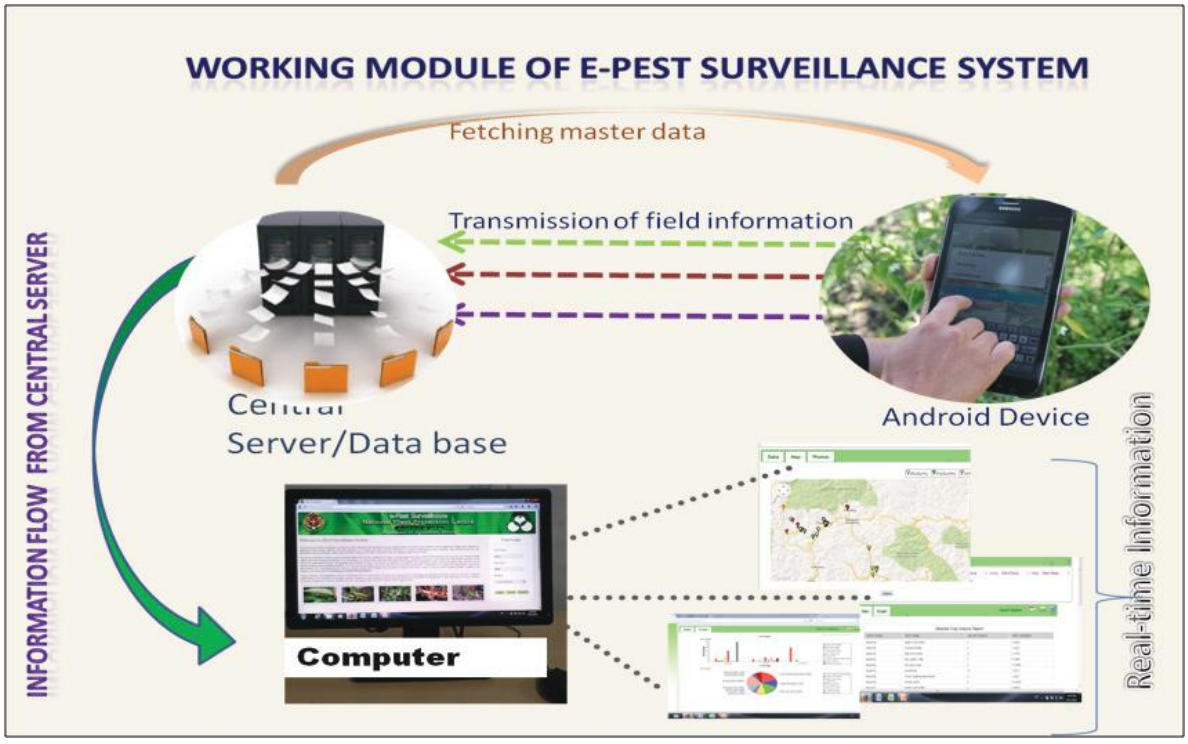


Figure 23 Working module of e-pest surveillance system

Group work

Group work was organized to complete two important task of the workshop. The first one for designing and planning their annual surveillance work based on their local situation and the latter to develop annual work plan for their respective Gewog. During the group work, the participants had identified the pests and crops to be surveyed in their respective localities based on their experiences. They became more aware of what the pre-information are and materials required to support them in surveying the pests in the field more accurately.

5.1.4 Hands-on-Practice for Android Apps

Adequate time was spent on hands-on-training after the demonstration and distribution of android devices. They were taught installing the ePest apps into the device, to update the system, and make use of other system apps that could support them for fetching information. Participants were also taught on how to set up the internet connectivity through other devices, particularly, by using hot-spots and WiFi system, if no direct access to mobile internet services is available. Within NPPC premises, participants practiced how to design survey and follow sampling pattern; collect information using android ePest apps; and upload data into the central database. The participants, except for a few, were distributed the android devices along with accessories (Annexure X).

Agreement between NPPC and participants assigned for implementation were signed during the time of gadget distribution and also the Terms of Reference was reviewed, amended and agreed during the closing session of the program in presence of Chief Agriculture Officer.

Field Visit and Data Collection

During field visits, Participants practiced the method of site selection, application of sampling patterns, and finding sampling units in the actual field condition. During the two days field visits to Paro and Punakha, participants collected real time information on pest prevalence from the field using the android ePest apps. The processed data were presented to the participants on the following day and report was discussed with participants for relevance and its accuracy.

Figure 24: Training Participants Collecting Real-Time Data from the Field

Conclusion

The evaluation of the training report showed that the program was very useful for them to gain knowledge on pest surveillance science and skills to survey pest in the field. It was expressed that such training with complete package not only inspired them, but highly motivated, given its importance and its application in the field.

The Centre expects that pest surveillance system henceforth will able to generate more reliable information from field which could not only ease data processing, but to provide advisory services to the farming communities as well as to maintain information for agriculture traders. Such system is expected to generate information required to meet the Sanitary and Phytosanitary Standards (SPS). To ensure that activity is implemented successfully, the surveillance work in the field and efficiency of ePest gadget will be regularly monitored. Wherever required, changes will be made to improve the system. System will be assessed for another couple of years to make it completely functional.

6. Status of Integrated Pest Management

6.1 Introduction

From the early 1990s, the plant protection program was implemented within a framework and strategies of Integrated Pest Management (IPM). Since then, a number of achievements had been made ranging from the reduction of pesticide use in general to adoption of organic techniques in some areas in managing the pests of agriculture crops. With increasing concerns for environments and awareness of food safety, IPM technology has important role in agriculture production in Bhutan. IPM approach will also safeguard environment and enhance production of safe food in areas where 100% organic system is not feasible. In this report, the progress and status of IPM in Bhutan is discussed.

6.2. Historical Background-IPM Development

The plant protection program in Bhutan started formally in 1964 during the 1st Plan Period as Plant Protection Unit under the Department of Agriculture. Until 1980s, the plant protection program was focused on use of chemical pesticides to manage agricultural pests and diseases. Pesticides were supplied free to the farmers. However, the free supply system not only resulted in misuse of pesticides, but huge quantities of obsolete pesticides got accumulated in many agriculture stores across the country.

Realizing these undesirable impacts, pesticides delivery system was reorganized from independent procurement system to an organized and centralized system with institutionalization of National Plant Protection Centre as an apex body for plant protection service. As an important part of pesticides reduction strategy, the subsidy for pesticides was withdrawn in phase-wise manner from early 1990s and simultaneously introduced cash and carry system. Plant protection inspectors were deputed during this period in each district to monitor the pesticide use and plant protection activities. By the 7th FYP, plant protection emerged from a pesticide-based system to an ecological IPM-based system. This change in focus for pest management is mainly because of government policies geared towards sustainability of production system and environmental preservation imperatives.

6.3. Important Pest Incidences and Crop Losses in Bhutan

There is no specific research carried out to assess the level of damages or losses caused by pests and diseases. However, based on experiences of plant protection personnel working regularly in the field, the following estimates have been made. Rice blast caused total loss of rice production for some farmers

in Western Bhutan in 1995-96, Rice stem borer over 90% loss in Samtse district in 2005; Turcicum leaf blight and grey leaf spots damage on maize was estimated as high as 70-90% in Eastern Bhutan in 2006-07; Potato tuber moth, over 95% loss in Eastern Bhutan in 2006 and fruit fly up to 80% loss of mandarin orange in 1990. In recent years, armyworm damage on paddy and maize had been very severe in certain areas. Giant African Land Snail (GALS) is another pest of concern currently under surveillance. Under regular pest incidences, an average estimated loss (but not based on field study) for most of the pests and crops had been in between 10-20% or and at least about 10% even under well managed crop-pest systems.

6.4. Collection and Disposal of Obsolete Pesticides Stocks

The uncontrolled imports of pesticides not only stimulated overuse of toxic insecticides, but also resulted in an accumulation of obsolete pesticides. The collection of unused pesticide stock was initiated since 1980s. In 1995, a total of 66 tons of obsolete pesticides were collected including 13 tons of fungicide, 23 tons of herbicides and 30 tons of insecticides from all agricultural stores all over the country (Table 4). These have been re-packed under the supervision of international experts and latter incinerated with the assistance of Swiss Government.

Table 4: Obsolete Pesticides collected and destroyed

Pesticides	Quantity	Source	Remarks
Insecticides	30	MoA	17 MT of carbofuran returned to manufacturer
Fungicides	13	MoA	
Herbicides	23	MoA	22 MT of herbicide were reused in rice
Medical waste Chemicals	4.6	MoH	

Source: MoA

6.5. Removal of Pesticide Subsidy

Pesticide subsidy had been a major constraint for IPM implementation. Until 1989, all types of pesticides, despite their persistence, mammalian and eco-toxicity were independently procured and supplied free of cost to the farmers. From early 1990s, the system was completely changed with regard to pesticide subsidies. Subsidies were removed in phase-wise and completely done away by 1995 (Table 5).

