National Plant Protection Centre

ANNUAL REPORT 2013-14

ROYAL GOVERNMENT OF BHUTAN
MINISTRY OF AGRICULTURE AND FORESTS
DEPARTMENT OF AGRICULTURE

Contents

Foreword

It is the earnest effort of the National Plant Protection Centre (NPPC) to bring forth the annual report to reflect the achievements and challenges faced during the past year. Through this annual report, it is our wish to present herein the sincere efforts put in by all our researchers, support staff and collaborating agencies, individuals and that of farmers. As is undertaken by various agencies and institutions, the documentation of annual activities in such a format is carried out to serve as: a) a referral source for future, and; b) to present possibilities of collaboration and cooperation with agencies and institutions, from within the Ministry of Agriculture and Forests and outside.

Towards these efforts, this document briefly presents the program profile outlining the mandate and functions of the technical divisions of the Centre; the broad overview of the activities undertaken by each of the divisions and major challenges faced during the implementation of the services provided by the Centre. A few major highlights of the achievements that are being presented in the document for advancing Centre's effort towards ecosystem's approach to pest management are:

a. A training program organized by the Centre on bio-control for the staff of the Centre, Dzongkhags and the RDCs in collaboration with UN-ESCAP underlining the Centre's effort towards maintaining and improving the resiliency, sustainability and integrity of the agro-ecosystem's health while carrying out pest management activities;

b. Management of lichen in apple through use of dilute concentration of lime;

c. Pest epidemic monitoring and management – Use of pheromone traps for monitoring army worm for early warning and forecasting;

d. Fruit-fly monitoring and management in citrus orchards through use of lures and baits – an effective technology developed through the knowledge based on sexual maturity of female fly for preserving natural enemies and ecosystem balance;

e. Promoting human wildlife conflict management through use of electric fencing system;

f. Screening and evaluation of novel herbicide for management of major rice weeds; and

g. Tracking the citrus HLB disease through PCR techniques for protecting healthy orchards, managing infected ones and effecting quarantine restrictions for containing further spread of the disease.

The implementation of the activities highlighted in the document and many that goes unaccounted for is always being achieved through the collaboration and in partnership with the Dzongkhags and the Gewog Extension officers and RDCs. Therefore, we would like to take this opportunity to express our sincere gratitude to all our collaborators from within and outside the Ministry of Agriculture & Forests who had supported and helped us to make this financial year a successful year. Finally, a very big "thank you" to all the staff of NPPC for their steady support without which this successful year would not have materialized.

Yeshey Dema

Program Director

1.0 PLANT PROTECTION PROGRAM PROFILE

The official plant protection service support to the farming community started in the 1960's with the implementation of planned agricultural development programs. However, the organized plant protection service began only with the establishment of the National Plant Protection Centre (NPPC) in 1984 to oversee plant protection programs in the country.

The NPPC is designated as a national referral and coordinating centre for information, policy and activities related to plant protection services. The Centre is largely mandated to develop and disseminate integrated pest management strategies in managing pests in Agricultural and Horticultural crops. To achieve this goal, the Centre undertakes intensive program of research and development activities; and extension & farmer trainings through on-farm research activity; training programs and development and dissemination of plant protection extension materials. In order to carry out and address the mandates, the Centre has five main technical divisions catering to specific responsibilities outlined below:

1.1 Entomology Division:

Entomology Division specifically deals with insect pest problems in agricultural field, including storage pests. Therefore, the division is responsible for carrying out research and development activities for developing pest management measures and disseminating them to the farming community via the national extension system.

Towards the above goal, the division conducts adaptive field trials in priority crops for major insect pests; develops referral collection for insect pests; undertakes identification work for insect pests of agricultural importance; imparts training to farmers and extension personnel; develops extension materials; and provides advisory services to farmers, extension and researchers, and other stakeholders.

1.2 Pathology Division:

Pathology Division is mandated to develop disease management measures, following Integrated Disease Management (IDM) concept, in identified agricultural crops and disseminate the technologies to the farming community through the extension network.

For achieving the above goals, the division is responsible for carrying out disease surveillance and surveys; conducting adaptive research and development trials in priority crops for major diseases of concern; carrying out diagnostic work for identification of disease organisms; providing training to extension and farmers; and providing advisory services to farmers, growers, extension, researchers and other stake holders.

1.3 Weeds and Vertebrate Pests Division:

The task of the Weeds & Vertebrate Pests Division is to develop management measures on weeds and vertebrate pests in agricultural crops. The division also conducts on-farm research trial for major weeds; survey on major weeds; train farmers and extension agents, collect weed species and develop herbarium and develop extension material on weed management. The division also works on wildlife management strategies and provides technical backstopping on electric fencing system including the procurement of essential items that are not readily available in the local markets.

1.4 Pest Surveillance Division:

This newly created division conducts regular pest monitoring and reporting. It is mandated to feed vital information to the whole plant protection system that dictates and shapes other plant protection (PP) activities. Through the surveillance system, critical information on emergence, spread, severity and losses to a pest organism can be generated which assist in rapid diagnosis and effective PP service delivery and for prioritizing PP R&D programs. Currently, the division is engaged mainly in upgrading the pest monitoring system to an ePests Surveillance/Survey system.

1.5 Plant Protection Product Division:

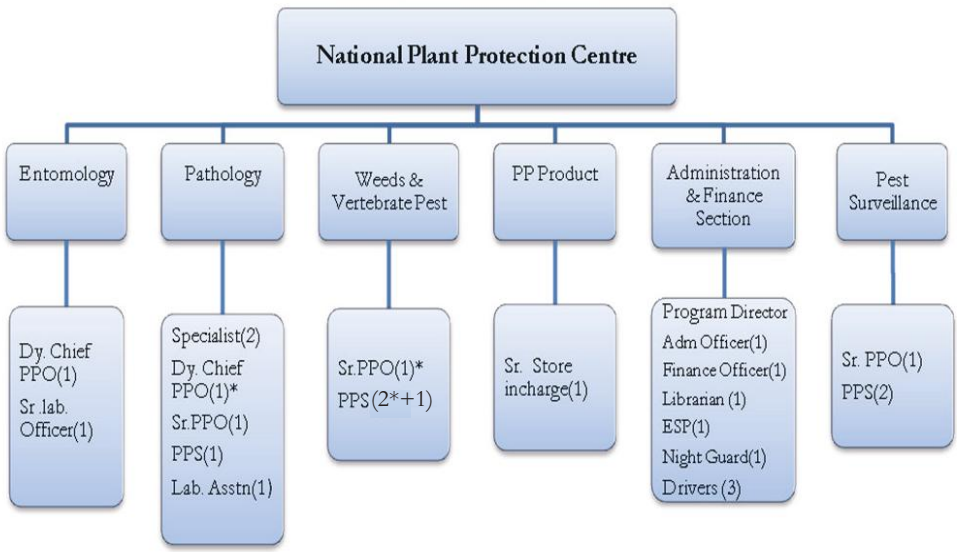
This division is responsible for pesticide management including indent collection from Dzongkhags, procurement and distribution of chemicals. Along with, it provides advisory services on pesticide use and safe handling to farmers and extension agents. In brief, following are the two important mandates;

- Maintenance of pesticide data base
- Capacity development on pp product management

1.6 The Program Management Division:

The Program Management of the centre includes Administration, Procurement and Accounts section. The Management is responsible for overall program direction, guidance and facilitation of the plant protection activities.

2.0 ORGANIZATIONAL SET UP



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

HIGHLIGHT OF ACTIVITIES

3.0 ENTOMOLOGY DIVISION

3.1 Maize storage consultancy from the International Centre for Wheat and Maize Development centre (CIMMYT).

Huge losses occur after maize is harvested and stored through traditional practice. To address this situation, the NPPC fielded two consultants from the International Centre for Wheat and Maize development centre (CIMMYT), based in China and Kenya. The consultants visited Bhutan and in collaboration with a team from NPPC undertook a field trip to Tsirang to look at the current field storage conditions especially for the maize storage in Bhutan. The consultants also provided technical presentation to the field extension staff and the technical staff of NPPC. As part of the team's recommendations, the NPPC has put up a project proposal to the Ministry of Agriculture and Forests which will be put up to the Food and Agriculture Organization (FAO), Rome. The project will focus on improving maize storage system in Bhutan. As part of this exercise, the NPPC is also in the process of evaluating novel and improved techniques in maize storage encompassing the use of reliable house hold storage system using super bags.

