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NATIONAL PLANT PROTECTION CENTRE
DEPARTMENT of AGRICULTURE
MINISTRY of AGRICULTURE & LIVESTOCK
SEMTOKHA



Vision Document 2040: National Plant Protection Program

The National Plant Protection Center (NPPC)



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Vision Document 2040: National Plant Protection Program

Towards Healthier Planet, People and Economy

The National Plant Protection Center (NPPC)

Semtokha, January 2023

“The principal task of a conductor is not to put himself in evidence but to disappear behind his function as much as possible,” Franz Liszt

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MESSAGE: DIRECTOR, DEPARTMENT OF AGRICULTURE

First and foremost, I congratulate the National Plant Protection Center (NPPC) for coming out with this vision document. Within the overall effort of transforming the work culture and radically improving performance and productivity of professionals and institutions, it is a timely document. The document has succinctly captured the necessary elements that will drive system's efficiencies by complementing and synergizing the performances of professionals. This perspective and the focus on processes and procedures towards generation of and rendering quality services that are aimed at achieving highest levels of standards is commendable.

Therefore, vision document has touched every aspect of improvement and enhancement, from organizational perspective to an individual professional's performance. The vision and hence, the utility of a document can be realized only when its essence is captured through implementation. As has been highlighted within the document, it takes more than NPPC to implement plant protection services successfully. It is only appropriate for me to urge all stakeholders to engage actively with NPPC in our effort to enhance crop production and to improve the livelihood of our farming communities. The document provides the necessary tools, guidance and platform to collaborate and cooperate for ensuring food and nutrition security. With optimism, I urge all our colleagues to go beyond the call of your duty to deliver whatever is possible within your capacity to contribute to the overall goal of nation building and specifically, to our agriculture development agenda.

My core message here is that the WILL to participate and engage actively must come from a cause that is greater than one's own profession or institution – a WILL that embraces greater goodness!

Thank You,

TASHI DELEK!



YONTEN GYAMTSHO

(DIRECTOR)

DEPARTMENT OF AGRICULTURE

MINISTRY OF AGRICULTURE AND LIVESTOCK

MESSAGE: PROGRAM DIRECTOR, NPPC

The importance of a vision document for the Center cannot be over emphasized. The value it provides to the growth and development of the Center as an institution and its professionals through networking, by way of engendering communication and collaborative activities is beyond description. It also presents a platform for viewing the importance of advancing the growth and development of National Plant Protection Center (NPPC) within the broader scope of growing international trade and economics (*e.g., WTO SPS, Codex Alimentarius*), contribution to science, sustainable development efforts (*Brand Bhutan in perspective – clean and green*), protection of bio-diversity and promotion of eco-tourism to mention a few.

Another striking feature is that through the vision document, seeking resources - technical and financial, and collaboration and cooperation with institutions from within the country or with institutions and professionals of the region or across international organizations is made significantly sounder. The insight and experience gained in networking (*particularly use of digital tools*) and the strength found in collaboration during this pandemic needs to be utilized further. Going forward, to further this networking and collaboration, and to reach wider audience, a particular area of focus will be in exploiting the potentials and possibilities provided by digital technology.

Within the context of the advancing solutions towards mitigating triple planetary crisis (*the crisis of: climate change; nature and biodiversity loss; and pollution and waste*), the plant protection program and its activities are exceptionally placed in educating and bringing awareness on the sustainable development efforts – agenda 2030, particularly in reinforcing the importance of protecting our natural capital of bio-diversity. These varying and varied functionalities provided by the vision document can only bear fruits if it is utilized in spirit of its presentation. Therefore, I would like to humbly urge everyone, who is convinced of its potentials, to take full advantage of this document.

Thank You,

TASHI DELEK!



YESHEY DEMA
(PROGRAM DIRECTOR)
NATIONAL PLANT PROTECTION CENTER

DEFINITIONS AND REFERENCES

Biocontrol

A pest control strategy that uses living natural enemies, antagonists or competitors of the organism being protected and other self-replicating biotic entities. (*World Health Organization & Food and Agriculture Organization of the United Nations. (2017). International code of conduct on pesticide management: guidelines for the registration of microbial, botanical and semiochemical pest control agents for plant protection and public health uses. World Health Organization. <https://apps.who.int/iris/handle/10665/259601>*)

Bio-pesticides (or Biological Pesticides)

A generic term generally applied to a substance derived from nature, such as a microorganism or botanical or semiochemical that may be formulated and applied in a manner similar to a conventional chemical pesticide and that is normally used for short-term pest control. (*World Health Organization & Food and Agriculture Organization of the United Nations. (2017). International code of conduct on pesticide management: guidelines for the registration of microbial, botanical and semiochemical pest control agents for plant protection and public health uses. World Health Organization. <https://apps.who.int/iris/handle/10665/259601>*).

The OECD programmes on **Biological Pesticides** or BioPesticides further categories BioPesticides to include **microbials** - bacteria, algae, protozoa viruses, fungi -, **pheromones** and semiochemicals, **macrobiols/invertebrates** such as insects and nematodes, and **plant extracts/botanicals**). <https://www.oecd.org/chemicalsafety/biological-pesticides.htm>

Botanical pesticide

Botanical pesticide ingredients are naturally occurring chemical derivatives of plants that act as repellants, attractants, antifeedants, and growth inhibitors. (Ngegba, P.M.; Cui, G.; Khalid, M.Z.; Zhong, G. *Use of Botanical Pesticides in Agriculture as an Alternative to Synthetic Pesticides. Agriculture* 2022, 12, 600. <https://doi.org/10.3390/agriculture12050600>).

OR

Botanical active substance

A botanical substance that consists of one or more components found in plants and obtained by subjecting plants or parts of plants of the same species to a process such as pressing, milling, crushing, distillation and/or extractions. The process may include further concentration, purification and/or blending, provided that the chemical nature of the components is not intentionally modified or altered by chemical and/or microbial processes. (*World Health Organization & Food and Agriculture Organization of the United Nations. (2017). International code of conduct on pesticide management: guidelines for the registration of microbial, botanical and semiochemical pest control agents for plant protection and public health uses. World Health Organization. <https://apps.who.int/iris/handle/10665/259601>*).

Climate Smart Agriculture (CSA)

CSA defined as agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces/removes GHGs (mitigation) where possible, and enhances achievement of national food security and development goals.

Codex Alimentarius

The Codex Alimentarius, or "Food Code" is a collection of standards, guidelines and codes of practice adopted by the Codex Alimentarius Commission to ensure that food is safe and can be traded. Veterinary drugs, pesticides, food additives and contaminants are some of the issues that are being addressed by the Codex. (Source: <https://www.fao.org/fao-who-codexalimentarius/en/>)

Food and Nutrition Security

Food and Nutrition Security exists when all people have, at all times, physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (*Definition by United Nations' Committee on World Food Security; reaffirmed definition at the World Food Summit, 2009*)

Food Security

"Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". (Source: *The State of Food Insecurity, FAO, 2001*)

Food Self-sufficiency

The concept of food self-sufficiency is generally taken to mean the extent to which a country can satisfy its food needs from its own domestic production. (Source: <https://www.fao.org/3/i5222e/i5222e.pdf>)

Food Self-sufficiency

Food Self-sufficiency is defined as, "being able to meet consumption needs (particularly for staple food crops) from own production rather than by buying or importing. (Source: <https://www.ifpri.org/publication/food-security-and-food-self-sufficiency-bhutan>)

Food Systems

Food systems embrace the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption, and disposal (loss or waste) of food products that originate from agriculture (incl. livestock), forestry, fisheries, and food industries, and the broader economic, societal, and natural environments in which they are embedded. (Source: *UN Food Systems Summit 2021*)

Integrated Pest Management (IPM)

Integrated Pest Management (IPM) means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human and animal health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms. (*World Health Organization & Food and Agriculture*

Organization of the United Nations. (2014). *International Code of Conduct on Pesticide Management* (FAO/WHO, 2014). <https://www.fao.org/3/I3604E/i3604e.pdf>.