Table 5: Withdrawal of Pesticide Subsidy in Bhutan

Year	Withdrawal of subsidy (%)
1990 - 91	**15**
1991 - 92	**30**
1992 - 93	**45**
1993 - 94	**60**

1994 - 95	**80**
1995 July	**100 (Complete withdrawal)**

Source: Mid-Term Review, Final report -1996; IPMD

6.6. Cash and Carry System of Pesticide Supply

The complete withdrawal of pesticide subsidies by 1995 has helped to prevent the misuse and abuse of pesticides. Following the subsidy withdrawal, cash and carry system for pesticides was introduced. The Dzongkhag Agriculture Officers (DAO) were mandated to collect the demand requirement before the start of the season and need to be submitted to NPPC along with cash before lifting pesticides. This system has further prevented the accumulation of outdated pesticides, which has been a serious problem in the past. However, the main drawback with this system is the availability of pesticide during the emergency outbreak of pests and diseases.

6.7. Import Banned for Toxic Chemical

Between 1986-1990, several highly toxic and persistence pesticides like Aldicarb, Aldrin, Aluminum phosphides, BHC, Captafol, Ekaflux, Agallol, Methyl-parathion, Red lead and Thimet were banned for use in agriculture. Such initiatives became possible because of the full authority given to NPPC by the Ministry of Agriculture and Forest for the import, distribution and sale of agro-pesticides through extension network.

6.8. Policy Initiatives and Pesticide Legislation

The pesticide act of Bhutan was passed in June 2000 to regulate the import and use of pesticides. NPPC is only authorized agency for the import, distribution and sale of pesticides. Only safer pesticides (except rodenticides) are imported and used in the country.

From 1980's, the pattern of pesticide use in Bhutan has changed considerably (Figure 25). The trend of pesticide use remained to be very high in the initial years of subsidy (Fig.25 & 26), but declined as the cash and carry system was introduced. After removal of pesticide subsidies, the farmer would buy and use pesticides only if they expect to get a good return from their use.

However, herbicides were never subsidized in the past. There has been a steady increase in the use of herbicides over the years (Figure 26).

It is also worth mentioning the following relevant government initiatives and commitments that helped to develop IPM.

- Signing the Rio de Janeiro Convention (UNCED) in 1992
- Declaration and demarcation of 26% of total land as protected area in 1993
- Passing the Forest and Nature Conservation Act in 1995
- Environment Assessment Act 2000
- Biodiversity Act of Bhutan 2003

- Ratification of the Basel Convention in 2004 and subsequent destruction of obsolete chemicals with fund from Swiss Agency for Development Cooperation (SDC), Switzerland in 2006.
- Wang Watershed Project with focus on Farmers field School in 2000
- Organic program under horticulture division in 2008

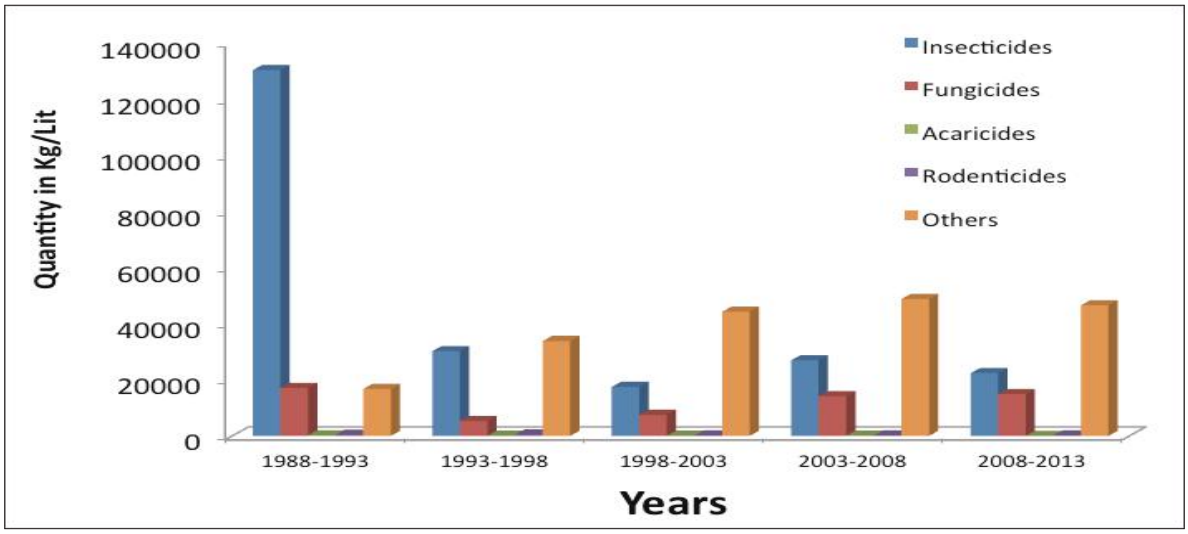


Figure 25: Pesticide Use Trend in Bhutan (Excluding Herbicides)

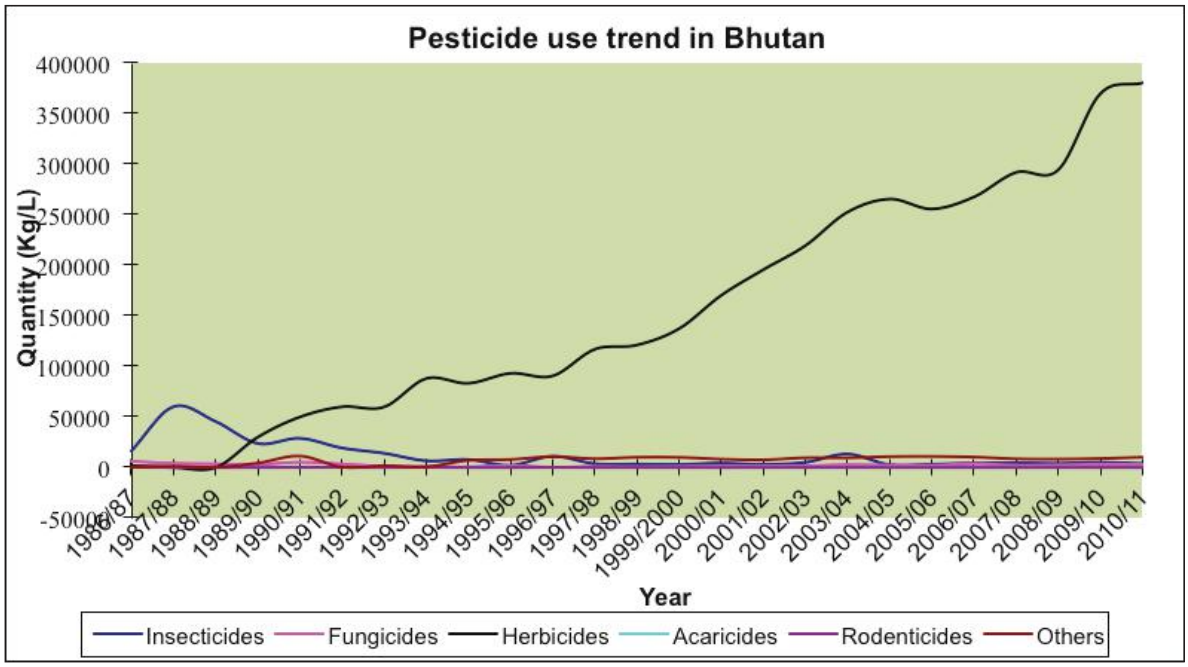


Figure 26: Steady rise in herbicide use as compared to other pesticide

6.9. Issues and Problems as a Result of Pesticide Use

Insecticides were most commonly used in fruits and vegetables. A prophylactic spray of fungicides were carried out for the control of rice blast in the past and lately for the corn blight control. Likewise, the cover sprays in citrus and scheduled sprays in apple and potatoes were commonly practiced before the implementation of IPM as pest management policy.

Many apple orchards before 1980s that followed calendar spraying ranging from 5-6 sprays per season resulted in emergence of spider mite (Panonichu sulmi) as a major pest in many orchards. Similarly, diamond back moth was reported to have developed resistance in the past to conventional insecticides in some Cole crops growing areas.

Besides abusive use in the field, huge accumulation of obsolete pesticide due to free supply to the farmers had to be collected and incinerated and some returned to manufacturing company. Until now, no issues related to herbicides use had been observed despite seeing significant rise in consumption of herbicides particularly the Butachlor. This may cause serious weed succession problem and environmental contamination if the current trend is continued. It is likely that there will be an increase use of Butachlor if no other equivalent or alternative to it is provided in future.