Training Programme

Traditional maize storage technique

3.2 Biological control training in collaboration with UN-ESCAP

The NPPC in collaboration with Asian and Pacific Centre for Transfer of Technology (APCTT) of the United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP) New Delhi, India, organized and conducted a 5-day training program from 24th -28th February, 2014 on biological

Biological Training at NPPC

Participants of the training

control techniques and mass rearing of important bio agents such as predators, parasitoids, fungal antagonists and some entomopathogens. The main objective of the training program was to provide basic knowledge and skills in rearing and mass culturing some of the most commonly used bio agents. The training was also aimed at establishing a bio control laboratory at NPPC and to develop a core technical team to disseminate knowledge and skills on bio control and culturing techniques to various stakeholders in future. The participants comprised of technical staff from NPPC, RNR-RDCs, Dzongkhag extension, National Soil Services Centre (NSSC) and National Organic Program (NOP). The training program was organized with financial support from the EU-RNRSP budget and resource person support was provided from the Asian and Pacific Centre for Transfer of Technology (APCTT).

3.3 Army Worm monitoring using pheromone traps

The NPPC in collaboration with the Sydney Museum, Australia identified the species involved in the 2013 army worm outbreak as *Mythimna separata*

(Walker). In order to study the pest population dynamics and monitor pest epidemic development, the NPPC procured pheromone lures and traps. Pheromone lures and traps can be used both for populating monitoring of a specific pest and for mass trapping purposes. The pheromone lures and traps were used in areas where army worm was reported last year with the following objectives:

- To monitor the pest population levels in critical crop growing period for early warning and intervention
- To study the population dynamics and incidence of *M. separata* pest in different location
- To study the efficacy of the lure and traps in monitoring the pest complex

Pheromone trap for army worm

Brochures on the pheromone and lure use, field deployment and data collection were produced and distributed to the Dzongkhag agriculture sectors. The activity is ongoing and will be continued in 2014-15 season as well.

3.4 Fruit fly area-wide management and training program (ACIAR project):

The NPPC in collaboration with the Dzongkhag Agriculture sector, Tsirang conducted the Chinese citrus fruit fly (CCFF) area-wide management training in Kikhorthang and Dunglagang Gewog on 21 and 22 April, 2014. The training program is in continuation of the program implemented by the NPPC as part of the Australian Centre for International Agriculture Research (ACIAR) citrus project which is being executed since 2013. In 2013, the program was implemented in Kikhorthang Gewog. The area-wide fruit fly management program has focused on imparting knowledge and skills in managing the CCFF with implementation of environmentally techniques like protein baiting and fruit drop collection. The program has advocated effective community mobilization and implementation of the management strategies over seasons to attain the desired level of control against this pest in the two Gewogs. A total of 33 groups have been formed in these two Gewogs with 230 farmers participating in area wide fruit fly management program (Annexure 1&2). Farmers were trained on aspects related to fruit fly biology, management strategies like protein baiting and timely collection and destruction of dropped fruits. In 2013 November, two cages were established in these Gewogs to monitor fruit fly emergence and to show to the farmers and make them identify the pest species involved. A door to door visit was also conducted in these Gewogs to advocate and monitor pit digging and fruit drop collection activities involving the local leaders (Tshokpas).

View of area wide management sites

Field emergence traps

3.5 Lichens control trial in Apple

Lichens have been a major issue in apple. In order to test a reliable strategy for this problem, two trial sites in Thimphu and Paro were set up with the following treatments:

I) Bordeaux mixture; Copper Sulphate:Lime:Water (1kg:1kg:50lt)

II) Lime: water mixture(2 mixtures); 1kg lime: 25lt water and 1kg lime: 50 lt water

Controlled tree

Treated tree

The data from the trial showed significant results in controlling lichens on the trees. All treatments showed equal efficacy in managing lichens. However, spraying of lime with water (1kg:50lt) can be a viable and cost effective option for lichens management in apple. Commercial grade lime will be tested during 2015-2016. Recommendations will be made after completion of the trial.

3.6 Fruit drop survey

Fruit drop survey was conducted in 2012 and as a continuation to determine the cause and level of infestation especially by the Chinese Citrus Fruit fly, a survey was conducted mainly in the area wide fruit fly program sites falling under Kikhorthang and Dunglagang Gewogs under Tsirang Dzongkhag. The information gathered will provide information and trends in fruit drop due to fruit fly infestation across the area.

Fruit drop dissection

3.7 Fruit fly Green spheres and Vinegar trapping trial

The green spheres have been developed specifically for the Chinese Citrus fruit fly by a Chinese professor. It consists of a green sphere, to which the fruit fly gets attracted as CCFF are most attracted to green color that mimics fruit color. Secondly, an olfactory attractant is applied on it which further attracts them as food bait. The traps showed promising results and the NPPC will explore the possibilities of importing and further testing and demonstrating its effectiveness.

Fruit fly green sphere traps in the field

3.8 Field evaluation of new Pheromones and attractants for fruit fly pest

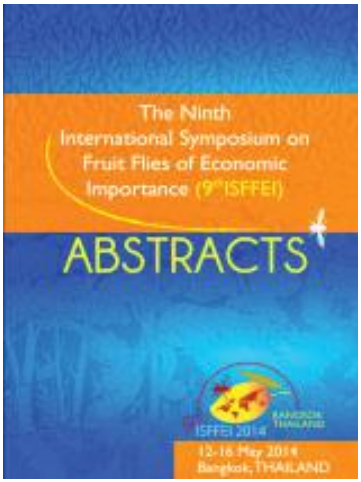
A range of novel lures supplied by the Department of Primary Industries(DPI),Queensland, Australia were tried against the Chinese citrus fruit fly (CCFF) as this pest does not respond to any commercial available parapheromone. Of these attractants, a novel attractant, Zingerone has been found to attract fruit fly species that do not usually respond to lures. However,

the lures were not successful in attracting the CCFF though it attracted other species of fruit flies.

Field evaluation of Zingerone

3.9 Fruit fly symposium attendance /Presentation

A staff from the Centre presented the findings on the Chinese Citrus fruit fly (CCFF) during the 9th International Symposium on Fruit Flies of Economic Importance (ISFFEI) held in Bangkok, Thailand. The findings were part of field work conducted under the ACIAR area wide fruit fly management project work.



Results from the field evaluation of different range of protein baits on attraction of the CCFF and spot effectiveness of these baits against the CCFF were presented through a poster presentation. The research indicated the following results:

3.10 Field study 1: Field research on protein bait attraction and effectiveness as spot sprays

- The main Objective of this study was to determine the attractiveness of different protein baits;
    i. Probiofer L (Protein Hydrolysate Liquid)
    ii. Probiofer A (Protein Hydrolysate Powder)
    iii. Australian Protein (Mauri Pinnacle protein®)
    iv. Jaggery

Field trials conducted from mid-May to August, 2013 in 4 citrus orchards in Tsirang. A total of 96 Polyethylene terephthalate (PET) bottle traps were used with the lures mentioned above. Each treatment was replicated 6 times in four citrus blocks. Weekly records of *B. minax* captured in the traps were recorded.

Mean number of *B. minax* captured in PET bottle traps containing different lures

Treatment	Mean flies captured
Pinnacle protein	45.12a
Probiofer L	42.64a
Probiofer A	11.52b
Jaggery	5.44b

Means followed by the same letter do not differ significantly. (Fisher's LSD test on log (x+1) transformed data; $P < 0.05$

Results: Pinnacle protein and Liquid protein were the most attractive protein followed by powdered protein. Peak fly activity was observed in the second and third week of June. Jaggery is not attractive to CCFF (which is recommended for *B. dorsalis* in India in Mango).

3.11 Field study 2: Determine the effectiveness of lures and insecticides in killing *B. minax* when applied as spot sprays

The effectiveness of Probiofer L (Protein Hydrolysate Liquid), Probiofer A (Protein Hydrolysate Powder), Australian Protein (Mauri Pinnacle protein®)

mixed with Malathion were determined by counting dead flies after bait application on citrus trees. Dead flies were collected on a white sheet placed below the treated spots. Total flies killed within 1 hour after bait application were recorded. There were 3 replications for each treatment.