IPM is an approach to manage pests in an economically viable, socially acceptable, and environmentally safe manner. (Surendra K. Dara (2019). *The New Integrated Pest Management Paradigm for the Modern Age*. *Journal of Integrated Pest Management*, (2019) 10(1): 12; 1–9). <https://academic.oup.com/jipm/article/10/1/12/548054>).

International Plant Protection Convention (IPPC)

The International Plant Protection Convention (IPPC) is an intergovernmental treaty signed by over 180 countries, aiming to protecting the world's plant resources from the spread and introduction of pests, and promoting safe trade. The Convention introduced International Standards for Phytosanitary Measures (ISPMs) as its main tool to achieve its goals, making it the sole global standard setting organization for plant health.

The IPPC is one of the "Three Sisters" recognized by the World Trade Organization's (WTO) Sanitary and Phytosanitary Measures (SPS) Agreement, along with the Codex Alimentarius Commission for food safety standards and the World Organization for Animal Health (OIE) for animal health standards. (Source: <https://www.ippc.int/en/about/overview/>)

International Standards on Phytosanitary Measures (ISPMs)

ISPMs are, international instruments, recognized by the members of the World Trade Organization (WTO) as international benchmarks for trade in plant commodities. These standards are applied in international trade under the Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement). The International Plant Protection Convention (IPPC) is the only internationally recognized standard setting convention for plant health. (Source: <https://www.fao.org/3/ca8476en/CA8476EN.pdf>)

Jigme Tenzin (2013). Status of IPM in Bhutan

Livelihood Securities

A **livelihood** comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term. (Chambers, R. & Conway, G. 1992. *Sustainable rural livelihoods: practical concepts for the 21st century*. IDS Discussion Paper No. 296. Brighton, UK, Institute of Development Studies).

Household livelihood security is defined as adequate and sustainable access to income and resources to meet basic needs (including adequate access to food, potable water, health facilities, educational opportunities, housing, time for community participation and social integration)". (T.R. Frankenberger and M.K. McCaston. (1998). *The household livelihood security concept*. CARE, USA. <https://www.fao.org/3/X0051t/X0051t05.pdf>.)

Livelihood system

A livelihood system is the total combination of activities undertaken by a typical household to ensure a living. Most rural households have several income earners, who pursue a combination of crop and livestock, farm, off-farm and non-farm activities in different seasons to earn a living. (Source: *Livelihoods, poverty and institutions* - <https://www.fao.org/3/a0273e/a0273e04.htm>)

National Plant Protection Program (NPPP)

The NPPP will include all stake holders in the agri-food system, from production to consumption, that impacts on crop production and crop protection.

Natural control

Natural control is the maintenance of a more or less fluctuating population density of an organism within certain definable upper and lower limits over a period of time by the actions of abiotic and/or biotic environmental factors. (M. W. Johnson (2000). *Biological Control of Pests*, ENTO 675, UH-Manoa, Fall 2000. <https://ucanr.edu/sites/W2185/files/109428.pdf>).

Nationally Determined Contributions (NDCs):

Nationally Determined Contribution, is a climate action plan to cut emissions and adapt to climate impacts. Each Party to the Paris Agreement is required to establish an NDC and update it every five years. NDCs represent the commitments of each country to reduce greenhouse gas emissions and adapt to climate change. They were agreed to by countries during the Climate Change Conference of the Parties (COP) in Paris in 2015, a commitment known as The Paris Agreement. <https://www.un.org/en/climatechange/all-about-ndcs>; and; *Pocket Guide to NDCs under the UNFCCC*. <https://transparency-partnership.net/system/files/document/Pocket%20Guide%20to%20NDCs.pdf>.

Pest

Pest means any species, strain or biotype of plant, animal or pathogenic agent injurious to plants and plant products, materials or environments and includes vectors of parasites or pathogens of human and animal disease and animals causing public health nuisance. (*Integrated pest management of major pests and diseases in Eastern Europe and the Caucasus*, FAO (2017).

OR

Pests

Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products. Note: In the IPPC, “plant pest” is sometimes used for the term “pest”. (ISPM 05)

Pesticide

Pesticide means any substance, or mixture of substances of chemical or biological ingredients intended for repelling, destroying or controlling any pest, or regulating plant growth. *International Code of Conduct on Pesticide Management: Guidelines on Highly Hazardous Pesticides*, FAO (2016).

Pesticide management

Pesticide management means the regulatory and technical control of all aspects of the pesticide life cycle, including production (manufacture and formulation), authorization, import, distribution,

sale, supply, transport, storage, handling, application and disposal of pesticides and their containers to ensure safety and efficacy and to minimize adverse health and environmental effects and human and animal exposure. *International Code of Conduct on Pesticide Management: Guidelines on Highly Hazardous Pesticides*, FAO (2016)

Pest Surveillance

Surveillance is an official process which collects and records data on pest presence or absence by survey, monitoring or other procedures. *International Standards for Phytosanitary Measures (ISPM) – 05* (2018).

Supply Chains

A supply chain is an entire system of producing and delivering a product or service, from the very beginning stage of sourcing the raw materials to the final delivery of the product or service to end-users. The supply chain lays out all aspects of the production process, including the activities involved at each stage, information that is being communicated, natural resources that are transformed into useful materials, human resources, and other components that go into the finished product or service. (Source:

<https://corporatefinanceinstitute.com/resources/knowledge/strategy/supply-chain/>)

Sustainable Development Goals (SDGs):

(<https://sustainabledevelopment.un.org/topics/sustainabledevelopmentgoals>)

World Trade Organisation (WTO)

“The World Trade Organization (WTO) is the only global international organization dealing with the rules of trade between nations. At its heart are the WTO agreements, negotiated and signed by the bulk of the world’s trading nations and ratified in their parliaments. The goal is to help producers of goods and services, exporters, and importers conduct their business”.

(Source: https://www.wto.org/english/thewto_e/whatis_e/whatis_e.htm)

WTO Sanitary and Phytosanitary (WTO SPS)

It concerns the application of food safety and animal and plant health regulations to protect human, animal or plant life or health.

For the purposes of the SPS Agreement, sanitary and phytosanitary measures are defined as any measures applied:

- to protect human or animal life from risks arising from additives, contaminants, toxins or disease-causing organisms in their food;
- to protect human life from plant- or animal-carried diseases;
- to protect animal or plant life from pests, diseases, or disease-causing organisms;
- to prevent or limit other damage to a country from the entry, establishment or spread of pests.

These include sanitary and phytosanitary measures taken to protect the health of fish and wild fauna, as well as of forests and wild flora. (Source: https://www.wto.org/english/tratop_e/sps_e/spsund_e.htm)

WTO Technical Barriers to Trade Agreement (WTO TBT)

WTO TBT is a mechanism to ensure that technical regulations, standards, and conformity assessment procedures (testing and certification procedures) are non-discriminatory and do not create unnecessary obstacles to trade”. (Source: https://www.wto.org/english/tratop_e/tbt_e/tbt_e.htm.)

However, the agreement also recognizes countries’ rights to adopt the standards they consider appropriate — for example, for human, animal or plant life or health, for the protection of the environment or to meet other consumer interests. (Source: https://www.wto.org/english/thewto_e/whatis_e/tif_e/agrm4_e.htm#TRS)

EXECUTIVE SUMMARY

The introductory part of the National Plant Protection Program Vision Document 2040 provides the setting for the national plant protection program activities within the overall agri-food system. As is the nature of pest management activities, the approaches (integrated pest management - IPM) taken has given particular attention to food security and safety; and biodiversity and environment, while highlighting on the issues of technological relevance to adoption.

The next four sections provide a framework and a firm management grounding based on broader perspectives, for both technical and non-technical aspects of plant protection. This is done to identify the subtleties that exists within the technical and non-technical domains and to take actions that will complement and synergize the professional and institutional potentials towards achieving the goals set, for professionals, programs and NPPC as an institution.