6.10. Success of IPM programs

Initially, the NPPC promoted IPM mainly in areas where farmers practiced calendar spray particularly by educating them on the consequences of pesticides use. Farmers were trained and encouraged on the concept of "as and when necessary use" of pesticide. This promotion resulted in pesticide use for example, control of pests and diseases through IPM in pilot areas, which was replicated in other areas at the latter periods. Some of significant achievements made through IPM are;

a. Abandoned calendar spray in Apple: With the introduction of IPM since 1993, farmers have given up the practice of calendar spray in apple. Unlike in the past spraying 5-6 times per season, they are practicing need based application of pesticides mainly during critical times. Prophylactic sprays against insect in other related crops had also been discontinued.

b. Adoption of bait splashing in Citrus: After the introduction of bait splashing, farmers have abandoned the practice of cover spray for the control of fruit drop by fruit fly in citrus. Farmers are also carrying out the collection of dropped fruits to reduce the population of fruit flies in the following years as a part of fruit fly management activity.

c. Trunk borer and twig borer: As recommended by NPPC; trunk borer in citrus and apple are managed by cleaning the hole with a flexible wire and inserted with a small piece of cotton wool or piece of cloth of the size of the hole dipped in kerosene. The hole is then plugged with mud. Whereas twig borer are managed through cutting the affected twigs and burning them after collecting.

d. Late blight control in Potato: Farmers are now trained in the identification of the diseases and timely application of fungicides as soon as the disease is seen. This has helped to reduce the

damages caused by disease which was very severe in the past that even wiped out whole crop. This has become common practice in all potatoes growing area in the country.

e. Rice blast control: Package of practices including seed replacement, seed treatment, disposal of infected straws, farmers training, nursery protection, pest surveillance, cultural practices/ sanitation, use of resistant cultivar and as last resort finally spraying the crop in case the symptom is seen, have been put in place and are strictly followed. There is significant reduction of the disease incidences after 1995 rice blast problem after adopting IPM strategy.

f. Chili wilt disease control: Cultural control method introduced by NPPC such as use of healthy seedling, crop rotation, proper spacing, planting in raised bed and a good drainage system has reduced the disease spread and widespread damages.

g. Other lepidopterian pest management: Significant reduction of use of pesticide against chili pod borer has been observed in principle chili growing areas in Punakha with the introduction of Pheromone traps in the field to control the adults from breeding. Pheromone traps and lures are under trial for armyworm, citrus fruit fly, and yellow stem borer..

h. Biological control: The key personnel in NPPC had been trained on rearing and mass multiplication of promising biological control agents such as Beuveria, Trichoderma, Trichogramma, Bracon, etc, under laboratory condition. Techniques learnt will be further disseminated to the field staff to apply under field condition.

i. Bio-pesticides: Promising bio-pesticides, particularly, the Neem products are under field trial against various pests. Recently a bio-pesticide supply rules and regulation is being developed and implemented.

6.11 Socio-Economic and Income Effects of IPM

There is neither a direct or indirect assessment of the IPM impact except for some pilot areas.. The impact assessment of IPM require data and trained manpower which are major constraints faced by the plant protection program. Besides the general benefits, some of specific economic impacts of IPM could be highlighted;

- In apple, previous calendar sprays of 5 to 6 times have been replaced with need based 1 to 2 sprays with no reduction in the quality and quantity of crop being harvested. There is reduction in expenses for chemical purchase and regular manpower required for the spray.
- Expensive cover sprays in citrus for the control of fruit fly has been replaced with cheaper and specific bait sprays and lately with introduction of pheromone traps resulting in more economic and effective control of the pest.
- In potato, farmers who practice a reasonably good management of plant protection could obtain 6-7kg for every kg of seed planted in comparison to earlier national figure of 4kg for every kg of seed and likely to increase up to 12-13kg for every Kg of seed.
- In maize, seed change, cultural practices and spray of chemical has reduced the diseases incidences and regaining the optimal yield.

- Wang watershed project that promoted IPM and Farmers Field School resulted in higher yields of potato, chili, tomato, cabbage, and broccoli crops.
- Expenses on chemical for the control of pod borer in chili has been reduced with introduction of pheromone traps in chili growing areas.

6.12. Realignments in the Plant Protection Programs for IPM

NPPC has been following the IPM approach in all its activities including extension trainings, presentations and teachings at College of Natural Resources, advisory services or in any deliberations concerning plant protection. As a result, the National Extension System has adopted the IPM approach in the effort of pest management.

Currently, there are more than 205 gewog under 20 Dzongkhag with extension personal in each gewog. Under the direct supervision of District Agriculture Officer (DAO) these extension officers are responsible for the implementation of IPM in the field. The schematic diagram represents collaborative research and development of IPM and dissemination of IPM technology to the farmers (Figure 27).

Beside the formal research and extension system, IPM measures are normally discussed and highlighted during important forums like annual planning and review workshops, meetings and conference, etc. to receive feedbacks, discuss technical collaboration, endorsement of IPM activities and policy direction. The technical forum has been very useful in bridging the coordination and linkage gaps between researchers and extension by fostering the professional exchanges. Dzongkhag extension services is playing huge role in IPM extension through exchanges and deliberations with extension personal during such meetings.

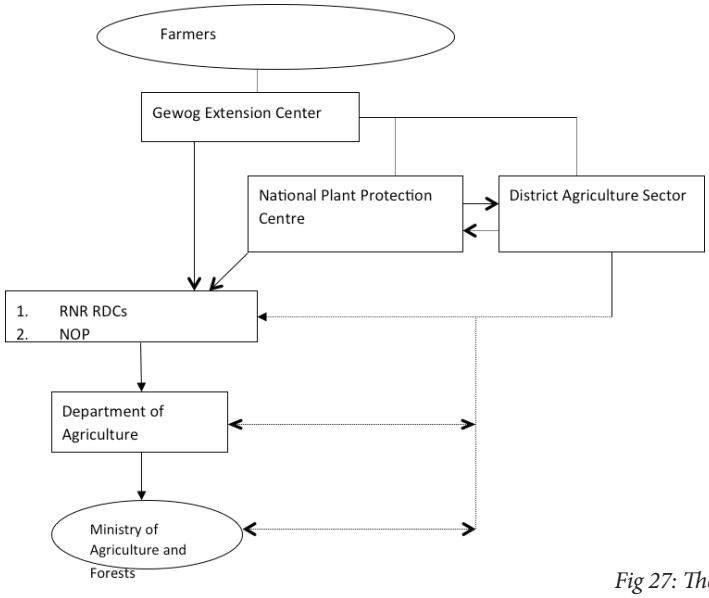


Fig 27: The flow of IPM information and Collaborative research networks

6.13 Ongoing Initiatives on IPM Development

The e-Pest Surveillance System

The NPPC has introduced e-pest surveillance system in Bhutan from 2015. Through this system, it is expected to obtain real time information of pests and diseases from a location or crops. This will enhance pest and disease management decision making process of farmers. In addition, this system will permit review of pest situation and dynamisms that will enable to study resistance development and resurgence issues, pest selection and emergence of new pests, environmental and human health risk monitoring etc. Such information is vital for development of IPM using real time information which will help to formulate more accurate and suitable IPM packages (Figure 28).

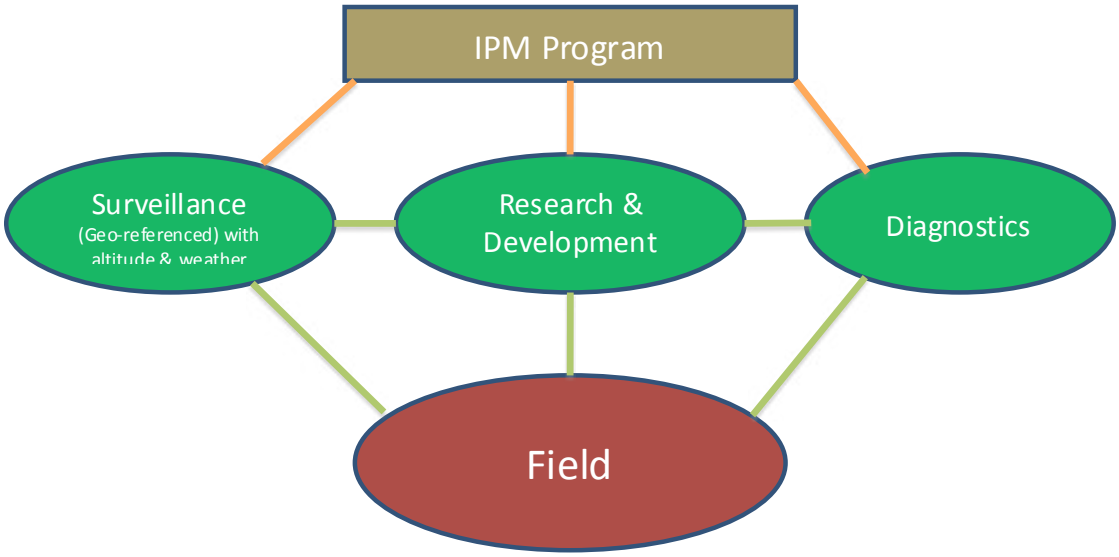


Figure 28. Surveillance as Integral Part of IPM Strategy

The e-governance Initiative on Plant Protection Input Management System

This is an important initiative towards streamlining plant protection inputs indenting system based on pest information. Such information will be useful in tracking plant protection inputs use, stock balance etc. so that accumulation of unused or obsolete products could be reported and record maintained for appropriate disposal.

R&D on Ecological Pest Management

The pest management in the current FYP will mainly emphasize use of bio-control research and development mainly for the important pest like Chili fruit borer, Citrus fruit fly, and Potato tuber moth and armyworm. The on-going activity includes pheromone monitoring and mass trapping, baiting during egg development stage and destruction of dropped fruits through dumping and burying in case of citrus fruit fly. Development of parasites and predators in lepidopteron pests, citrus psyllids and botanicals to manage various pests are currently on-going.

Some of other ongoing or completed pest management initiatives research works by RNR RDC, NPPC, and NOP that will have direct contribution on IPM includes;

- Turcicum leaf blight and Grey leaf spot tolerant maize cultivar selection
- Rice blast tolerant cultivar selection
- Disease free potato seed production through tissue culture
- Potato tuber moth management both under field and store
- Marigold as trap crop for Helicoverpa armigera in tomato cultivation
- Neem, Artemisia, Acorus –based bio pesticides for the control of fruit borers and aphids in vegetables
- Screening of various herbicides on weeds under wetland condition

The outcome of these important research works will be useful for the development of IPM package.
Future Plans and Vision.