Mean number of *B. minax* killed with protein baits applied as spot sprays on mandarin trees

Treatment	Mean flies dead
Pinnacle protein	23.26a
Probiofer L	4.00b
Probiofer A	6.63b
Control	0.00b

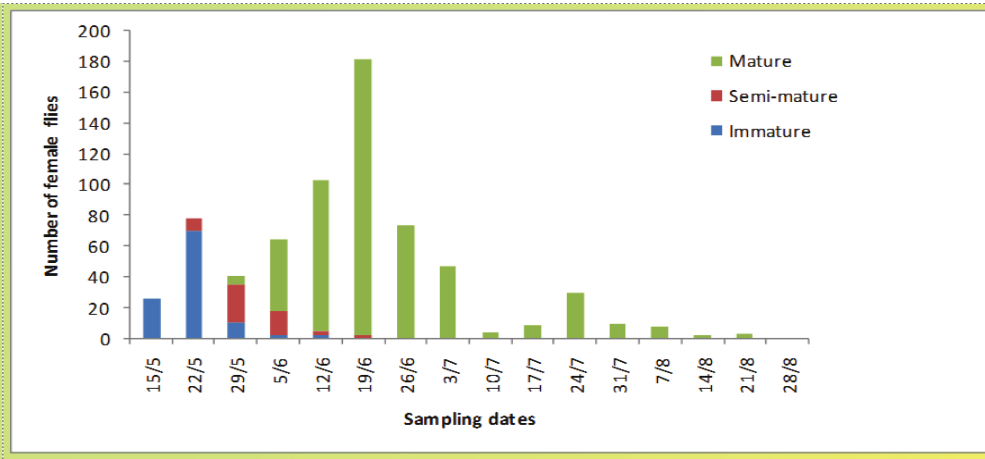
Means followed by the same letter do not differ significantly. (Fisher's LSD test on log (x+1) transformed data; $P < 0.05$

Results: Pinnacle protein was significantly more effective than the other two baits in killing *B. minax*. Therefore, there is a need to explore baits manufactured specifically as fruit fly baits to achieve higher level of control while implementing protein baiting as a control strategy against pest fruit flies.

3.12 Field study 3: Determination of sexual maturity of female *B. minax* flies in Tsirang

Flies ensnared in the PET bottle traps were dissected and sexual maturity determined by observing the eggs in their ovaries. They were grouped into mature (with mature eggs present), semi-mature (eggs slightly developed) and mature (fully developed eggs) flies.





Seasonal ovarian development pattern of female *B. minax* flies, captured in PET bottle traps, in mandarin orchards in Tsirang, Bhutan in 2013

Results: The eggs maturation data indicated that majority of the flies remained immature and semi-matured till the first week of June with most flies attaining full sexual maturity by the end of June. Therefore, baiting is recommended from fly emergence to full sexual maturity (from mid April to end of July).

4.0 PATHOLOGY DIVISION

4.1 Crucifer Clubroot soil solarization trial

A study on the effect of soil solarization on clubroot was conducted at Nago under Naja gewog in collaboration Gewog Extension. Transparent plastic sheet was used for solarization with an objective to increase the temperature of the soil. A rise in temperature was compared with control plot and their subsequent effect on yield was recorded.

Observation/Results: The average soil temperatures recorded were 10.53 ^{o}C and 8.50^{o}C for covered and uncovered beds respectively when the average outside temperature was 7.17^{o}C. There was not much of variation in rise in temperature between the treatments and also observed no difference in the disease development. However, a huge difference in yield was recorded. The yield from the solarized plot was 106.20 kgs, and from the controlled plot was 62.50 Kg. Therefore, the results show that there is not much of effect in increasing the soil temperature by using transparent polyethelen sheet and a small difference in temperature between covered and uncovered plots has no effect on clubroot disease development. High yield from the covered bed could be due to other factors such as soil fertility, good control of weeds and conservation of soil moisture. There is need for further study on the effect of temperature on this disease development using black polyethylene sheet and by optimizing other factors for better results.

4.2 Chili blight management trial using bio-pesticides

To test safe alternative and an environmentally friendly solution for chilli blight management, on-station trial using bio-pesticide Trichoderma and Pseudomonas formulations were carried out. Following treatments carried out to evaluate

- T1: *Tricoderma harzianum* with FYM,
- T2: FYM only,

- T3: Control,
- T4: *Pseudomonas fluorescens* with FYM.

FYM was mixed with both biopesticides to retain/maintain moisture required and left under gunny bags for three weeks. Each mixture was turned over/ mixed every week. Two handful lots of each mixture were used for each treatment at the time of transplanting.

Results of treatments:

Treatments	Pod blight affected yield (kg)	Wilted plants (nos.)	Root rot (nos.)	Total Yield (kg)
T1	**2.15**	**32**	0	**22.23**
T2	**2.0**	**36**	0	**17.95**
T3	**0.75**	**45**	0	**7.85**
T4	**1.80**	**33**	0	**21.3**

A higher yield was obtained from the beds treated with bio-pesticides as compared to only FYM treatment and control plot. Between the two bio-pesticide treatments, the yield from *Tricoderma harzianum* treatment was slightly higher than *Pseudomonas fluorescens* treatment. The numbers of wilted plants in plots treated with bio-pesticides were comparatively low. The treatments indicate that these bio-pesticides could be used for reducing chili blight incidence and in improving the yield.

4.3 Farmer's Training on Powdery Mildew

A total of 86 farmers from Kikhorthang and 48 farmers from Dunglagang under Tsirang Dzongkhag were trained on Powdery Mildew management in citrus. The training was conducted in collaboration with Dzongkhag Agriculture sector with fund support from ACIAR project under Horticulture Division.

4.4 Powdery mildew trial using Sulphur 80WP in citrus orchards

The efficacy trial of sulphur 80WP against Powdery mildew in citrus was established at Kikhorthang and Dunglagang Gewogs under Tsirang

Dzongkhag. There were two treatments (sulphur spray & water spray as control), 2 locations (orchards) and replicated with 5 treatments; i.e. 5 locations were identified at Kikhorthang Gewog (Lower Dekiling, Nyezergang & Tashiyangju chiwogs) and 5 at Dunglagang Gewog. Sprays were repeated after every two weeks. Visual assessment was carried out to determine the effectiveness of the sprays.

Field spray of Sulphur

Powdery mildew trial results:

Table 1: Results

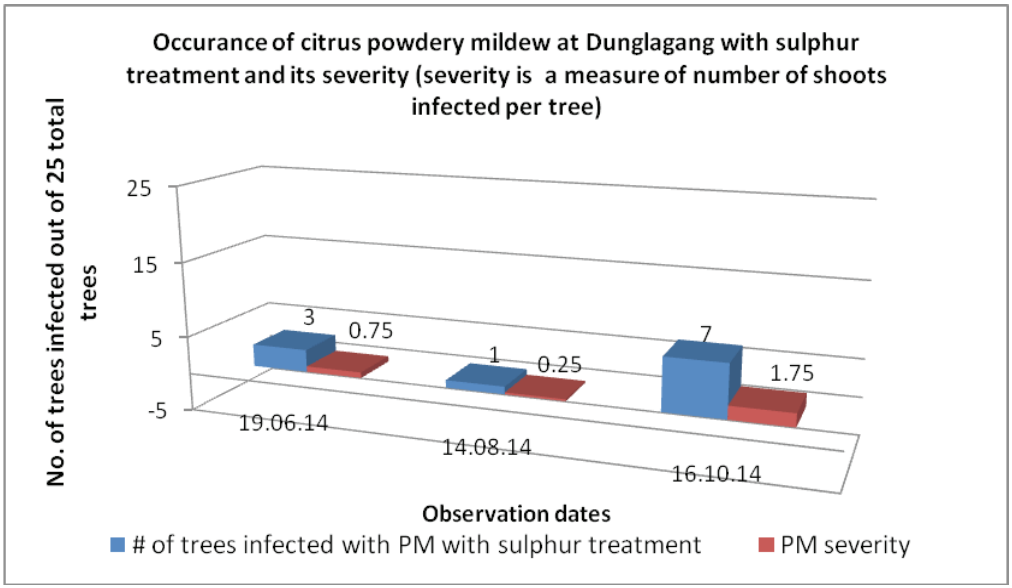
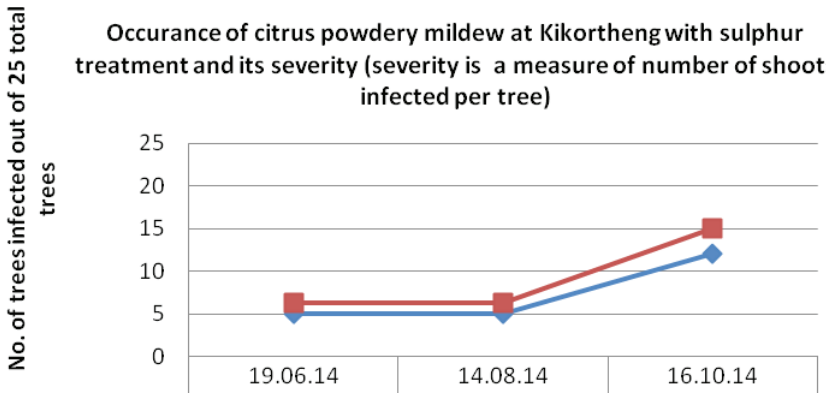


Table 2: Results



	19.06.14	14.08.14	16.10.14
PM severity	1.25	1.25	3
# of trees infected with PM with sulphur treatment	5	5	12

Powdery mildew trial results are shown in the table 1 and 2. Powdery mildew infection during third observation was observed to be more at both the sites, probably due to young autumn flush. During second observation in the month of August not many trees were infected possibly due to heavy rainfall that washed off the infecting fungal spores. It appears from the results that more trees are infected with powdery mildew at Kikhorthang compared to Dunglagang which may be due to the more older trees at Dunglagang compared to the younger trees at Kikhorthang. Due to tall tree height and difficulty in covering the whole tree with sulphur sprays, a combination of approach such as pruning infected shoots and burning them and sulphur treatment can be recommended.