The following sections, VI & VII, provides vision and mission statements for clearly communicating on the priorities, direction and focus of the activities, and the mandates that is required for fulfilling the goals set. For realization of the goals set, it is vital that stakeholders are identified, understood and engaged. It is also imperative that within the plant protection institution, NPPC, strategic actions are taken to bring out the professional (both technical and non-technical) and institutional potentials for providing quality plant protection technologies and services that is pragmatic for adoption. Section VIII and IX highlights on these aspects.

After establishing the required ecosystem and paraphernalia for taking action, the last part, section X details out the action areas at 3 different levels of policy, operation and implementation to achieve results that is desired. This part is the heart of the vision document. Within the NPPC for rendering harmony and synergy (ease-of-doing-business approach) management structures with functions are identified. This is complemented with streamlined planning processes, framework, and action areas that is connected with expected outputs, impact and outcomes. Overall, the vision document captures all aspects of plant protection activities and ties with the expected output, impact and outcome from local to national levels.

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The National Plant Protection Program Vision Document

“What man really fears is not so much extinction, but extinction with insignificance,” — Ernest Becker

I. INTRODUCTION

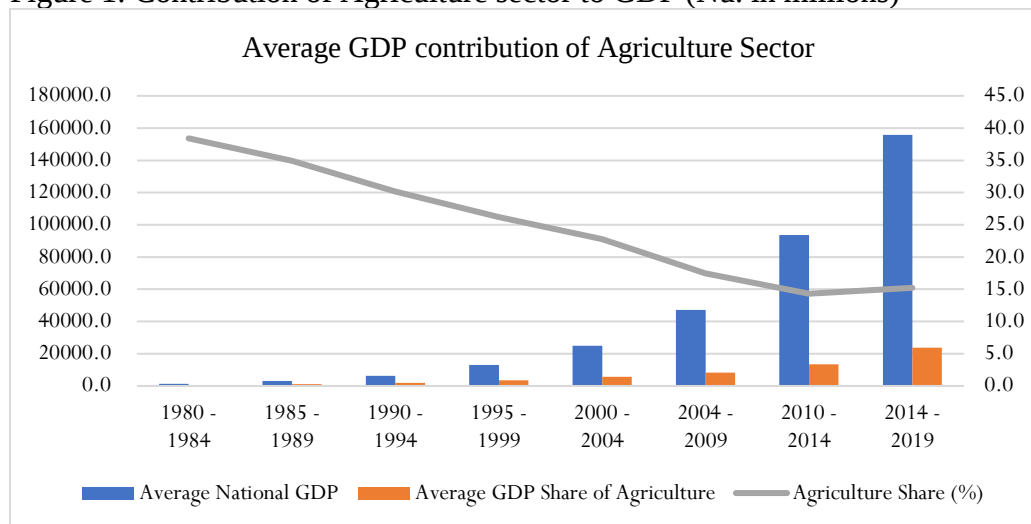
A. The General Background

Pest emergence, in the form of endemic (*including new and emerging pests*) or exotic (*non-native*), limit crop production by causing crop losses, notwithstanding the effect of climate change on: crops (*affecting factors such as inherent tolerances due to abiotic stresses*), pests (*impact on epidemiology and pest status*) and the dynamics between them. The evolving management practices (*intensive, both in terms of inputs and cropping practices*) will also change the equation of pest epidemiology and management.

“By farming, humans create an ecological niche which is favourable to plant growth and accumulates primary resources. Many organisms including plants, insects, nematodes, fungi, bacteria, and rodents compete with humans over the exploitation of this niche. These organisms – pests in the generic sense – decrease yields, reduce product quality, spoil or destroy harvests. Their irregular occurrence, often linked to climatic conditions, combines with year-to-year climate differences to create large variations in the outputs of crops. These irregularities can disrupt farming economy and, historically, have been a major cause of famines”, (*Pierre Ricci, 2010: European Crop Protection in 2030*).

Given the mountainous ecosystem with vastly varying microclimatic conditions, the challenges of climate change and pest occurrences could translate into detrimental outcomes to the rural population. Almost 50% of the population (*Labour Force Survey Report of Bhutan - LFSR, 2021*) is dependent on agriculture and close to 70% of rural population (*LFSR, 2021*) is employed in agriculture sector. This indicates that the livelihood securities of rural population and the rural economy are inextricably linked with agriculture.

Figure 1: Contribution of Agriculture sector to GDP (Nu. in millions)



Source: Statistical Yearbook of Bhutan (SYB), 2020

The total contribution of agriculture to GDP is recorded at 19.23% with crop sector contributing 10.88% (*National Accounts Statistics, 2021*). This also underlines the importance of agriculture sector in the national economy. In real terms, the GDP contribution from agriculture has been consistently on the increase for more than 4 decades (figure 1). These contributions from agriculture sector suggest that agricultural production has been and will be a major source of revenue for the country. But most importantly, it will remain as a major livelihood source delivering the ever changing livelihood securities (*including food and nutrition security needs*) for the farming communities.

In the crop sector, a major constraint to increasing production is losses attributed to pest organisms, which accounts to 20 to 40 percent (FAO, 2019). Therefore, for improving and sustaining production and productivity from crop sector, *ceteris paribus*, will require reducing preventable losses to pest organisms. With increasing commercialization efforts, the traditional mixed cropping systems will evolve in favour of monoculture and intensification activities with higher input to increase production and productivity. This will invariably change the dynamics between pests and crops, noting the climate change impacts, requiring more investment (*knowledge, skill, technology, finance and other resources*) in crop protection efforts.

Additionally, as the agri-food industry advances, farmers will be challenged with food safety and quality standards requirement, environmental concerns, food aesthetics including tastes, packaging, and design. As their market value chain advances, they will be necessitated to fulfill regulatory requirements of export (*at export level WTO SPS/TBT requirement; and national regulatory requirements in domestic market aligned with regional and international food safety and quality standard requirements – Codex Alimentarius*) and consumer preferences at the same time. This is where the relevance and need for IPM approach to pest management comes into focus, complementing regenerative agriculture approaches and facilitating the biogeochemical processes – contributing to not only mitigating food safety and quality concern aspects, but at the higher level contributing to climate change mitigation efforts.

Integrated Pest Management (IPM) is being adopted widely as a sustainable approach to pest management (*FAO, since 1966; United States Department of Agriculture (USDA) in 1977; European Legislation – EU 2009b*) since the introduction of Integrated Control concept in 1959 for insect pest management by four Californian entomologists. In Bhutan the second phase EU project, the IPM Development Project (IPMDP - *ALA/92/12, 1 November 1993*) that extended from 1993 to 2000, had formally initiated the IPM activities for managing pests. In the 12th five year plan, the GNH development framework integrating the SDGs had provided the policy platform to further advance IPM approaches towards reducing risk of synthetic pesticides to human and animal health and the environment - advancing the guiding principles of sustainable development goals (SDGs) - *a healthy planet, people and their prosperity*.

Within the climate change landscape with agri-food industry as both a source and sink of greenhouse gases (GHG), the implementation of IPM principles and practices are more necessary than ever before. Additionally, against this backdrop and in tandem with evolving socio-economics, changing farming system, and cropping system and practices, sustaining crop production and productivity is a major concern. From the plant protection perspective, sustaining

crop production and productivity will require adoption and implementation of IPM principle, methods and practices. This method will require involvement and engagement of more than training and education of farmers – consideration on socio-technical components of the agri-food system (*policy and decision makers, researchers and extensionists, agri-entrepreneurs, producer association/ groups or cooperatives, agri-business support services, consumers and so on*). Therefore, the broader goal of this vision document is to:

- ❖ Provide a platform for harmonizing and making plant protection activities coherent to agri-food industry and that of higher level national development goals and agendas.
- ❖ Provide an overall architecture of plant protection program providing focus and direction as elucidated through its vision and mission statements, strategic policies, mandates and plant protection services;
- ❖ Serve as a guide to management and plant protection professionals; and
- ❖ Facilitate knowledge-based adoption of IPM technologies by farmers for sustainable crop production.