IPM is the best way for pest management, which will foster conservation and protection of ecosystem that will in turn ensure income generation and food production at a minimal environmental cost. Organic production, on the other hand, gaining momentum will be a complimentary towards the promotion of IPM, but will remain limited to a few locations and varieties. Therefore, IPM will still remain as pest management policy for the national plant protection services in the current decade and beyond.

For the further promotion of IPM, institutional strengthening is required both at the center, regional and Dzongkhag levels through institution of IPM officers. Collaboration with RDCs, commodity coordinators, extension officials and other agencies need to be strengthened. Integration of bio-pesticides as part of pest management research programs will be essential given its comparative advantage both in terms of social and ecological acceptability. There is an opportunity to explore use of botanicals such as Xanthoxyllum, Artemesia, Acorus, Melia for pest management.

7. PLANT PROTECTION PRODUCTS SUPPLY

7.1 Plant Protection Product Supply Report

In addition to the past practice of procurement and supply of pesticides, the responsibility of managing Butachlor has been transferred from NSC to NPPC from the last season. Unlike other chemicals, supply of Butachlor, which is significantly in higher quantities, has demanded more space and manpower to manage.

Table 6 : Total plant protection products supplied and distributed in 2014-2015

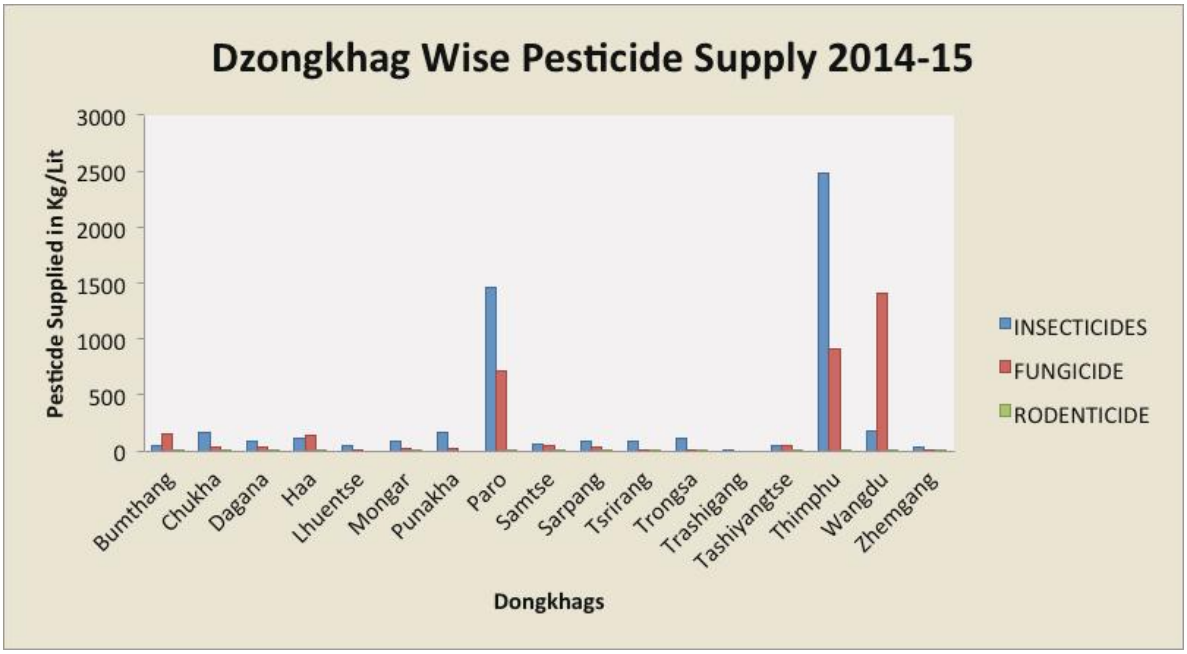
SI.No.	Particulars	Quantity supplied (Kg or L)	Total Amount(NU)
1	INSECTICIDES	5272.75	1,359,561.00
2	FUNGICIDES	3,587.00	1,406,102.00
3	HERBICIDES	526,168.30	17,532,005.00
4	RODENTICIDES	22.55	27,666.00
5	NON-TOXIC	10,172.50	1,808,988.00
	G. TOTAL	54,5223.10	44,268,644

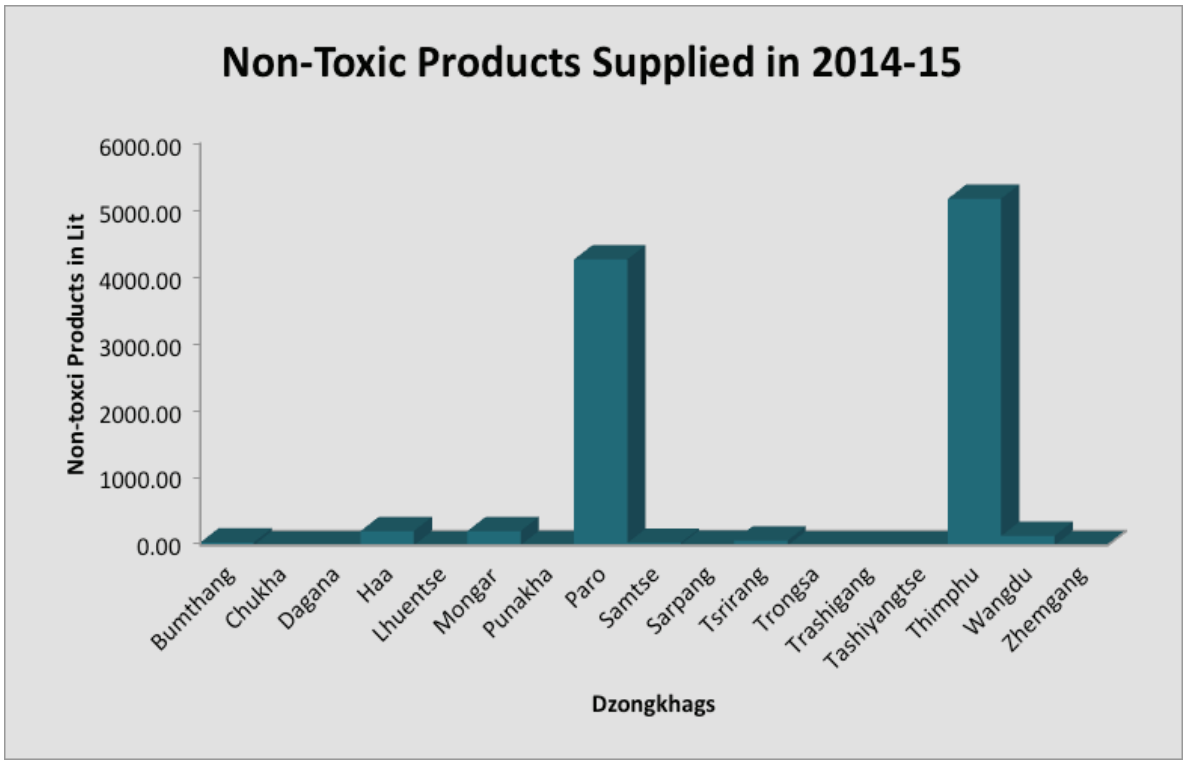
For the convenience of the general public plant protection products were made available and sold from the NPPC store. The record of purchase, supply/distribution and value has been updated on a regular basis for information and for future projection.

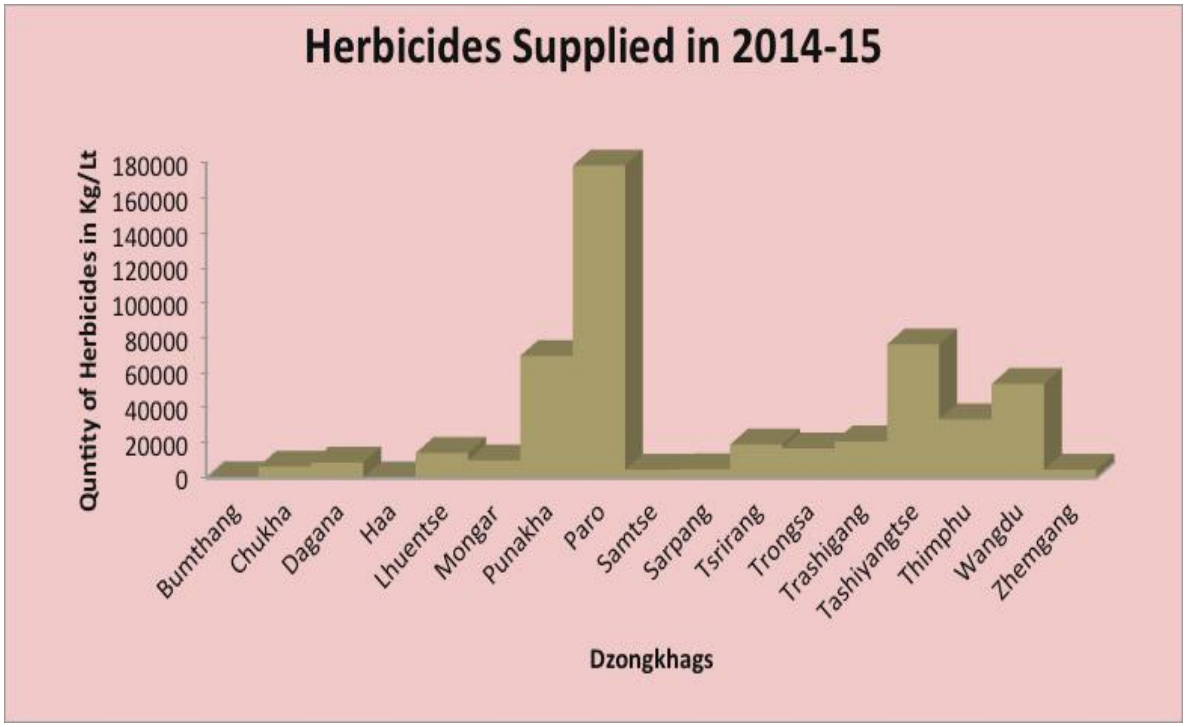
7.2 Plant Protection Product tender and procurement

The collection and compilation of plant protection products demand from twenty Dzongkhag were carried out successfully by the section. Tender documents were prepared and tender was floated, after which bids were evaluated and supply orders placed according to the demand for the 2014-15 season.