4.5 Citrus leaf Sample analysis with Polymerase Chain Reaction (PCR):

A total of 137 citrus leaf samples were tested for Huanglongbing (HLB) pathogen out of which 19 detected positive and 118 negative. Samples were collected from 6 citrus orchards from Wangduephodrang, Chukha, Sarpang, Tsirang, and Dagana Dzongkhags.

PCR test result 2013-14

Dzongkhag	Positive	Negative	Total
Wangdue	1	35	36
Sarpang	2	3	5
Chukha	0	7	7
Tsirang	3	18`	21
Dagana	13	55	68
Total	**19**	**118**	**137**

Out of 1639 citrus leaf samples tested, 202 samples tested positive HLB. In addition, 484 DNA samples were extracted and collected from mandarin, curry leaf, and Murraya from experimental plots in Baychu, Wangdue and Reldri (Phuntsholing). These DNA samples will be used to study the molecular characteristics of the HLB bacterium and/or in host plant characterization.

4.6 Determination of citrus HLB disease transmission by the black psyllid

The experiment commenced with selection of naturally infected mandarin stumps in March 2014, and test plants were set up in May 2014. Twenty four naturally infected stumps were used as source of infection. Eleven stumps were caged with curry leaf and the other eleven stumps were caged with mandarin seedlings.

Experimental set-up in the field

Adults of *Diaphorina communis* were collected from Basochu and released into the test cages of infected stump with either curry leaf or mandarin. Observations of adult survival, egg laying and nymph development were collected at seven day interval. Leaf samples from the infected stumps were collected both at the beginning and at the end of the experiment. Inoculated mandarin and curry leaf plants were removed from the cages two months after establishment, and placed in a shed house at Baychu for disease development. Leaf sampling and testing for HLB bacterium will begin two and half month after termination of experiment, and repeated every same interval for the next one year.

4.7 Determination of effects of altitude on ambient temperature, relative humidity, leaf temperature, citrus HLB bacterium, and psyllid infestation

The experiment to determine whether altitude has any effect on leaf temperature which in turn will affect the survival of HLB bacterium was set up in 2013. The experiment was established in eight sites from ~800 to ~1500masl in Tsirang. Data collection on plant growth, psyllid infestations, and leaf temperature commenced from March 2014 and will be collected on a monthly basis. Analysis of data will be completed by end of 2015.

4.8 Impacts of tree guards on leaf temperature, citrus HLB bacterium and psyllid infestations

The experiment was conducted to assess the effect of different tree guard materials on leaf temperature of infected mandarin seedlings (~3yrs) which in turn will affect the HLB bacterium, and infestation of psyllids. The experiment was set up in June 2014 at Phunsumgang (783masl) under Goseling Gewog, Tsirang. Four different materials were used for tree guard with three treatments per material: control (no tree guard), partially closed tree guard, and open tree guard. Each treatment was replicated five times and designed in a RCBD. Each replicate had 12 plants. A total of 60 infected seedlings were used in total. Treatments were allocated using a ballot system. Data collection to determine

the HLB bacterium and psyllid infestation and leaf temperature will begin by March 2015.

Experiment on impacts of tree guards established in Phunsumgang, Tsirang.

4.9 Screening rice isogenic lines for assessment of *Pyricularia grisea* (rice blast disease) population structure

In Bhutan, the pathogen population structure of rice blast is highly variable depending on rice varieties grown and local micro environmental conditions. Also, the geographical isolation of rice growing areas from one another leads to development of isolated and distinct pathogen populations. Such variable populations of the blast pathogen must be monitored regularly to assist selection of rice varieties that are tolerant or resistant to blast disease. The best way to monitor such distinct populations of blast fungus is by screening rice isogenic lines with unique resistance genes.

Materials and methods

Rice iso-genic lines: Seventy three rice isogenic lines with distinct and unique resistance genes were received from the International Rice Research Centre (IRRI) in the Philippines. Together with released Bhutanese varieties, these isogenic lines were grown in the nursery bed in single row.

Rice Isogenic lines grown in the nursery bed

Each row sown with 15 to 20 seeds, and nursery soil fertilized with NPK. Later, leaves top dressed with 5% Urea to create conducive conditions for disease infection. The seedlings were grown to three or more leaves stages before assessment of blast disease infection. Results: Annexure 3 Shows the reaction (3-4 LS) of isogenic lines and released Bhutanese cultivars

Experimental screening site: Given a very limited number of seeds of each isogenic lines, not more than three sites were selected for the test. The sites were at:

Mid altitude: Site 1; (Rimchu) (1220 MASL): Humid and high rainfall site. Nursery raised near forest edge which provides shady conditions.

Site 2; (Damchi, 1200 masl): site in open field surrounded by farmers rice fields; fully exposed to sun and hardly any shade. Rainfall is same as Rimchu but due to exposure to direct sunlight dew formation on leaves is less or quickly disappears as sun rises.

High altitude: Site 3; Wang Bama: Site is near stream that flows along the edges of rice fields. The site remains wet and moist most times of the day and dew formation is high. The site is at high altitude (>2300 masl).

Results: The results are presented in annexure 4. At Rimchu (site 1) most isogenic lines did not germinate. At Damchi (site 2) all isogenic lines including

Bhutanese cultivars are clean without any blast disease infection. At Wang Bama (site 3) seedlings are irrigated for seed production and also for assessment of neck and node blast since these types of blast infection is serious in high altitude rice environments. In order to draw specific conclusions, testing of isogenic lines has to be continued.

4.10 Laboratory Activities

Seed germination after fungicide treatment was performed to assess for fungal diseases of paddy seeds of varieties Ngapja, Tan Tshering and IR64 collected from Lobesa, Punakha. The laboratory procedures include soaking of seeds for 30 minutes and air dry for 45 minutes. Seeds were treated with carboxin WP 75% at the rate of 2-2.5 grams per one kilogram of seed. Seeds were placed in Petri-dishes, and tray lined with moist blotting paper.

Seed fungal infection test

The germination was recorded after ten days of maximum germination of seed and following result were found:

1. No fungal growths were found on both treated and non-treated seeds of all three varieties.
2: 100% germination growth in both treated and non-treated test in all three varieties.

The test confirmed that seeds of all three varieties were healthy and not infected with any fungal diseases and can be used for raising seedling nursery.

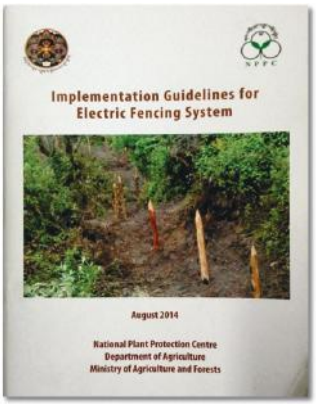
5.0 WEEDS AND VERTEBRATE PESTS DIVISION

5.1 Sochum herbicide screening/procurement

A range of herbicide developed by DuPont, an American chemical company, falling in the class Sulfonylurea were screened and procured from India for field evaluation. These new generation herbicides have a low application rate and mammalian toxicity. In addition, they are supposed to be effective on a broad range of grasses and broadleaf weeds and were specifically chosen to be tested against Sochum (*Potamogeton distinctus*) in paddy. Sites in Thimphu and Wangdue were also selected to implement the trial.

5.2 Electric Fencing System Implementation Guideline

Due to the lack of clear roles and responsibilities in procedures related to the implementation of the Electric Fencing System (EFS), an implementation guideline was developed after numerous consultative meetings with various stakeholders. The Implementation guideline for the EFS was developed to provide a clear direction to the implementing agencies and other stakeholders. The guideline spells out clearly the roles and responsibilities of all the agencies involved in the implementation of EF. The guideline was developed with an objective to help clear out ambiguity and confusion while establishing the EFS.