Efforts are made through this vision document to highlight, explicitly or implicitly, on the interdisciplinary nature of agri-food chain to add value on every effort made, and services and supports rendered to reduce risk of crop production losses to pest organisms.

B. The IPM Approach

Traditionally, crop production under the subsistence farming system with integrated mixed cropping and with low levels of inputs, barely required plant protection intervention. Over the years as demand on food increased, agriculture commercialized. Efforts towards increasing profitability from crop sector led to intensification of inputs (*particularly synthetic pesticides and inorganic fertilizers*), adoption of high yielding varieties, and focusing on improving productivity (*through monoculture and density planting*) to highlight on a few. As a result, pest attacks and losses to pest organisms have become much more routine and regular.

The labour shortage on the farm and focus on profitability has invariably led to adoption of easier means of pest management – application of synthetic pesticides to control pest. Studies (*for instance, the pesticide resistance observed in Woolly apple aphid and Red Spider Mite in Paro and Thimphu in the 1990s, and brown plant hopper (BPH) (Nilaparvata lugens) story of Indonesia and elsewhere in Asia*) have indicated health, environmental and biodiversity concerns. Many such observations had triggered adoption of IPM approach as a pest management tool across the globe.

Learning lessons from elsewhere, since the early 1990s, the National Plant Protection Center (NPPC) has adopted the IPM policy approach to pest management. Through this vision document, the NPPC will further elucidate on IPM policy approach and provide the necessary policy guidance, strategic view and direction, and implementation focus. For providing clarity, an approach to implementation of IPM activities is presented in a pyramid fashion (Figure 2).

It must be emphasized that IPM technologies and approaches have two facets: the technical pest management aspect; and the other aspects of pest management relating to socio-economics, health

and the environment. For understanding both these aspects clearly and to generate an IPM technology that addresses both these aspects, a robust system of pest information and R&D are essential. These two basic aspects underline all activities at the 3 different levels of the IPM pyramid. Therefore, gathering quality pest information and carrying out robust IPM R&D are vital at all these 3 levels for generation of IPM technologies, and their dissemination. It means (*within the given conditions*) knowing the pest, looking for means to manage it, and delivering these means to a farmer to manage the pest. The color coding of the 3 levels generic interventions of the IPM pyramid is used as a means to caution all the stakeholders engaged or involved in the plant protection activities (*in particular the PP professionals, extensionist, and farmers*) on the consequences of the “approach and action” chosen to manage a pest organism(s). (*Green: safest; Blue: next preferred option with high level of safety; Yellow: last option involving limited risk*).

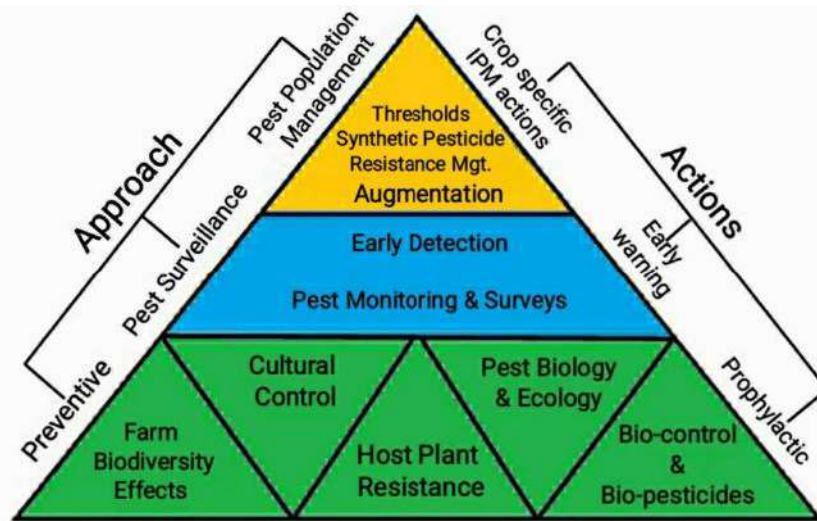


Figure 2: Modified from IPM Pyramid, Naranjo, 2011

Following the general pest management guideline of IPM pyramid, the lowest level (*green color*) interventions require intelligent use of all prophylactic measures (*such as selection of tolerant or resistant varieties; natural control and augmentation; crop health aspects – plant density, water & nutrition, weeds management; and so on*). The next level (*blue color*) interventions require regular plant health and pest monitoring activities to effect early interventions to realize flattening of curve on pest development. This is where regular pest surveillance and monitoring activity becomes a vital service – to achieve early pest detection, risk identification and communication through early warning system, resulting in early management activities – a core concept in Pest Risk Identification and Management (PRIME) approach – *activities include routine monitoring, surveys, diagnostics, early warning and implementation of preventive measures (a concept adopted from PRIME project of Philippine Department of Agriculture (DA) & International Rice Research Institute - IRRI)*.

The top level IPM pyramid interventions focusses on integrating different options available in the IPM toolbox to manage pest population at an acceptable level in a given situation, when capacity of natural and/ or preventive measures are not adequate enough to keep the pest population below the economic injury level. The higher goal behind this pyramid approach is to minimize risk from

use of synthetic pesticide, and to foster a safe and sound ecosystem for sustained economic outcomes for farmers and society at large.

For achieving effective pest management action, three key elements are considered important. They include: a) risk assessment under the given conditions of crop management; b) availability of resources; and c) value of the crop or crop product. These three aspects are vital while considering IPM options for decision making. The IPM pyramid could be called pest management decision making tool or tree.

II. A STRATEGIC PERSPECTIVE

*“The principal task of a **conductor** is not to put himself in evidence but to disappear behind his functions as much as possible”* Franz Liszt

Before even delving into the core essentials of this vision document, a strategic perspective as a preamble to this document is provided. The aim of this perspective is to present a general approach that will provide the coherence required for translating the vision and mission statements into policy objectives. This would then cascade seamlessly into planning and execution of operational and implementation level activities. With such an approach adopted, actions taken at any decision making levels, broad or specific, could be reviewed and revised as progress is made.

In general, this is viewed critical because actions taken at any level will have direct and cascading effect down the value chain on growth and development of: institutions, professionals, services, and thereby on their outcomes – growth and development of agri-food industry (*which includes our farming families and communities, supply chains, products and market, and so on*).

The approach here has adopted 3 broad levels of decision making (*policy, operational and implementation levels*) processes with clearly defined functions which are required to be performed to meet the vision and mission goals. Therefore, the scope of this approach is to provide insight into “actionable areas” at these 3 distinct decision making levels to improve and enhance system’s efficiencies, beginning at the policy level. The underlying aspiration here is to better support, engage and interact with each other, both vertically and horizontally, while rendering developmental services, in this case, plant protection services to improve services and reduce costs.

In a nutshell, the goal of this brief preamble is to provide an understanding of the underlying causes of challenges (*“Whys”*); identify system level changes required to address them (*“Whats”*); and guide interventions that can bring about sustainable changes (*“Hows”*).

The 3 broad levels of decision making levels considered are:

A. Strategic Level – Policy Level

Crop loss to pest organisms (*Problem*) is a function of direct and indirect impact of crop protection services and system’s efficiencies (*2 major challenges*). Therefore, to improve and enhance a system’s performance in general and that of plant protection services in particular, strategic actions are required. Following this approach, the strategic aspects like vision, mission and policies for strengthening the plant protection program are taken into consideration. They will become the basis for developing any plans, making decisions or taking any implementation actions along the value chain related to plant protection activities.

B. Operational Level – Managerial Level

Through the overall understanding of vision, mission and policy outcomes and directions, at the operational level, an operation action plan will help advance the mission goals that will have a significant bearing at the implementation level. Through an operational action plan, management activities could be aligned for enhancing institutional and professional performances and productivity (*upgrading and strengthening capacities & capabilities*,

networking, and so on); resources required could be mapped including finance & ICT; actions planned with time frames determined; and indicators reflected for assessing specific and overall outcomes. It's all about facilitating and harmonizing (*required resources and ecosystems necessary*) activities of every professional and operational unit to function as "one organism" at its maximum potential. This entails a strong networking and collaboration, preferably within a formalized professional platform.