7.3 Sale of Plant Protection Products




Non-Toxic Products Supplied in 2014-15
Non-toxci Products in Lit
6000.00
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
Bumthang
Chukha
Dagana
Haa
Lhuentse
Mongar
Punakha
Paro
Samtse
Sarpang
Tsrirang
Trongsa
Trashigang
Tashiyangtse
Thimphu
Wangdu
Zhemgang
Dzongkhags


Herbicides Supplied in 2014-15
Quntity of Herbicides in Kg/Lt
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
Bumthang
Chukha
Dagana
Haa
Lhuentse
Mongar
Punakha
Paro
Samtse
Sarpang
Tsrirang
Trongsa
Trashigang
Tashiyangtse
Thimphu
Wangdu
Zhemgang
Dzongkhags

8. OFFICIAL WEBSITE

The Centre launched its official website to provide important information and updates. It is aimed at benefiting the extension, research, academician and farming communities both for research and extension purposes.

The main content of the websites are;

1. Publication on IPM technologies.
2. Plant protection products-Active ingredient (a.i.) content, application rate and uses, price, etc.
3. Pest management information
4. Information on materials requirement and estimation including the costs for electric fencing
5. Pest forecast information
6. Tender documents, and
7. Downloads and institutional linkages.

The website can be accessed through www.nppc.gov.bt.

9. FINANCIAL PROGRESS REPORT

Table 7: Financial Progress Report 2014-15

Revised Approved Budget (RGOB)	Amount (Nu. in millions)	Expenditure	Financial Achievement
Current	14.384	13.732	92.96 %
Capital	6.083	5.834	95.90%
Grand total	20.467	19.566	95.60%

Annexure I: Chili pod borer monitoring by Pheromone traps, 2015

Village: Waku-Damchi
Gewog: Kabjisa
Dzongkhag: Punakha

Name of the farmer	*Date of Installation of Traps*	*Date of first inspection*	*Pod Borer Trapped (no's)*	*Date of second Inspection*	*Pod Borer Trapped (no's)*
Yeshey Dorji	16/3/2015	18/3/2015	2	27/3/2015	10
Dechen	16/3/2015	18/3/2015	14	27/3/2015	45
Yangden	16/3/2015	18/3/2015	1	27/3/2015	30
Aum Needup	16/3/2015	18/3/2015	7	27/3/2015	35
Passang Wangmo	16/3/2015	18/3/2015	5	27/3/2015	75
Tshewang Dema	16/3/2015	18/3/2015	2	27/3/2015	53

Annexure II: Army Worm Monitoring by pheromone trap 2015

Name of the farmer	**Date of Installation of Traps**	**Date of first inspection**	**Pod Borer Trapped (no's)**	**Date of second Inspection**	**Pod Borer Trapped (no's)**
Yeshey Dorji	16/3/2015	18/3/2015	2	27/3/2015	10
Dechen	16/3/2015	18/3/2015	14	27/3/2015	45
Yangden	16/3/2015	18/3/2015	1	27/3/2015	30
Aum Needup	16/3/2015	18/3/2015	7	27/3/2015	35
Passang Wangmo	16/3/2015	18/3/2015	5	27/3/2015	75
Tshewang Dema	16/3/2015	18/3/2015	2	27/3/2015	53

Annexure III: Distribution List of Pheromone Traps for Army Worm, 2015

Sl. No	Dzongkhag(s)	Sent through	Qty.
1	Paro	Dema	10 nos
2	Trongsa	Dechen Pelden	10 nos
3	Sarpang	Tsahi Dawa	10 nos
4	Dagana	Sonam Dechen Dorji	10 nos
5	Chhukga	Gyem Tshering	10 nos
6	Haa	N B Tamang	10 nos
7	Samtse	Kinlay Wangmo	10 nos
8	Zhemgang	Tshewang Thinley	10 nos
9	Monagar	Chhimi Tshewang	10 nos
10	Trashigang	Pem Dorji Moktan	10 nos
11	Pemagatshel	Sha Bahadur Barkoti	10 nos
12	Tashiyangtshi	Ugyen Tenzin	10 nos
13	Wanduephodrang	Jigme Lhamo	10 nos
14	Lhuentse	Tashi Wangdi	10 nos
15	Punakha	Karma Tenzin	10 nos
16	Gasa	Tshering Penjore(DAO)	10 nos
17	Bumthang	Gaylong(DAO)	10 nos
18	Samdrupjongkhar	Jigme WangchuK (NOP)	10 nos
19	Thimphu	N B Lama	10 nos
20	Tsirang	L B Chhetri	10 nos

Annexure IV: List of farmers where super bag trials were conducted at Mendrelgang gewog in Tsirang

Name of the farmer	**Village**
Aum Rinchen	Tashipang
Mrs. Pema	Tashipang
Mrs. Pemo	Reserbo-B
Mr. lungten Dhendup	Reserbo-B

Annexure V: Lists of farmers who attended training on Area-Wide Management of Chinese Citrus Fruit Fly in Dunglagang and Kilkhorthang gewog, April 2015

SI No	Name	Village
	Man Bdr Ghimray	Dangray Bu ka
	Pusan Adhikari	Dangray Bu ka
	Karna Bdr Chowan	Dangray Bu ka
	Bal Bdr Prabu	Dangray Bu ka
	Ram Chandra Rasily	Dangray Bu ka
	Bhaji katti Dhinmal	Dangray Bu ka
	Nanda Lal Dhinmal	Dangray Bu ka
	Purana Bdr Prada	Dangray Bu ka
	Yam Lal Suberi	Dangray Bu ka
	Dhan Bdr Chawan	Dangray Bu ka
	Tulashi Ram Acharaya	Dangray Bu ka
	Ram Bdr Chawan	Dangray Bu ka
	Tulashi Ram Acharya	Dangray Bu ka
	Nara Patti Acharya	Dangray Bu ka
	Barma Lal Dhinmal	Dangray Bu ka
	Harka Bdr Kathet	Dangray Bu ka
	Ram Bdr Chowan	Dangray Bu ka
	Kharka Bdr Chowan	Dangray Bu ka
	Ram Bdr Chowan	Dangray Bu ka
	Ram Chandra Rai	Dangray Bu ka
	Hari Prasad Suinchori	Dangray Bu ka
	Chandra Bdr Kathet	Dangray Bu ka
	Tek Bdr Darku	Dangray Bu ka
	Om Nath Chowan	Dangray Bu ka
	Gopal Kalikotay	Dangray Bu ka
	Padan Lal Pradhu	Dangray Bu ka
	Teh Bdr Subba	Dangray Bu ka
	Bishnu Maya Subba	Dangray Bu ka
	Damber Sigh Chowari	Dangray Bu ka
	Chowla	Dangray Bu ka
	Kalhi Nath Khotiwari	Dangray Bu ka
	Prem Maya Tiruwa	Dangray Bu ka
	Tika Ram Tiruwa	Dangray Bu ka
	Suddha Bir Tiruwa	Dangray Bu ka
	Tsering Dolker	Dangray Bu ka
	Moni Prasad Darnal	Dangray Bu ka

	Mon Maya Darnal	Dangray Bu ka
	Santa Bdr Mahat	Dangray Bu ka
	Ram Lla powdrel	Dangray Bu ka
	Tashi Gyelsten	Dangray Bu ka
	Tsering Lhamo	Dangray Bu ka
	Marlur Chettri	Dangray Bu ka
	Dharma Dhok Towari	Dangray Bu ka
	Amir Rai	Dangray Bu ka
	Lal Bdr Mahat	Dangray Bu ka
	Gopilal Dujeo	Dangray Bu ka
	Birkha Bdr Tiruwa	Dangray Bu ka
	Tula Ram Tiruwa	Dangray Bu ka
	Sanlla Maya Dorji	Dangray Bu kha
	Ram Chandra Rai	Dangray Bu kha
	Chandra Prasad Dulal	Dangray Bu kha
	Rudra Man Dulal	Dangray Bu kha
	Kinzang Dorji	Dangray Bu kha
	Wangmo	Dangray Bu kha
	Biram Rai	Dangray Bu kha
	Suran Rai	Dangray Bu kha
	Tularam Rai	Dangray Bu kha
	Ijen Rai	Dangray Bu kha
	Man Kumar Rai	Dangray Bu kha
	Hem Kumar Rai	Dangray Bu kha
	Phul Maya Rai	Dangray Bu kha
	Kumar Gurung	Dangray Bu kha
	Sooraj Rai	Dangray Bu kha
	Shyam Kuha Khati	Dangray Bu kha
	k.B.Pradha	Dangray Bu kha
	Dhana Pati Pradhan	Dangray Bu kha
	Uma Devi Pradhan	Dangray Bu kha
	Ram Ganga Drahan	Dangray Bu kha
	Kubir Sigh Pradhan	Dangray Bu ka
	Choba Dhendup	Dangray Bu ka
	Pabitra Damal	Dangray Bu ka
	Ram Maya Damal	Dangray Bu ka
	Rak kumar Damal	Dangray Bu ka
	Kamal Damal	Dangray Bu ka
	Kharkha Bdr Damal	Dangray Bu ka

Annexure VI: Reactions of isogenic lines and released Bhutanese rice varieties to blast disease at Wokuna and Rimchu respectively, Kabjisa, Punakha.