EFS Implementation guideline booklet

5.3 Training of Trainers on Electric Fencing System

After the approval for use in country by BEA, BPC and BSB, demand for the establishment of Electric fence has seen a steady rise. Therefore, to cater the needs and demand of the stakeholders, relevant research officers were provided hands on training on electric fencing system, in collaboration with RNR-RDC, Wengkhar and RNR-RDC, Yusipang. The training was attended by research

officers from RNR-RDC, Jakar; RNR-RDC, Bhur; RNR-RDC, Yusipang and RNR-RDC, Wengkhar. Further, officers from Agriculture Machinery Centre (AMC), Dzongkhag agriculture and forest officers and officers from the National Plant Protection Centre also participated in the training (Annexure 5). These trained officers will now act as the regional resource persons for further training and dissemination of information with regard to the establishment of the EF in their respective regions.

Participants of ToT on EFS, 2014

Clearing of fencing area

5.4 EFS establishment status in the country

A total of 97.69 km of fence length, covering and protecting 1291.30 acres of agriculture land, benefiting 760 households have been established. The total cost incurred for the ESF establishment was Nu 4.62 million. The electric fencing has been established in 12 Dzongkhags (Thimphu, Paro, Haa, Sarpang, Tashigang, Mongar, Pemagatshel, Samdrupjongkhar, Lhuentse, Trongsa, Zhemgang, and Tashiyangtse). The details of the EFS established so far are presented in Annexure 6.

Electric fence

Fence perimeter of Kaba & Daba village, Trongsa

6.0 PEST SURVEILLANCE DIVISION

6.1 Introduction

The effective delivery of plant protection services, including R&D, PP input, and technical backup are highly dependent on the information gathered through pest surveillance activities. To cater to this need the NPPC has developed the ***ePest surveillance system*** to enhance efficient surveillance system mainly to improve communication from and to the field thereby expediting the plant protection services and data storage system for future reference. This system uses an android operating system that captures real time geo-referenced data and transmission via internet.

6.2 Development of ePests Surveillance System

The e-pests system development initiated about a year back through Decentralized Rural Development Project (DRDP) fund support is now completed and undergoing the field tests. The major works that includes customization and prototyping of software based on Software Requirement Specification (SRS) provided by NPPC is completed. This system was initiated and developed given the advantages; it was compared to earlier system/old system of survey. (Annexure 7).

6.3 Up-gradation from Windows to Android OS

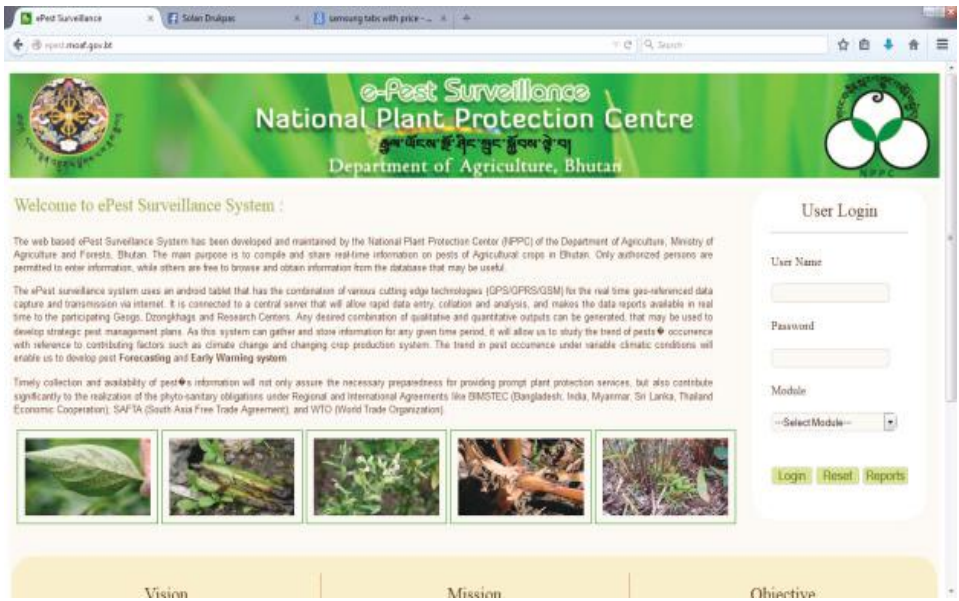
Initially, the e-pest surveillance system was hosted on windows based operating system on the handheld terminal (HHT). However, the assessment of the HHT based operating system was not user friendly and was costly. It was then upgraded to android based operating system

HHT Device (Windows-OS) **Android Device (Android-OS**

with a flexibility to host on any android device. An application (apps) on android Tabs was designed and built in android tabs.

6.4 E-Pest Surveillance Website

The development of website is an integral part of the system for overall operation and management of ePests surveillance system. This facilitates user management, inputting of master information into database, and to access the reports. The website, ***epest.moaf.gov.bt*** has been developed and hosted under/within Ministry of Agriculture Forests Server System in Information and Communication Services (ICS).

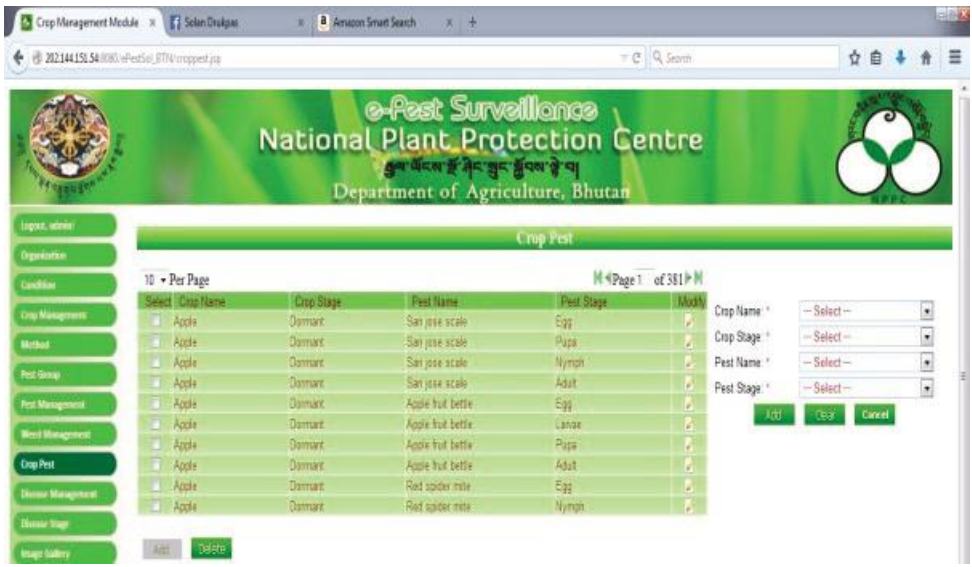


E-Pest website (epest.moaf.gov.bt)

6.5 Crop management module (CMM)

The crops management module is the part of software design for managing the users, crops and pests library and is accessible to only administrator and data manager. It is mainly for entering new data into the central database. The pests data entered and stored in the database can be fetched into android gadgets by using the ePests apps to assist the surveyor while carrying out the

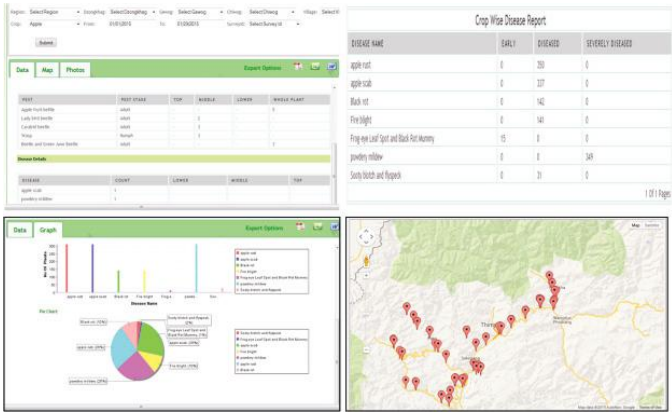
survey in the field. All important pests data has been entered and is ready for use.