C. Implementation Level – Field Level

Implementation of activities concerns the operationalization of action plans with goals and targets in sight, committed resources and with functional linkages and collaboration. This level concerns tactical decisions in the field, on prioritization of activities and resources that are necessary based on field facts. This implies that a calendar of activities with clearly defined roles and responsibilities and time lines - such as the answers to *whats, whens, and whos*. The activities here will cater to the specific policy objectives as a translation of the mission statements that are in alignment with strategic goals and outcomes of plant protection program and/ or specific work-plans.

From a strategic vantage point, partitioning action areas into 3 distinct functional and management zones (*not that they are exclusively separate functions*) will invite opportunities for taking actions that will harmonize activities and complement system's efficiencies. Communicating this through a vision document will provide a common platform for understanding of and direction to all and any plant protection activities. On the other hand, understanding this connection and processes will provide the necessary information to source and commit resources for advancing plant protection development activities.

For instance, for making policy decisions in the areas of advancing infrastructures, institutions, capacities, standards, necessary platforms (*internal information exchange*) or networks (*internal and external collaborations and linkages for technical exchanges*), specific information required could be captured. For clarity and in support of this perspective, a strategic framework (*under Section VIII*) is provided with a brief elucidation.

Therefore, the outcome expected through this vision document is a wider level understanding of and communication on plant protection program and its activities. This encompasses the vision and mission objectives, policy goals to the plant protection activities (*activities from R&D to pest management in the field*). This presentation is deliberate for garnering support and collaboration while advancing plant protection service development.

III. PRINCIPLES GOVERNING THE VISION

The vision document is grounded in four basic principles for ensuring a long term sustained growth and development of plant protection program and its activities, and to contribute meaningfully to the advancement of agri-food industry. However, the benefits accrued to the system from the enhanced capability and competencies of professionals and that of institutions as a result will go beyond the direct services rendered. Therefore, these principles are presented to provide a stable grounding to the vision, mission goals and objectives within this vision document.

A. Aligning growth and development of Professionals and Institution with the 21st century challenges

Agri-food industry is becoming ever more important, not just for socio-economic development goals, but it is inextricably linked with the human health and that of the environment (the triple planetary crisis in perspective: climate change; nature and biodiversity loss; and pollution and waste). The challenges and opportunities could only be better understood and addressed through competent professionals and institutions with all the requisites of the 21st century. Within the context of presenting Brand Bhutan agriculture products and services to the world, it is vital that such needs are identified and addressed for grooming and nurturing competent professionals and institutions in the whole agri-food industry value chain - plant protection technologies and services in this case.

B. A harmonized development approach to harness the potential of a system

Often times a system is not able to harness the capacities and capabilities of professionals and institutions and vice versa as a result of issues with development approaches and its communication. It is seen vital that development approaches and processes are made clear and communicated so ambiguities could be taken care wherever and whenever they occur. This document attempts to address these shortcomings.

C. Pursuing efficiency in resource use - financial and human capital

As mentioned elsewhere, one of the core principles of this vision document is to provide us with a clear cut guide that will enable us to deliver our services without duplication of efforts or getting our priorities incorrect or wrong. Through this document, harmonization of activities and roles and responsibilities are expected. This is quintessential for plant protection program to meaningfully contribute towards the growth and development of agri-food industry.

D. Development of ecosystem for a sustained performance and productivity

For translating the competencies of professionals and institutions into sustained performance and productivity (*knowing Science, developing Technology and Innovating solutions - STI*) an ecosystem of nurturance (mentoring) with protocols, standards, processes, goals, timelines and targets are required within a set of shared values (*core being - leadership, professionalism, integrity and so on*) are necessary. The return on investment accrued will have a substantial impact on emergence of our professionals and institutions as leaders in their own field. This will invariably lead to implementation of strong R&D

activity in the country, enabling us to meet the global standards at ease. The cascading effect of collaborations and cooperation with R&D institutions in the region and also from specific institutions from across the globe will be a natural outcome. The net gain will be agricultural productivity with ripple effect across allied sectors and business enterprises including supply chains and markets.

IV. THE PLANT PROTECTION SERVICE APPROACH

“Viewing Plant Protection Services (PPS) as a Business Development Service (BDS)”

For all the different roles an agriculture enterprise plays (*implying farms here, whether in their commercial or livelihood roles - from food and nutrition security to food self-sufficiency goals, and from income and employment generation, to meeting NDC requirements, bio-diversity, food safety standards and so on*), it is imperative to view farming, both farm and off-farm activities, as a business enterprise. This shift in perspective will provide the necessary ambience for viewing **agriculture development services as agri-business development services**. As a result product development (*value addition*), market information, marketing and all the other paraphernalia necessary for enhancing agricultural productivity (*through agri-food industry development initiatives and activities*) will become the center of attention and focus. This will create demand on agricultural development services (*plant protection services*) as demonstrated in figure 3.

For instance, with new markets or value added products identified and promoted, the adoption of a plant protection technology, its innovation and utilization will invariably depend on the absorptive capacity of the clientele (farmers/producers/entrepreneurs) as influenced by demand on services (*business development supports services including product development, market, and finances*); farms being considered as business enterprises. Figure 3 demonstrates the importance of understanding the process flows and connection for creating and rendering a demand-driven agri-development services.

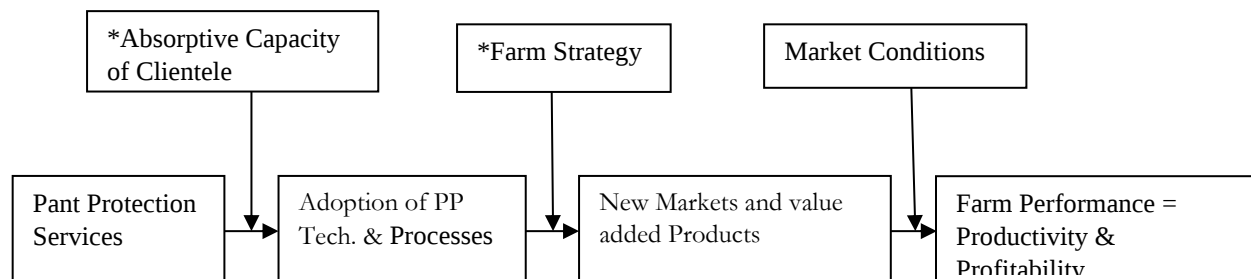


Figure 3: Adapted from, “A long causal chain of connections” by Kevin Mole, (2018)

(*Absorptive capacity - is a function of business development services)

Figure 3 also demonstrates the importance of realizing impact of business ecosystem outcomes (*implying mainly *business development services*) on translation of technology(-ies) into returns (*expressed in terms of “reduced losses of crops to pest organisms” here*). This shift in perspective is considered imperative for advancing the demand-driven pull on agricultural development services.

This perspective and focus is taken to leverage a demand-driven agricultural service provision; for the plant protection program, it is to leverage demand on plant protection services. Within this broad agri-food industry development perspective, the plant protection program’s vision and mission are drawn.

V. NATIONAL PLANT PROTECTION PROGRAM STRATEGIC FRAMEWORK

From the overall national economic development perspective, the strategic frame could apply to the government of the day's development vision, mission and implementation imperatives. From a sector's perspective, in this case it falls within the vision, mission, mandate and implementation priorities of the Ministry of Agriculture and Livestock (MoAL), and more specifically within the Department of Agriculture's development concern areas. However, here as it is a National Plant Protection Program Strategic Framework, this framework will provide insight into NPPC's approach at the 3 levels of decision making: Policy, Operation, and Implementation, as an extension and translation of the Strategic Perspective presented above into a framework. But the cascading effect of the two higher levels, national and sector levels cannot be ignored.

Therefore, the purpose of this framework is to serve as a referential and a guiding tool that will help in implementation of plant protection program activities. It will, therefore, help in gathering information and getting insight into understanding and identifying bottlenecks. In general, the benefits of such a framework could include: (a) identifying bottlenecks to pp service delivery and resources (*challenges and their causes at system, institutional, professional and their interactions levels*); (b) presenting prospects for improvement and change; and (c) enabling lasting changes in the system, as stated above. Hence, the framework will support in planning and implementation of plant protection program activities and beyond.