		Wokuna reactions to blast disease					*Rimchu reactions to blast disease*				
Rice Isogenic Lines		0	1-2	3	4-5	Remarks	0	1-2	3	4-5	Remarks
1	WH13-3198				**S**	**11 lesions per leaf**				**S**	entries heavily infected by Brown spot disease
2	WH13-3201	**I**				**Immune reaction**		**R**			entries heavily infected by Brown spot disease
3	WH13-3243		**R**					**R**			entries heavily infected by Brown spot disease
4	WH13-3204		**R**					**R**			entries heavily infected by Brown spot disease
5	WH13-3205			**MR**				**R**			entries heavily infected by Brown spot disease
6	WH13-3206		**R**					**R**			entries heavily infected by Brown spot disease
7	WH13-3218			**MR**						**S**	entries heavily infected by Brown spot disease
8	WH13-3240				**S**	**7 lesions per leaf**				**S**	entries heavily infected by Brown spot disease
9	WH13-3242			**MR**				**R**			entries heavily infected by Brown spot disease
10	WH13-3248			**MR**						**S**	entries heavily infected by Brown spot disease
11	WH13-3208			**MR**	**S**	**Mixed reactions**				**S**	entries heavily infected by Brown spot disease
12	WH13-3245		**R**							**S**	entries heavily infected by Brown spot disease
13	WH13-3262				**S**					**S**	entries heavily infected by Brown spot disease
14	WH13-3263		**R**					**R**			entries heavily infected by Brown spot disease
15	WH13-3269		**R**						**MR**	**S**	Mixed reactions
16	WH13-3207			**MR**	**S**	**Mixed reaction**		**R**			entries heavily infected by Brown spot disease
17	WH13-3217				**S**			**R**			entries heavily infected by Brown spot disease
18	WH13-3216		**R**						**MR**		entries heavily infected by Brown spot disease
19	WH13-3211		**R**						**MR**	**S**	Mixed reactions
20	WH13-3214		**R**					**R**			entries heavily infected by Brown spot disease
21	WH13-3203		**R**						**MR**		entries heavily infected by Brown spot disease
22	WH13-3199			**MR**	**S**	**Mixed reaction**				**S**	entries heavily infected by Brown spot disease

Released Bhutanese varieties											
23	N011		**R**							**S**	entries heavily infected by Brown spot disease
24	BK-2		**R**					**R**			entries heavily infected by Brown spot disease
25	BK-1		**R**	**MR**		**Mixed reaction**		**R**			entries heavily infected by Brown spot disease
26	BM-1		**R**					**R**			entries heavily infected by Brown spot disease
27	BM-2		**R**					**R**			entries heavily infected by Brown spot disease
28	IR2093		**R**					**R**			entries heavily infected by Brown spot disease
29	K-Maap		**R**					**R**			entries heavily infected by Brown spot disease
30	IR64		**R**					**R**			entries heavily infected by Brown spot disease

Annexure VII: Samples and results of PCR analysis that showed positive for HLB

Sl.No	Sample Label*	DNA extraction date and Place	Sample details**
1	N1A	24 June 2015; NPPC	NSC Bhur: Composite samples from the propagation house (1) next to the office complex. Mandarin grafted on trifoliate
2.	N2A	24/June/2015; NPPC	NSC Bhur: Composite samples from mandarin plants in the mother block above house (1); where N1C was collected
3	N1C	18/Sep/2015; Australia	NSC Bhur: Composite samples from the propagation house (1) next to the office complex. Mandarin grafted on trifoliate,
4	N2A	18/Sep/2015; Australia	NSC Bhur Mandarin composite samples from the mother block above house (1) ; where N1C was collected
5	A1	Jan 2015	NSC Bhur: Grafted seedlings in house 1 (source from Dorokha source)
6	A2	Jan 2015	NSC Bhur: Grafted seedlings in house 1 (source from Dorokha source)
7	D1	Jan 2015	NSC Bhur: Mother Block (source Wengkhar)
8	D2	Jan 2015	NSC Bhur: Mother block (source: Wengkhar)
9	MF1	27/May/2015	Composite samples from lemon trees in the Citrus varietal evaluation trial in RDC Mithun, Tsirang (established 11/June/2008)
10	MF2	27/May/2015	Composite samples from lemon trees in the Citrus varietal evaluation trial in RDC Mithun, Tsirang (established 11/June/2008)

* Samples showing positive with both real time and conventional PCR are shown here

** Propagation house numbers are assigned by the sample collector (s). Locations of the houses are indicated wherever possible. Therefore, house 1 for samples collected in January may be different for samples collected in June. However, this does not affect the overall result interpretation.

Annexure VIII: Electric Fencing Coverage during 2014-15

Dzongkhag	Fence Length (km)	No. of beneficiaries households	Approx. area protected (Acres)	Pest	Main Crop	Amount		TOTAL (Nu)	Fund by
						Funding Agent	Others		
Thimphu	34.3	239.0	367.3	Wild pig	Potato, Vegetables	269500.0	70000	339500	RDC-Yusipang, SNV, RGoB, Farmers
Haa	8	87	104	Wild pig	Potato, Vegetables	210000	0	210000	RGoB
Punakha	8.2	31	211	Wild pig, deer, monkey, porcupine	Rice, Vegetables	490500	20000	510500	RGoB
Trongsa	8.3	40	200	Wildpig & Monkey	Rice, Potato, Vegetables	440000	0	440000	RGoB, Mangduechu
Sarpang	9.4	68	124	Wild pig, monkey, elephant, rabbit	Rice, Citrus, Arecanut, Vegetables	620000	0	620000	RGOB, IFAD
Bumthnag	7.16	77	100.3	wildpig, deer	Potato, Vegetables	285000	0	285000	RGoB
Tashigang	29.79	269	431.3	wildpig	Maize, Potato	1238000	80000	1318000	RGOB, MAGIP
Mongar	30.04	138	217.1	wildpig, deer	Maize, Potato, vegetables	815240.57	31000	846240.57	RGOB, MAGIP
Lhuentse	7.2	59	102	wildpig	Maize, Rice	388000	31000	419000	RGOB, MAGIP
Trashiyangtse	2	24	28	wildpig	Chili, Maize	60000	0	60000	RGOB, MAGIP
S/Jongkhar	6	34	80	wildpig, monkey, elephant, rabbit	Citrus, Maize, Rice	360000	0	360000	RGOB, MAGIP
P/gatshel	16.6	136	210	wildpig, monkey, rabbit	Citrus, Maize, Rice	767350	0	767350	RGOB, MAGIP
Zhemgang	6.2	64	75	wildpig, monkey	Citrus, Maize, Rice	417000	0	417000	GCCA
Dagana	1	60	30	wildpig	Citrus, Maize, Rice	65000	0	65000	RGoB
Wangdue	10.15	157.59	71	wildpig	Paddy, potato, vegetables.	310000	0	310000	SNV & NPPC (RGoB)
Tsirang	11.2	31	75	wildpig, deer, monkey, porcupine	Citrus, Maize, Rice	360000	0	360000	RGoB, RDC-Yusipang
TOTAL	**195.5**	**1514.6**	**2426.0**			**7095590.6**	**232000**	**7327590.57**	

Annexure IX: Participants of ePest Surveillance Training-Workshop

Name	District	Gewog/RDC	No of Days	Venue-Theory	Venue -Practical	Date
Gem Dorji	Paro	Wangchang	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Delma	Paro	Dobshari	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Gembo Dorji	Punakha	Dzomi	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Karma Tenzin	Punakha	Kabisa	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Dechen Pelden	Trongsa	Tangsibji	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Jambay Wangmo	Trongsa	Drakteng	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Tashi Dawa	Sarpang	Chuzagang	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Sonam Dechen Dorji	Dagana	Drujegang	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Choki Wangdi	Dagana	Tashidhing	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Gem Tshering	Chukha	Phuntsholing	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Kinkhen Tenzin	Chukha	Darla	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
N.B Tamang	Haa	Bji	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Kinlay Wangmo	Samtse	Norbugang	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Dorji Wangmo	Samtse	Tendu	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Rajan Rai	Samtse	Yoeseltse	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Sangay Wangdi	Tsirang	Phuentenchu	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Tshewang Thinley	Zhemgang	Trong	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Thinley Zangpo	Zhemgang	Ngangla	5	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Jigme Lhamo	Wangdi	Kazhi	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Chimmi Tshewang	Mongar	Khengkhar	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Pem Dorji Moktan	Tashigang	Kangpara	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Tenzin Dema	Tashigang	Bidung	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Pema Wangchuk	Tashigang	Khaling	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Sha Bdr Barakoti	Pemagatshel	Nangkhor	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Ugyen Tenzin	T/yangtsi	Bumdiling	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Tashi Wangdi	Lhuentse	Khoma	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Nancha	Lhuntse	Jarey	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Karma Yangden	wangdue	MH	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Tempa Rabgay	Mongar	MH	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Legjay	Wangdue	RDC Bajo	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Dawa Delma	Wangdue	RDC Bajo	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Duptho Wangmo	Mongar	RDC Wengkhar	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Tashi Phuntsho	Mongar	RDC Wengkhar	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015