Crop Management Module

6.6 Reports

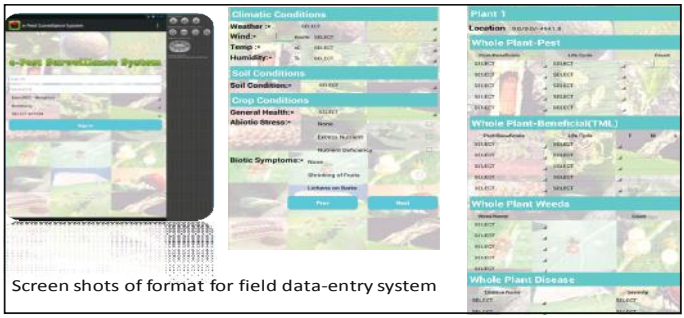
The Report section is another integral part of this system development. This is important in generating instant information available to the users on a real-time basis. Like in the crop management module, this section can be accessed through *epest.moaf.gov.bt*. Reports can be viewed in varied combinations and it is available in tabular, graphical form and in geo-reference maps.



Different combination of reports

6.7 Android apps

This application (apps) is built on android gadgets specifically to be utilized for ePests surveillance for data collection from the field. The apps is not only designed to capture real-time information from the field with geo-reference points, it is linked to the central database for ePests surveillance via internet interface system; enabled to fetch pests information from the pest library and upload the collected field data into the system.



Field data collection format

6.8 Installation of Server for e-Pest Surveillance (28th June, 2013)

To host the ePests surveillance system separately, the centre has procured two sets of servers and installed along with MoAF's central server at ICS, MoAF. It is being maintained and managed by ICT officials of ICS.

6.9 Android Device

To implement this system, NPPC procured 37 numbers of android handheld devices (Samsung Tab3). Field testing have been carried out successfully. These devices will be handed over to the assigned field extension officers for the implementation of ePests surveillance system in the first.

Android device

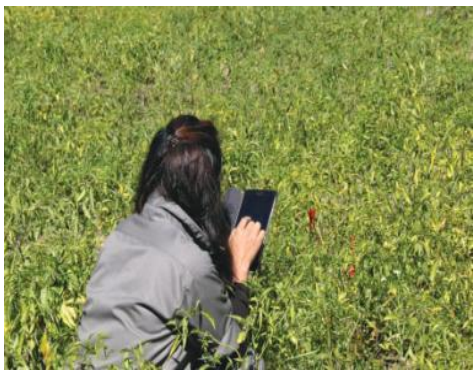
6.10 Working module

For the ePests surveillance system to function, central database, android device, website/internet services are the integral part of the system. Central database system is the most integral part to managing pest library, analysis of field information uploaded and to store the uploaded information. The overall working module of the system function is illustrated below.

Working module of ePests surveillance system

6.11 Field Testing of Android ePest Apps

To ensure that both the system and device is functional, thorough field tests were conducted in various regions on different crops and pests. Many rectifications and improvements were incorporated based on the field testing of the android apps in Paro, Punakha, Wangdi and Tsirang on apple, chilli, cabbage, paddy and wheat.



Field testing of the android devices

6.12 Implementation and up-scaling of ePests surveillance system

6.12.1 Implementation Plan

Terms of Reference (ToR) and guidelines are under development. Pilot Gewogs for first phase of implementation has been selected and extension staffs from these gewogs will be trained.

6.13 Constraints /Challenges

6.13.1 Capacity

Limited ICT capacity within NPPC has been a key challenge in completing the software development and to maintain and upgrade the system. The NPPC requires a permanent database manager (ICT) for system maintenance and improvements.

6.13.2 Budget

The centre could procure only 37 android gadgets through DRDP fund support. Hence, budget remains to be a constraint for the E-pest system up scaling.

6.13.3 Internet services and maintenance

Lack of reliable internet service facilities can be a constraint to Gewog extension officials. Fund for gadget maintenance could be another challenge in future.

7.0 PLANT PROTECTION PRODUCT DIVISION

7.1 Total plant protection products supplied and distributed in 2013-2014 season

Sl. No.	Particulars	Quantity Supplied to Dzongkhags (Kg or L)	Total Procured by NPPC (Value in Nu.)
1	Insecticides	6817.00	1870530.00
2	Fungicides	3197.80	1074156.00
3	Herbicides	5028.10	4283150.00
4	Rodenticides	46.81	37500.00
5	Others – non-toxic	9483.10	1372020.00
Total Amount		**24574.96**	**8637356.00**

7.2 PP product tender and procurement

The collection and compilation of PP products demand from twenty Dzongkhags were carried out successfully by the division. Tender documents were prepared and floated. Bids were evaluated and supply orders placed according to the demand for the 2013-2014 season.

7.3 Sale of PP products and data base maintenance

For the convenience of the general public, PP products were also made available and sold from the NPPC store to locals living in and around Thimphu. The record of purchase, supply/distribution and value has been updated on a regular basis for future record and information (Annexure 8).

8.0 FINANCIAL REPORT (2013-2014)

Revised approved Budget (RGOB)	Amount (Nu. in Million)
Current	9.824
Capital	9.027
Grand total	18.851
Budget	**Expenditure (Nu. in Million)**
Current	9.037
Capital	6.956
Grand total	15.996

9.0 ANNEXURE

Annexure 9.1: List of farmers trained: Fruit fly area-wide management program

Kilkhorthang Gewog

Sl. No.	Farmer(s)	Village
1	Icharam Bastola	Tashi Yangjug
2	Rinzin Wangmo	Ninzirgang
3	Om Nath Koirla	Tahi yangjug
4	Leki Phuntsho	-do-
5	Dina nath Koirala	-do-
6	Jai Prasad Dalal	Dangray-bu
7	Lemo	Tashi yanjug
8	Beda Moni Koirala	-do-
9	Chura mani Dhol	-do-
10	Sangay Dema	-do-
11	Khina Maya Khatiwara	-do-
12	Sonam Dema	-do-
13	Bishnu maya Thapa	-do-
14	Wangdi Dukpa	-do-
15	Dhan Bdr. Subba	-do-
16	Churam koirala	Ninzergang
17	Hema Kumari Bastola	Tashiyangjug
18	Indra maya Achrya	-do-
19	Dambar Kumar Dhimal	-do-
20	Laximan Dhimal	-do-
21	Dambar Kumar Mongar	Ninzergang
22	Bhakta Maya Rana	-do-
23	Chura Mani Rai	-do-
24	Rinzin Sherpa	-do-
25	Bal Bahadur Subba	Tashiyangjug
26	Bishnu Maya Lamchamay	-do-
27	Hari maya Balampaki	-do-
28	Ram Maya Tamang	Ninzirgang
29	Laximan Archarya	-do-
30	Karna Bahadur Rai	-do-
31	Ran Data Mongar	-do-
32	Ran Maya Mongar	-do-
33	Ganga MayaChamlagai	Tashi yangjug

34	Bala Ram Chamlagai	-do-
35	Tika Maya Bhimal	-do-
36	Chang Mola	-do-
37	Yangzom	-do-
38	Tsenga	Ninzirgang
39	Bagey maya Dungana	-do-
40	Sarita Rai	Ninzirgang
41	Kota Ria	Dangray bu tey
42	Bedha nath Koirala	Tashi yangjug
43	Tanka Nath Dhungel	Ninzergang
44	Bhawani Shangkhar Archrya	-do-
45	Dhana Pathi Chamlagai	-do-
46	Leela Dhal Damal	Dang ray bu tey
47	Prabu Nnda Bastola	Tashi yangjug
48	Dorji Pelden	Nin zergang
49	Pelzom	-do-
50	Chandra Prasad Chamlagai	-do-
51	Tanka Nath Dhulal	Dangray bu
52	Kar Zom	Ninzirgang
53	Jitendra Subba	Tashiyangjug
54	Aita Singh Rai	Dangray bu-B
55	Pubi Maya Archrya	Ninzergang
56	Bedha Mani Koirala	-do-
57	Soma Moktan	-do-
58	Hari Lal Gotamay	Tashi Yangjug
59	Ram Kumar Chamlagai	Ninzergang
60	Sherab Tenzin	Tashiyangjug
61	Jeten dara Rai	Ninzergang
62	Nidup	Menchuna
63	Hema Devi Phulami	Ninzergang
64	Kharka bahadur Rai	Ninzergang
65	Devi Charan Archrya	Tashiyangjug
66	Lal Bir Pulami	Ninzergang
67	Ganga Ram Mongar	-do-
68	Jit Bahadur Mongar	Tashiyangjug
69	Tika Ram Mongar	Ninzergang
70	Khara Nanda koiral	-do-
71	Damber Singh Tirwa	Tashiyangjug
72	Tek Bahadur Tirwa	-do-
73	Dham Maya Mongar	-do-