Specifically, this strategic framework will serve as a basis for developing Operational guides and Implementation frameworks in reference and relevance to the policies specified in the vision document. Therefore, the framework will enable in keeping the harmony between the policies and the operational & implementation activities. It will also provide the platform required for addressing issues at different decision making levels and in turn guide in performance assessments at institutional and professional levels.

The vision document with its strategic framework will make it a key driver of all plant protection activities. This is because initiatives leading to policy reforms, institutional and professional developments, technical initiatives and technological innovations, and improvement and enhancements in process flows of pp services are all captured. In a nutshell, the strategic framework will throw light on "Where to do what, by whom, and at what levels" to achieve the vision goals and mission objectives (Figure 4).

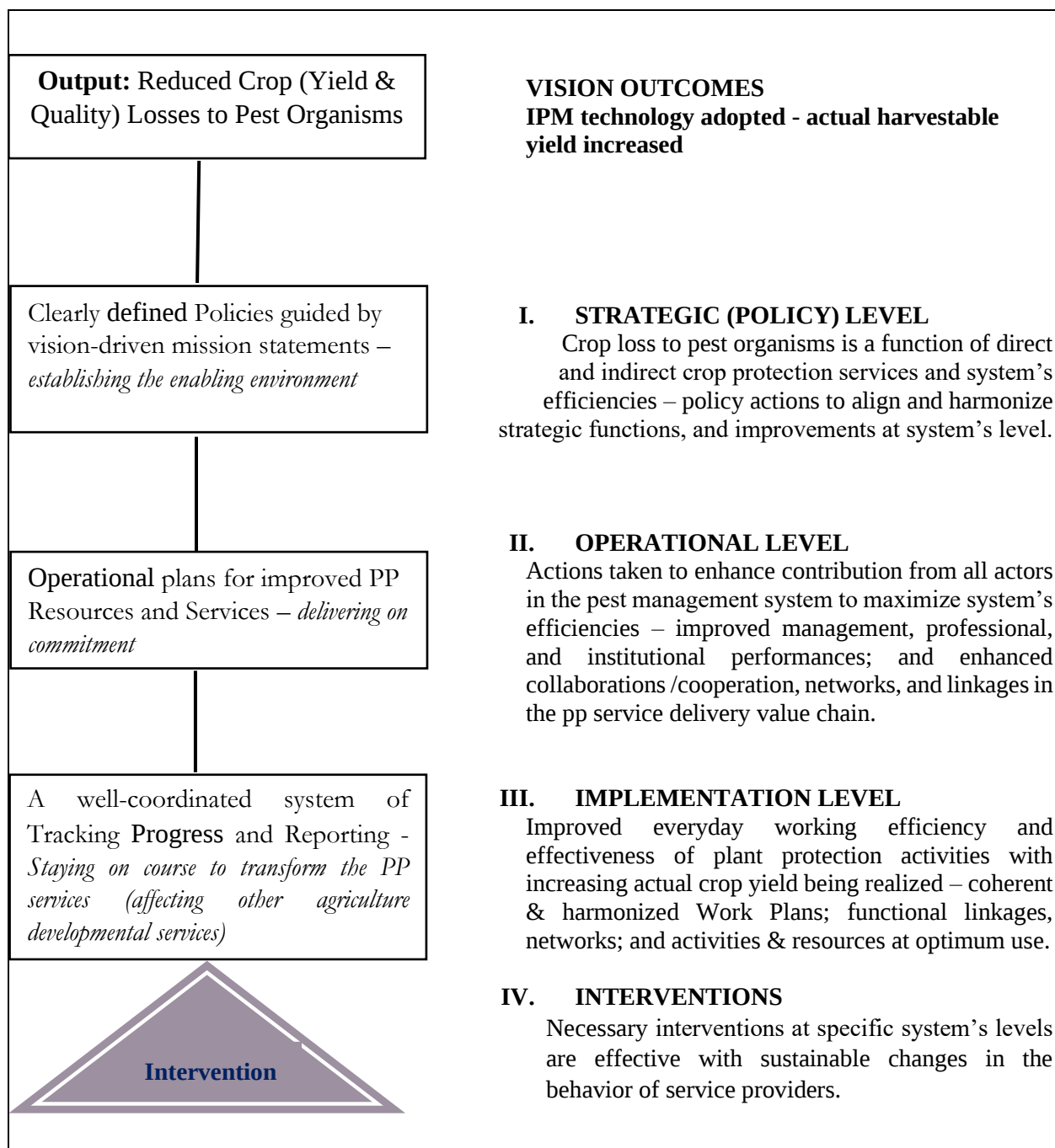


Figure 4: Strategic framework for Plant Protection Program Implementation (The concept and illustration is adapted from M4P – The Operational Guide for making Markets work for the Poor (M4P) Approach – Red Book).

VI. THE VISION AND MISSION STATEMENTS

Bhutan, like other countries across the globe is going through a period of economic vulnerability caused by a combination of contributing factors like increasing impact of climate change, and other global concerns impacting on economic growth (*like global pandemics, political issues, and other economic vulnerabilities associated with cyber-security, digital gaps, crypto-currency issues and so on*). Against these spectrum of developmental challenges, sustaining food production; ensuring access, availability, and affordability to nutritious food; and improving employment are few very important development agendas faced by countries across the globe without exception.

The other side of this challenging time is characterized by rapid growth in the domain of science, technology and innovation (STI) enhanced by development in ICT (*information communication technology*). As a result, like in other industries, the services under agri-food industry in Bhutan is experiencing rapid growth influenced by digitalization - from production to market and consumption. Like many other developmental services, for supporting the emergence of and sustaining a robust agri-food industry, delivering quality services in time and space at required quantity is critical. From the National Plant Protection Program perspective, provision of quality pp services in time and space in required quantity is vital for supporting sustainable crop production. For delivering on these aspiration a clear vision and mission statement is most vital that is able to guide the growth and development of plant protection services. Therefore, the heart essence of this vision document, the vision and mission statements are outlined below:

A. VISION

Towards realizing sustainable crop production goals, Bhutanese farmers adopt and incorporate Integrated Pest Management (IPM) principles and practices in their daily farming activities to reduce preventable losses of crops to pest organisms within 15% by 2040.

B. MISSION

Following the principles and practices of IPM, the NPPC will strive to reduce crop losses below 15% by 2040. Towards achieving this vision goal, the NPPC will improve the competencies and capacities at the institutional, professional and plant protection service delivery levels as outlined below:

1. Institution Level

- i. Improve the credentials of professionals and NPPC as a national premier institution for all plant protection activities.
- ii. Provide adequate training and education on IPM principles and practices to Extension personnel, farmers and other clientele through utilization of digital tools and platforms in addition to hands on training onsite.

- iii. Mainstream pest surveillance and monitoring activities in work-plans of NPPC, regional PP programs, and Dzongkhag Extension.
- iv. Carryout periodic review of crop losses to pest organisms and set targets for achieving the targets set.
- v. Institute and implement Rapid Response Mechanism to mitigate risks of pest epidemics (*mechanisms for risk assessment, communication and management*) in collaboration with the ARDCs and the National Extension System.
- vi. Provide appropriate pest and pest management information for early warning to effect early response for pest management by farmers - in both epidemic and endemic situations.
- vii. Utilize recent advances in science and technology through digital tools and platforms to effectively advance IPM activities related to pest monitoring, diagnostic, R&D, and management.
- viii. Institute and implement Rapid Response Mechanism to mitigate risks of pest epidemics (*mechanisms for risk assessment, communication and management*) in collaboration with the ARDCs and the National Extension System.
- ix. Assess risks as per international standards and guidelines (*regarding WTO SPS, Codex Alimentarius, and plant protection products*) as and when called for.
- x. Reduce risk and reliance on synthetic pesticides.
- xi. Institute professional platforms for promoting regular professional exchanges and deliberations, including mentoring.
- xii. Promote professional code of conduct and standards (*such as professional work ethics, integrity, leadership and so on*) in all spheres of plant protection activity.
- xiii. Be responsible for providing policy and strategic level advisory services to the Royal Government in matters of crop protection.
- xiv. Whenever necessary, undertake reviews and revisions of the vision document and plant protection related standards, legislations and so on.