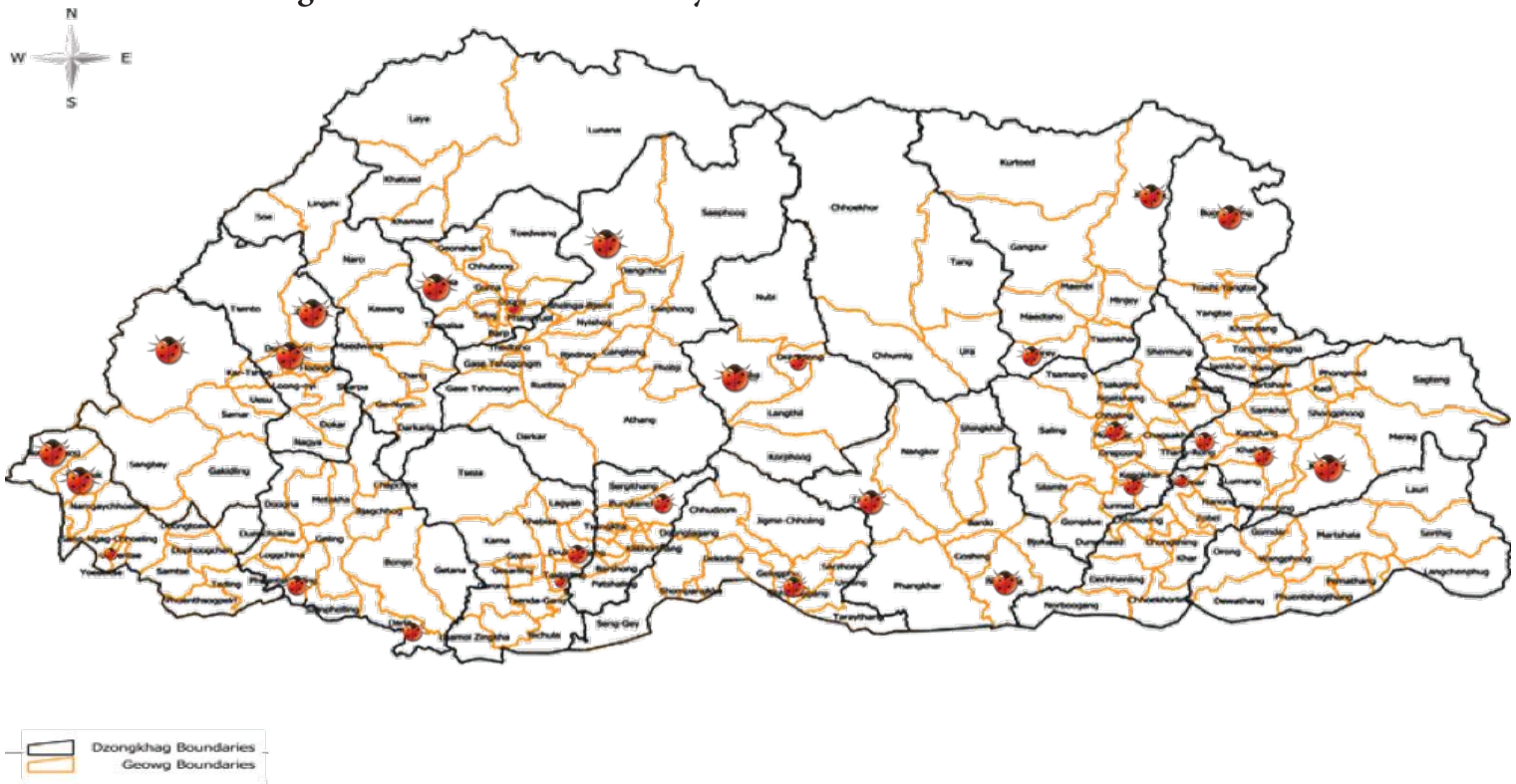
Ugyen Wangdi	Sarpang	RDC Bhur	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Ugyen Dendup	Sarpang	RDC Bhur	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Lobzang Chophel	Bumthang	RDC Bumthang	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Karma Dema	Tsirang	RDC Tsirang	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Lhendup Dorji	Thimphu	NPPC	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Tshomo	Thimphu	NPPC	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Kezang Tobgye	Thimphu	NPPC	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Tshelthrim Zangpo	Thimphu	NPPC	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Sonam Dorji	Thimphu	NPPC	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015
Tshering Zam	Thimphu	NOP	7	NSSC-Semtokha	Paro, Punakha	21-27 April 2015

Annexure X: Android Gadget Distribution List

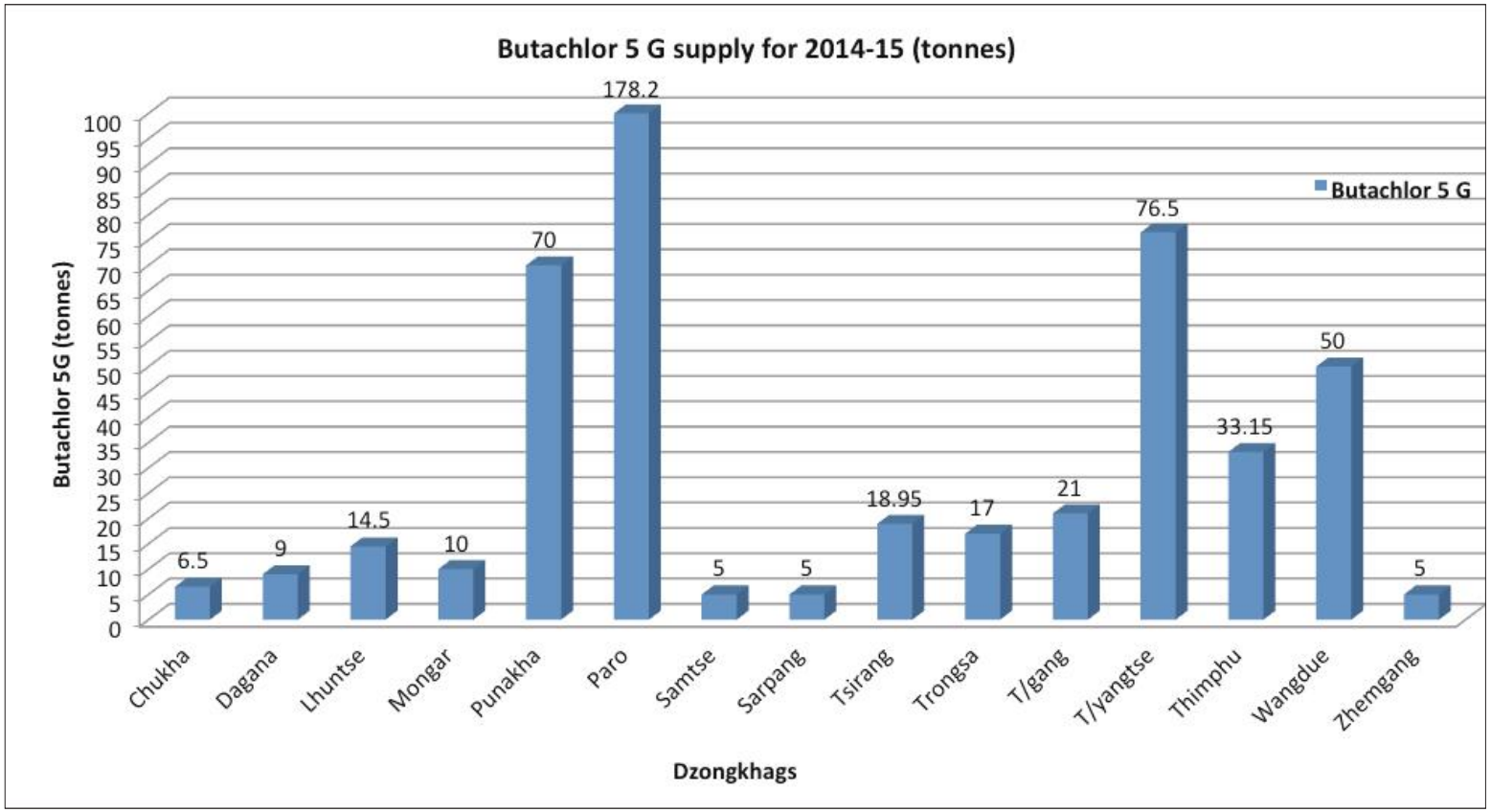
Name	District	Geog/RDC	CID NO	Tab No (Built No.)	Tablet (No.)	Adapter (No.)	Data cable (No.)	Tab Cover (No.)	Screen Protection (No.)	Issue date
Kezang Tobgye	Thimphu	NPPC	11107002434	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Tshelthrim Zangpo	Thimphu	NPPC	11103000065	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Sonam Dorji	Thimphu	NPPC	11105002935	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Jigme Tenzin	Thimphu	NPPC	11515000045	KOT49H.T231XXUOANJ4	1	1	1	1	1	4/23/2015
Dawa Delma	Wangdue	RDC Bajo	10710000454	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Duptho Wangmo	Mongar	RDC Wengkhar	11602002434	JDQ39.T311XXUAMG1	1	1	1	1	1	4/23/2015
Tashi Phuntsho	Mongar	RDC Wengkhar	10602001096	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Ugyen Wangdi	Sarpang	RDC Bhur	11107004470	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Ugyen Dendup	Sarpang	RDC Bhur	10802001403	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Ugyen Tenzin	T/yangtsi	Bumdiling	11213003067	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Delma	Paro	Dobshari	11315000614	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Gembo Dorji	Punakha	Dzomi	10210000816	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Karma Tenzin	Punakha	Kabisa	11505003710	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Dechen Pelden	Trongsa	Tangsibji	11213001346	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Jambay Wangmo	Trongsa	Drakteng	10101002788	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Tashi Dawa	Sarpang	Chuzagang	12004000405	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Sonam Dechen Dorji	Dagana	Drujegang	11410003004	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Choki Wangdi	Dagana	Tashidhing	12001002930	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Gem Tshering	Chukha	P/ling	10702000888	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Kinkhen Tenzin	Chukha	Darla	11514001830	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
N.B Tamang	Haa	Bji	11801000230	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Kinlay Wangmo	Samtse	Norbugang	10906002666	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Dorji Wangmo	Samtse	Tendu	10709000194	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Rajan Rai	Samtse	Yoeseltse	11204000340	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Sangay Wangdi	Tsirang	Phuentenchu	12005001257	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Tshewang Thinley	Zhemgang	Trong	10703002660	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Thinley Zangpo	Zhemgang	Nangla	12004004271	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015