74	Iman Dharlami	-do-
75	Khem Nath Temsena	Ninzergang
76	Tashi Tshewag	Dekiling
77	Dema	-do-
78	Roshan Kaflay	Ninzergang
79	Abi Narayan Subidi	Tashi Yangjug
80	K B Subba	-do-
81	Hem Raj Rai	-do-
82	M B Kaflay	Bokaray
83	Passang Mo	Tashi Yangjug
84	Guru Wangmo	-do-
85	Leptang	-do-
86	Kanjur Tshering	-do-

Annexure 9.2: List of farmers trained: Fruit fly area-wide management program

Dunglagang Gewog

Sl. No	Farmer(s)	Village
1	Kiran rai	Dangrau bu
2	Ram Chandra Rai	-do-
3	Santa Bahadur Mahat	-do-
4	Burma Lal Dhamal	-do-
5	Juda Bir Tirwa	-do-
6	Hari Prasad Sinchuri	-do-
7	Kamala Rai	-do-
8	Yam Lay Suberi	Dangray bu-Ka
9	Bal Bahadur Pradhan	-do-
10	Pawan Kumar Chhetri	-do-
11	Ram Bahadur Chawan	-d0-
12	Man Bahadur Genray	-do-
13	Kharkha Bhdur Darmal	-do-
14	Pushapa Lal archarya	-do-
15	Krishna Maya Powdel	Dangray bu
16	Ratna Maya Rai	-do-
17	Dil Maya Rai	-do-
18	Kharka Bahadur Ria	-do-
19	Wangmo	-do-
20	Abi Maya Kami	-do-
21	Goma Chawan	-do-
22	Anjali Rai	Dangray bu tey

23	Hem Kumar Rai	-do-
24	Saroj Rai	-do-
25	Dharma Dhoj Tiwari	Dangray bu
26	Hari Maya Neopani	-do-
27	Ganga Khati	-do-
28	Nar Maya Chhetri	Dangray bu ka
29	Shyem Kumar Khati	Kherithang
30	Sancha Maya Darjee	Dangray bu ka
31	Rudra Mani Dulal	-do-
32	Padam Lal Pradhan	-do-
33	Kama Bahadur Chuwan	-do-
34	Moni Raj Dulal	-do-
35	Puma bahadur Pradhan	-do-
36	Kashi Nath Khatiwara	-do-
37	Bikash Chuwan	Dangray bu ka
38	Kubi Singh Pradhan	-do-
39	Bishunu Maya Subba	-do-
40	Man Maya Gagmeer	-do-
41	Phip Rani Subba	-do-
42	Choba Dhendup	-do-
43	Tek Bahadur Subba	-do-
44	K B Pradhan	Kirithang
45	Nanda Lal Dhimal	-do-
46	Suk man Rasaily	Dangray bu Ka
47	They Raj Gurung	-do-
48	Ran Manya Rai	-do-

Annexure 9.3: Results of the reaction (3-4 LS) of isogenic lines and released Bhutanese paddy cultivars

Rice isogenic lines	R Genes	Reaction types (SE, IRRI 1988)		
		Site 1 (Rimchu)	Site 2 (Damchi)	Site 3 (Wang Bama)
WH13-3201 (co)	*Pik*		0	5 (S)
WH13-3207 (co)	*Pi7(t)*		0	5 (S)
WH13-3216 (co)	*Piz-S*		0	5 (S)
WH13-3211 (co)	*Pita*		0	5 (S)
WH13-3217 (co)	*Piz-t*		0	3 (MR)
WH13-3214 (co)	*Pita-2*		0	3 (MR)

WH13-3198 (co39)			0	3 (MR)
WH13-3203 (co)	*Pik-h*		0	1
WH13-3199 (co)	*Pib*		0	0
WH13-3200 (co)	*Piks*		0	0
WH13-3202 (co)	*Pik*		0	0
WH13-3204 (co)	*Pik-m*		0	0
WH13-3205 (co)	*Pik-p*		0	0
WH13-3206 (co)	*Pi1*		0	0
WH13-3208 (co)	*Pish*		0	0
WH13-3209 (co)	*Pish*		0	0
WH13-3210 (co)	*Pish*		0	0
WH13-3212 (co)	*Pita*		0	0
WH13-3213 (co)	*Pita-2*		0	0
WH13-3215 (co)	*Pita-2*		0	0
WH13-3218 (co)	*Pi5(t)*		0	0

WH13-3229 (LT)		5 (S)	0	0
WH13-3231 (LT)		3-5 (MR-S)	0	0
WH13-3239 (LTH)		3-5 (MR-S)	0	0
WH13-3233 (LT)		3 (MR)	0	0
WH13-3234 (LT)		3 (MR)	0	1 (R)
WH13-3237 (LT)		3 (MR)	0	0
WH13-3228 (LT)		1 (R)	0	0
WH13-3230 (LT)		1 (R)	0	0
WH13-3232 (LT)		1 (R)	0	0
WH13-3235 (LT)		1 (R)	0	0
WH13-3236 (LT)		1 (R)	0	0
WH13-3238 (LT)		1 (R)	0	0
WH13-3219 (LT)			0	0
WH13-3220 (LT)			0	0
WH13-3221 (LT)			0	0
WH13-3222(LT)			0	0
WH13-3223 (LT)			0	0
WH13-3224 (LT)			0	0
WH13-3225 (LT)			0	0
WH13-3226 (LT)			0	0
WH13-3227)	*Pi9*		0	0

WH13-3240	*Pia*	5 (S)	0	0
WH13-3242	*Pii*	5 (S)	0	0
WH13-3248	*Pizt*	1 (R)	0	5 (S)
WH13-3249	*PiztS*	3-5 (MR-S)	0	0
WH13-3258	*Pi3*	5 (S)	0	0
WH13-3268	*Pita*	0	0	5 (S)
WH13-3266	*Pita2*		0	3 (MR)
WH13-3256	*Pish*	0	0	3 (MR)
WH13-3243	*Piks*	1 (R)	0	0
WH13-3246	*Pikp*		0	1 (R)
WH13-3251	*Pita*		0	1 (R)
WH13-3253	*Pib*	0	0	1 (R)
WH13-3254	*Pit*	0	0	1 (R)
WH13-3241	*Pia*	1 (R)	0	0
WH13-3244	*Piks*		0	0
WH13-3245	*Pik*		0	0
WH13-3247	*Pikh*		0	0
WH13-3250	*Pizt*		0	0
WH13-3252	*Pita*		0	0
WH13-3255	*Pish*	0	0	0
WH13-3257	*Pi1*	0	0	0
WH13-3259	*Pi5(t)*	0	0	0
WH13-3260	*Pi7(t)*		0	0
WH13-3261	*Pi9*		0	0
WH13-3262	*Pi12(t)*		0	0
WH13-3263	*Pi19*		0	0
WH13-3264	*Pikm*		0	0
WH13-3265	*Pi20*		0	0
WH13-3267	*Pita2*	0	0	0
WH13-3269	*Pi11(t)*	0	0	0
WH13-3270	*Pizt5*	0	0	0
IR65482-4-136-2-2	*Pi40*	0	0	0

BajoKaap 1		5 (S)	0	5 (S)
BajoMaap		0	0	0
Wengkhar Rey Kaap		0	0	0

Note: Poor Germination

Annexure 9.4: Assessment Key for leaf blast disease (Adapted from Standard Evaluation system for rice, 3rd Ed. June, 1988, IRRI)

0: No lesions
1: small brown specks of pinpoint size or larger brown specks without sporulating center
3: Small roundish to slightly elongated necrotic sporulating spots, about 1-2 mm in diameter with distinct brown margin or yellow halo
5-7-9: Narrow or slightly elliptical or spindle shaped lesions, 1-2 mm in breadth, more than 3 mm in long with brown, grayish, or bluish lesions without distinct margin or with brown, yellow or purple margin

Annexure 9.5: Number of RNR Staff and gewog officials trained on EFS

SI.No.	Dzongkha/Institute	No. of RNR Staffs Trained	No of Gup/Tshokpa trained
1	Pemagatshel	4 Agriculture staff	2 Tshokpas, 3 drop out students
2	Mongar	8 Agriculture staff	1 Tshokpa
3	Lhuntse	8 Agriculture staff	1 Tshokpa
4	Tashigang	8 Agriculture staff	3 Tshokpas, 1 Gup
		18 Agriculture staff	23 farmers
		2 Dzongkhag engineering staff	
5	Tashiyangtse	4 BPCL staffs	
		2 Dzongkhag electrical staffs	
		3 Municipal staffs	
		8 Agriculture & staff	4 Tshokpas, 1 mangmi & 8 farmers
6	Trongsa	6 Agriculture staff	2 Tshokpas
		3 Forest staff	37 farmers
7	Dagana	1 Agriculture staff	1 Tshokpa
8	RDC-Bajo	2 Research staff	
9	RDC-Bhur	2 Research staff	
10	RDC- Jakar	2 Research staff	
11	AMC-Paro	3 Technical staff	
12	RAMC-Khangma	1 Technical staff	