2. Professional Level

- i. Advance IPM R&D and develop and package crop specific IPM technologies, methods and techniques that are friendly for adoption by farmers.
- ii. Promote bio-pesticides and mass produce biological control agents for release in farmers' fields to augment and conserve natural control mechanisms.
- iii. Institute mentorship program through professionally designed mentoring activities at all levels of plant protection profession.
- iv. Co-create conducive working environment and foster comradeship among professionals.

- v. Follow standard operating procedures (*protocols, standards, guidelines*) in all plant protection activities (*for instance, for testing plant protection product efficacy testing, data collection, survey and sampling and so on*)

3. Plant Protection Service Delivery Level

- i. Standardize and harmonize the delivery of plant protection services and plant protection products for maintaining and improving access and quality aspects.
- ii. Utilize digital technology in all plant protection activities, including plant protection service delivery mechanisms, networking across and between professionals and so on.
- iii. Improve and enhance collaboration, coordination and cooperation in plant protection activities.

VII. MANDATES

Towards developing a robust plant protection services in the country in coherence with IPM principles and practices, and in conformity with the vision and mission objectives, the National Plant Protection Center (NPPC) is mandated to:

A. The NPPC as Apex Plant Protection Body

1. Function as the national referral and coordinating body on matters concerning plant protection (pp) activities in the country (*for instance, being responsible for development and/ or review and revision of vision documents, plant protection policies (on R&D, Pest Information System, PP Products, PP Information dissemination system, and so on), rules and regulation, advising government on matters of plant protection, except quarantine, whenever and wherever required and so on*).
2. Develop professional competency and institutional standards (*progressing towards accreditation*) to carry out plant protection activities (*research, diagnostics, extension, training and so on*) progressively and confidently.
3. Improve and enhance pp service delivery mechanisms and professional ecosystems.
4. Function as a national repository Centre for all information regarding crop pest organisms.
5. Liaise and coordinate all pp activities, both in-country and with international agencies, organizations, and/ or institutions
6. Undertake necessary initiatives to mobilize resources and develop mechanism to create demand on pp services.

B. The NPPC as Technically Competent Authority

In the role as the technically competent national authority in matters of plant protection, the NPPC will:

7. Lead, coordinate and harmonize all pp activities in the country, including R&D, diagnostics, pest surveillance and pp products.
8. Advance IPM R&D, with focus on promoting non-chemical and alternative methods/ techniques including bio-pesticides and biological controls to augment and conserve natural control mechanisms and to reduce reliance on synthetic pesticides.
9. Develop standards and guidelines as per international standards and guidelines (*ISPMs - concerning WTO SPS; MRLs – concerning Codex Alimentarius; and Hazard and Risk assessment for plant protection products – particularly synthetic pesticides*).
10. Develop and implement standard operating procedures (*protocols, standards, guidelines*) in all pp activities for improving and enhancing professional competencies and work qualities (*for instance, for testing plant protection product efficacy testing, data collection, survey and sampling and so on*).

11. Provide quality pp services (*i.e. pest information, diagnostics, pest management technologies, early warning, training & education, field visits and advisory, and pp input services*) to farmers and other clientele.

C. Networks and Credentials

12. Establish mechanisms and ecosystems to foster professional engagement & deliberations with institutions within and outside the country to improve collaboration, networking & exchanges for advancing institutional and professional competencies.
13. Publish findings (*in national and international journals, pp websites, social media platforms, brochures, News Letters, leaflets and so on*) for advancing credentials of NPPC and particularly to create demand on plant protection services.
14. Host international or regional pp seminars and workshops to establish quality brand of NPPC and the plant protection activities.
15. Inform on Regional and International plant protection events and activities of relevance to Bhutan on NPPC website and social media platforms.

VIII. THE NATIONAL PLANT PROTECTION PROGRAM (NPPP) AND STAKEHOLDERS

The NPPP in general will include all stake holders in the agri-food system, from policy to production and consumption, that impacts on crop production and crop protection. It is deemed important to first clearly identify Institutions and/or personnel in terms of their roles with regards to provision and/ or utilization of services. This will inform on “where, how and who” could provide the necessary supports or sort out bottlenecks identified. They are grouped under A) Service Delivery Side Stakeholders; and B) Service Receiving Side Stakeholders as detailed below:

A. Service Delivery Side

The NPPP will comprise of Institutions - Department of Agriculture, NPPC, BFDA (Bhutan Food and Drug Authority), Dzongkhag Administration, Dzongkhag Agriculture Extension (*which also includes Gewog Extension*) and Gewog Administration; and Personnel - Dzongkhag Pest Surveillance Focal (PSF) person and Regional PP Focal persons.

In terms of decision making, the Service Delivery Side stakeholders are presented at 3 levels of decision tree with their broad functions:

- a. At the **Policy Level**, the Department of Agriculture and Ministry of Agriculture and Livestock will ensure policy, administrative and resources support.
- b. At the **Operational Level**, the NPPC, BFDA, ARDCs and the National Extension System (NES) will assure technological, technical, facilitation and coordination support. At the same time provide administrative and resource support aligning with plant protection activities.
- c. At the **Implementation Level**, the Dzongkhag Administration with Gewog Administration and Extension will facilitate implementation and ensure administrative and resources support. ARDCs with regional PP unit and NPPC will render technical support and where possible provide financial support as well.

B. Service Receiving Side

The NPPP comprise of farmers, commercial growers & producers, importers, institutions (*both national and importing bodies/countries as it relates to trade and commerce requirements*) academics, students, and researchers.

IX. ORGANIZATIONAL STRUCTURE

At a broader level, the organizational structure will present a bird's eye view of the management structure and the alignment of programs in a hierarchy. As a result the impact of policy and management decisions on operational and implementation level activities could be better understood. At the next level, it will underline the importance of the specific roles of each of the programs in generation of and rendering specific plant protection services that are quintessential for delivering a quality national plant protection services. The role of management in facilitating and coordinating these activities for meeting goals and targets that are set, in time and quality for generating and rendering of a national level plant protection services could be better understood. Additionally, it will also reveal the necessary horizontal relationships and coordination required between programs for establishing and utilizing synergies and complementarities of an institution for effective delivery of plant protection services.

On another hand, understanding the organizational structure will also provide a clear view on the sources and solutions of issues and challenges. As a result guide in bringing solutions for achieving targets and goals according to priorities and plans. In short, delving deeper into the purpose and potentials of organizational structure will enable in managing the resources effectively at all levels of decision making. Through a standardized processes, at the operational and implementation level, policies, plans, and procedures could be harmonized for all activities for gaining quantum leaps in managing and improving quality standards of services. Therefore, designing a correct organization structure and making effective use of it will enable smooth functioning and harmony within an organization or an institution.