Jigme Lhamo	Wangdi	Kazhi	10907001375	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Chimmi Tshewang	Mongar	Khengkhar	10712000960	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Pem Dorji Moktan	Tashigang	Kangpara	21801000314	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Tenzin Dema	Tashigang	Bidung	11512001294	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Pema Wangchuk	Tashigang	Khaling	10903003288	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Sha Bdr Barakoti	P/gatshel	Nangkhor	21811000111	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Nancha	Lhuentse	Jarey	11606001028	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Tashi Wangdi	Lhuentse	Khoma	11502000192	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015
Gem Dorji	Paro	wangchang	10804000555	JDQ39.T311XWUAMH1	1	1	1	1	1	4/23/2015

Annexure X1: Gewog under ePest surveillance system



Annexure XII: a) Butachlor herbicide Distribution by Dzongkhag 2014-15



Annexure XII: b) other pesticides excluding Butachlor distribution (Kgs/Litres) by Dzongkhag in 2014-15: No pesticides have been distributed to Pemagatshel, S/Jongkhar and Gasa.

Products	Bumthang	Chukha	Dagana	Gasa	Haa	Lhuntse	Mongar	Punakha	Paro	P/gatshel	Samtse	S/J	Sarpang	Tsirang	Trongsa	T/gang	T/yangtse	Thimphu	Wangdue	Zhemgang	Total
INSECTICIDES																					
Chlorpirifos 20 EC	20.00	23.70	0.00	0.00	0.00	21.80	22.50	60.50	130.10	0.00	0.10	0.00	9.00	1.00	15.00	0.3	9.00	194.40	25.50	1.00	533.90
Cypermethrin 10E	31.40	21.50	42.00	0.00	76.40	14.00	22.50	101.70	1013.40	0.00	20.50	0.00	28.00	21.00	63.10	0.00	26.00	701.80	88.50	39.20	2311.00
Dimethoate 30EC	0.00	46.00	3.50	0.00	1.00	7.00	30.00	5.70	57.60	0.00	36.00	0.00	17.00	2.50	37.50	0.00	6.00	107.70	42.10	1.00	400.60
Fenvelerate 0.4D	0.00	50.00	40.00	0.00	43.00	0.00	9.00	0.00	254.00	0.00	0.00	0.00	27.00	57.00	0.00	0.00	2.00	1414.00	27.00	0.00	1923.00
Malathion 50EC	3.25	25.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	61.00	0.00	0.00	104.25
Total	**54.65**	**166.20**	**85.50**	**0.00**	**120.40**	**42.80**	**84.00**	**167.90**	**1465.10**	**0.00**	**56.60**	**0.00**	**86.00**	**81.50**	**115.60**	**0.30**	**43.00**	**2478.90**	**183.10**	**41.20**	**5272.75**
FUNGICIDES																					
Captan 50 EC	6.50	0.00	0.00	0.00	37.00	0.00	6.00	0.00	31.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	41.00	0.00	0.00	127.50
Carbendazim 50 V	12.5	0.00	10.00	0.00	0.00	0.00	1.00	0	299.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	325.5	0.00	1.00	651.50
Cu oxychloride 50	5.90	17.00	0.00	0.00	0.00	0.20	2.00	11.10	17.00	0.00	25.00	0.00	12.30	0.00	0.00	0.00	2.20	36.50	12.70	0.00	141.90
Hexaconazole 5 E	0.00	0.00	0.00	0.00	37.00	0.00	0.00	0.00	3.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	44.20
Mancozeb 75 WP	124.25	7.00	1.00	0.00	70.50	0.00	10.00	5.00	357.75	0.00	0.00	0.00	0.00	0.00	10.00	0.00	31.75	488.5	1034.25	0.00	2140.00
(metalyxyl) Ridom	1.00	0.00	0.00	0.00	0.00	0.20	5.00	1.50	8.20	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00	5.40	356.60	0.00	382.90
Sulphor 80 WP	0.00	0.00	20.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00	24.00	0.00	6.50	1.00	0.00	0.00	0.00	17.50	0.00	0.00	74.00
Tricyclazole 75 WF	0.30	10.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	7.00	1.40	0.00	0.00	0.00	0.30	4.00	0.00	25.00
Total	**150.45**	**34.00**	**31.00**	**0.00**	**144.50**	**0.40**	**24.00**	**22.60**	**718.65**	**0.00**	**49.00**	**0.00**	**30.80**	**2.40**	**10.00**	**0.00**	**41.95**	**918.70**	**1407.55**	**1.00**	**3587.00**
HERBICIDES																					
Butachlor 5 G	0	6500	9000	0	0	14500	10000	70000	178200	0	5000	0	5000	18950	17000	21000	76500	33150	50000	5000	519800.00
Glyphosate 41 SL	19.00	66.00	35.00	0.00	14.50	0.00	176.00	4.00	262.00	0.00	0.00	0.00	85.00	278.00	71.00	1.00	15.00	308.50	2423.50	11.00	3769.50
Metribuzin 70 WP	304.70	186.00	0.00	0.00	72.90	0.00	0.00	1.00	255.80	0.00	0.00	0.00	0.00	5.00	1.20	20.00	0.00	221.20	1531.00	0.00	2598.80
Total	**323.70**	6752.00	**9035.00**	**0.00**	**87.40**	**14500.00**	**10176.00**	**70005.00**	**178717.80**	**0.00**	**5000.00**	**0.00**	**5085.00**	**19233.00**	**17072.20**	**21021.00**	**76515.00**	**33679.70**	**53954.50**	**5011.00**	**526168.30**
RODENCIDES																					
Zinc phosphide 80	**0.21**	**0.54**	**1.20**	**0.00**	**2.26**	**0.00**	**3.1**	**0**	**0.7**	**0**	**0.01**	**0.00**	**0.2**	**0.45**	**1.00**	**0.00**	**0.64**	**6.84**	**5.28**	**0.12**	**22.55**
NON-TOXIC																					
Neem Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	0.00	200.00	0.00	0.00	228.00
Tree Spray Oil	42.00	0.00	0.00	0.00	209.00	0.00	210.00	0.00	4200.0	0.0	0.00	0.00	0.00	70.00	0.00	0.00	0.00	4875.00	0.00	0.00	9606.00
Sticker	0.00	0.00	0.00	0.00	3.00	0.00	1.00	3.25	49	0	35.00	0.00	6.25	0.00	0.00	0.00	0.00	101.00	140.00	0.00	338.50
Total	**42.00**	**0.00**	**0.00**	**0.00**	**212.00**	**0.00**	**211.00**	**3.25**	**4271.00**	**0.00**	**35.00**	**0.00**	**12.25**	**70.00**	**0.00**	**0.00**	**0.00**	**5176.00**	**140.00**	**0.00**	**10172.50**
Grand Total	**571.01**	**6952.74**	**9152.70**	**0.00**	**566.56**	**14543.20**	**10498.10**	**70198.75**	**185173.25**	**0.00**	**5140.61**	**0.00**	**5214.25**	**19387.35**	**17198.80**	**21021.30**	**76600.59**	**42260.14**	**55690.43**	**5053.32**	**545223.10**