13	RDC-Yusipang	2 staffs	
14	NPPC	2 PP staff	
	TOTAL	**89 staffs**	**88 farmers/students/ tshogpas**

Annexure 9.6: Dzongkhag wise electric fencing establishment information

SI. No.	Dzongkhag	Location	Fence Length (km)	No. of beneficiaries households	Approx area protected (Acres)	Funded by	Amount (Nu)
1	Thimphu	Yusipang, Chang Gewog	1.6	7	21	RGoB & private	35000
		Sisina,Mewang Gewog	1	1	13	RGoB & private	100000
		Geney Gewog	1.5	1	19.5	RGoB & private	34500
2	Haa	Katsho Gewog	8	87	104	RGoB	210000
3	Punakha	Thinleygang	0.4	1	4.5	RGoB	31000
4	Trongsa	Trongsa Dzong	0.3	1	0	Mangdue chu project	20000
		Kaba &Daba, Nubi Gewog	6.5	21	80	RGoB	350000
		Jogthang	1.5	18	20	RGoB	70000
5	Sarpang	Latshakha, Singye Gewog	7	45	95	IDA & UNDP	420000
		Kamidara, Gakiling Gewog	1.5	9	20	RGoB	50000

6	Tashigang	Muktangkhar, Bartsham Gewog	4	17	60	RGoB & private	175000
		Nalung, Bartsham Gewog	4.5	18	70	RGoB & private	190000
		Tsebar, Bidung Gewog	7.5	67	95	MAGIP	250000
		Younphupam, Kanglung Gewog	8.5	120	110	MAGIP	350000
		Tonglingpam, Radhi Gewog	3	27	45	RGoB	100000
		Breng, Phongmey Gewog	2.29	20	51.3	MAGIP & RGoB	253000
7	Mongar	Phosorong, Mongar Gewog	0.8	1	5	RGoB	25000
		Shajola, Kengkhar Gewog	1.4	9	25	MAGIP	100000
		Atingkhar, Chaskar Gewog	1.8	30	30	MAGIP & RGoB	136600
		Gompa, Chaskar Gewog	1	4	10	RGoB	15200
		Silambi Gewog	1	5	13	RGoB	52500
8	Lhuntse	Jalang, Minjey Gewog	0.9	2	5	RGoB & private	25000
		Dragong, Minjey Gewog	0.9	1	2	RGoB & private	25000
9	T/yangtse	Litcheen, yangtse Gewog	2	14	28	MAGIP & RGoB	60000
10	S/jongkhar	Bhoney, Phuntshothang Gewog	6	34	80	RGoB	360000

11	P/gatshel	Wolungthang, Nanong Gewog	4	8	50	EU GCCA	163250
		Guyum, Changshin Gewog	2	35	30	EU GCCA	91200
		Yegur, Khar Gewog	4	18	45	MAGIP	182900
		Tshelingkhor, Zobel Gewog	3	38	40	MAGIP	150000
		Nanong, Nanong Gewog	3.6	37	45	MAGIP	180000
12	Zhemgang	Kikhar, Buli Gewog	2.2	28	25	EU GCCA	417000
		Gomphu, Tong Gewog	4	36	50		
TOTAL			**97.69**	**760**	**1291.3**		**4622150**

Annexure 9.7: Comparative advantages of ePests Surveillance System

Functions	**Electronic based pest surveillance system**
Built	Easy to carry and versatile/user-friendly
Speed	It is real time based and response could be within a day as all processes are computerized and analysis is programmed within the database
Reliability	Accurate real-time data can be captured and validation is possible anytime as the data is stored for future reference
Resource	Efficient use of the resources – as human resource and paper use involved is almost insignificant in comparison

Monitoring Frequency for data quality	Frequency of data collection will be high and hence data quality will be high in comparison. It is designed to provide **Time series data** for knowing pest development over time.
Factual information gathering for associated factors	The android device is designed to capture all environmental factors, geo-referenced points, soil conditions, NEs, and Crops for obtaining a holistic analysis of a pest complex situation.
Referencing accessibility, Utility and database function	Data captured is safe and secured and easily accessible at any point of time in future
Fixes Accountability	The GPS function and the additional color coding system generated automatically by the system ensure the accountability.

Annexure 9.8: Dzongkhag wise pesticide distribution(in litres and/or Kgs)

Products	B/thang	C/kha	D/gna	Haa	L/tse	M/gar	P/kha	Paro	P/sel	S/tse	S/pang	T/rang	T/gsa	T/gang	T/ytse	T/phu	W/due
Chlorpirifos20 EC	10.50	27.00	3.50	23.80	58.50	16.00	16.10	127.20	30.00	20.00	8.00	0.00	5.00	26.5	41.00	107.10	5.50
Cypermethrin 10EC	33.50	35.00	225.20	79.60	47.50	138.00	109.60	850.70	20.00	57.00	69.70	25.60	25.00	142.20	96.10	502.20	102.00
Dimethoate 30EC	1.00	100.00	171.20	0.00	0.00	26.60	7.00	39.00	0.00	10.00	31.30	9.50	27.00	29.40	13.50	65.30	11.40
Fenvelerate 0.4D	0.00	3.00	40.00	75.00	2.00	790.00	18.00	346.00	0.00	0.00	15.00	0.00	0.00	783.00	52.00	1030.00	0.00
Malathion 50EC	0.00	0.00	2.00	0.00	0.00	10.00	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	22.00	0.20
Captan 50 EC	7.00	0.00	0.00	59.00	5.00	0.00	0.00	27.50	0.00	0.00	10.00	0.00	0.00	0.00	13.00	24.00	0.00
Carbendazim 50 WP	13.25	1.00	0.00	2.75	0.00	0.00	0.5	244.00	0.00	20.00	0.00	0.00	0.00	25.25	217.50	0.25	0.00
Cu oxychloride 50WP	3.20	1.40	0.00	0.00	0.00	2.60	2.70	37.80	0.00	0.00	40.00	3.00	3.50	7.00	8.20	24.40	0.00
Hexaconazole 5 Ec	0.30	0.00	0.00	39.60	0.00	0.00	0.00	9.90	0.00	0.00	0.00	10.00	0.00	0.00	0.00	2.60	0.00
Mancozeb 75 WP	113.5	1.25	0.50	57.50	0.00	1.25	5.00	397.75	0.00	0.00	5.00	0.00	5.00	26.25	22.75	322.25	840.00
Ridomil 72 WP	3.20	0.00	0.00	0.00	0.00	1.70	5.00	34.00	0.00	0.00	0.00	0.30	0.50	7.70	0.00	9.10	320.00
Sulphor 80 WP	0.00	7.00	12.50	0.00	0.00	5.00	0.00	15.00	0.00	0.00	48.00	10.00	0.00	0.00	0.00	22.00	0.00
Tricyclazole 75 WP	0.50	0.00	0.00	0.00	0.00	0.00	1.00	10.50	0.00	0.00	1.00	0.60	0.00	0.00	4.00	0.00	0.00
Calcium hydroxide	0.00	0.00	0.00	0.00	0.00	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00
Copper Sulphate	0.00	0.00	0.00	0.00	0.00	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	0.00
Glyphosate 41 SL	1.00	18.00	34.50	0.00	0.00	51.00	0.00	395.50	0.00	1.00	35.00	124.50	80.00	0.00	0.00	95.50	2280.00
Metribuzin 70 WP	240.40	16.00	0.00	57.50	4.00	0.00	0.20	168.50	0.00	0.70	2.00	1.00	16.40	0.80	0.00	190.90	1213.70
Dicofol 18.5EC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.40	0.00
Zinc phosphide 80	0.54	0.15	4.53	2.82	3.55	3.19	3	7.45	0.00	0.00	0.1	2.30	0.01	5.67	4.60	5.3	3.6
Nim Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.10	0.00
Tree Spray Oil	14.00	0.00	0.00	327.00	0.00	210.00	0.00	4167.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4423.00	0.00
Sticker	0.00	0.00	159.00	6.75	0.00	0.00	0.00	67	0.00	0.00	5.00	1.25	3.25	0.00	0.00	49.75	48.00