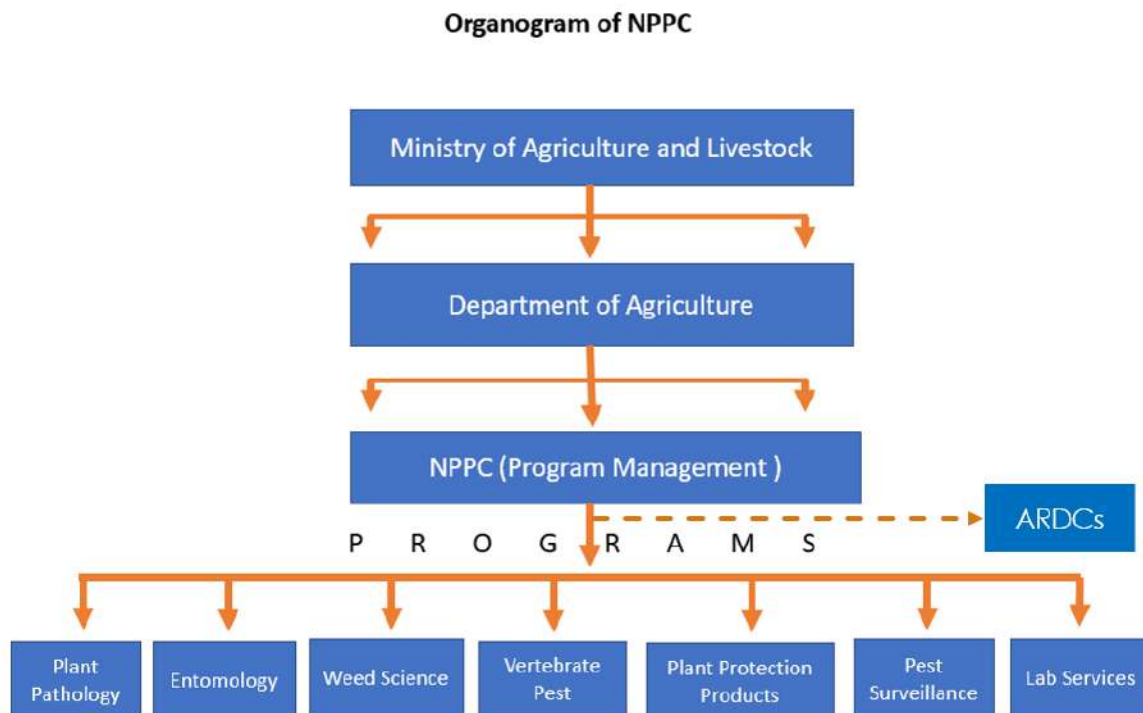


Figure 5: Organizational Structure of the National Plant Protection Center (NPPC)

X. STRATEGIC PLANT PROTECTION PROGRAM MANAGEMENT

(Doing the Right Things Right - being efficient and effective at the same time) – Peter Ducker)

Towards delivering quality plant protection services in time and space required, it is vital that the 3 levels of plant protection program management aspects - the Policy, Operational and Implementation levels are taken care. Partitioning a functional system into these 3 levels allows for identifying systemic flaws embedded at these levels and look at ways to address them at the specific level(s). A robust system will better professional performances and vice versa, without personalizing systemic deficiencies. Therefore, it is vital that a system's working is understood and supported to enhance professional performance beyond an individual's contributions (applying the concept of $X + YX = \text{Total Output}$. *X is the individual output; Y is the effect of the system – improvised from The New Economics by W. Edwards Deming*).

A. Policy Level

For catering to the broader goals of vision, mission and mandates, the Center will adopt a set of strategic policies that will drive and harmonize all the plant protection activities. The policy statements, like the mandates, are a direct outcome and translation of vision and mission goals for aligning the institutional and professional resources towards providing a plant protection service that will contribute to agri-food industry (*crop sector*) development goals. Therefore, broadly the plant protection program activities and the resulting plant protection services are aimed at sustaining crop production and productivity.

During the evaluation and appraisal mission in mid 1991, it was decided to formally reorient the new phase of the project towards the development of IPM strategies. This formal reorientation is reflected in the new name of the project:

INTEGRATED PEST MANAGEMENT DEVELOPMENT PROJECT

The full emphasis on development and implementation of IPM techniques in the 1993 - 1997 period is in full accordance with the RGOB policy of sustainable and safe systems of farming, and conservation of natural resources. IPM was also a focal point for the United Nations Conference on Environment and Development at Rio de Janeiro in 1992. An entire section of the Agenda 21 plan of action adopted at UNCED is devoted to IPM, calling on all signatory governments (including the Royal Government of Bhutan) to promote IPM at farm level through networks of farmers, extensionists and researchers.

Figure 6: Outline of IPMD Project - extracted from Inception Report of the IPMD Project (ALA/92/12, 1 November 1993).

Appreciating these sustainability concerns, and accounting for environmental and human and animal health, the NPPC has been carrying out all its plant protection activities in line with Integrated Pest Management (IPM) principles and practices for over 3 decades. Formally, IPM activities were initiated with the inception of the second phase European Union supported project,

the Integrated Pest Management Development Project (IPMDP) (1993 – 1997, extended to 2000) as outlined briefly in figure 6.

At the policy level, a major achievement has been the adoption of **Integrated Pest Management (IPM) as a National Plant Protection Policy** through, “THE PESTICIDES ACT OF BHUTAN 2000” on 14th July 2000 by the Parliament of Bhutan (figure7). Within the ambit of the broad IPM policy statement, the vision document presents a strategic approach (*including, but not limited to: vision, missions and mandates to specific policy statements and operational and Implementation requirements*) for standardizing and harmonizing all plant protection activities to enable a sound plant protection program management.

The vision document also provides a platform and opportunity to widely communicate on Integrated Pest Management as the plant protection policy tool for carrying out all plant protection activities. Additionally, it affords a systematic perspective on plant protection activities for both the novice and professionals alike to further advance national plant protection agendas. Therefore, through this document, the NPPC once again reiterates that **“IPM is the overriding National Plant Protection Policy.”**

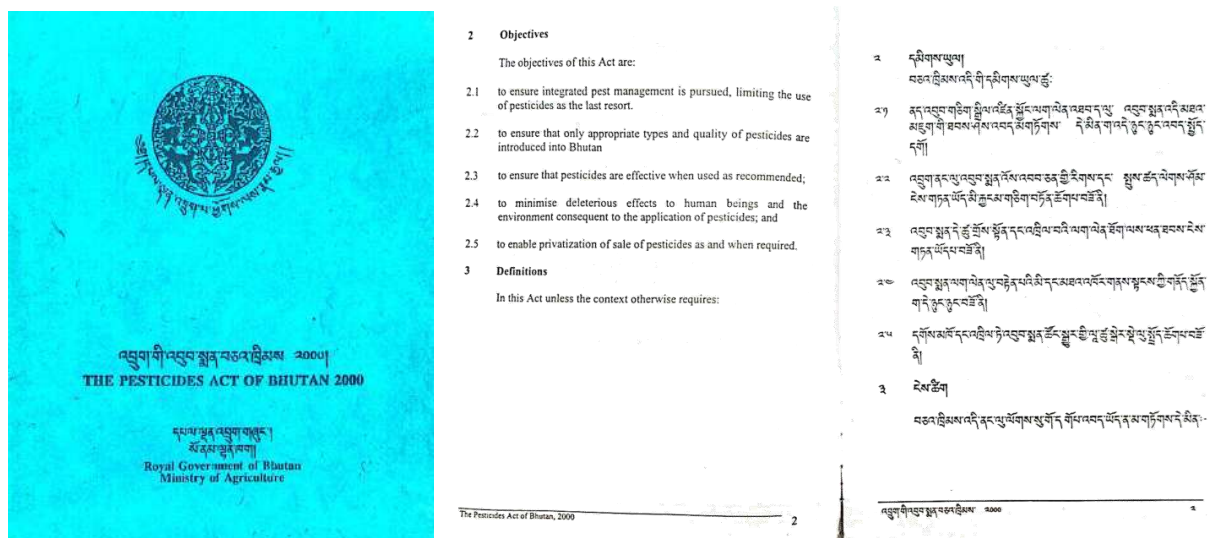


Figure 7: IPM Policy (the 1st objective) as reflected in the Pesticide Act of Bhutan

From the broad agri-food system’s perspective and within the overall Plant Protection Program activities, the NPPC will be guided by the IPM policy statements to render a timely and quality plant protection services. The IPM policies are captured mainly within the 6 broad thematic areas under two subsections of Section “A”. The two subsection include a: 1) General and 2) Specific subsection. The second subsection is partitioned into 5 other subsections. They include: a) the Integrated Pest Management (IPM) R&D policy; b) the crop pests’ information management system and dissemination policy; c) the transfer of plant protection (pp) technology, pest management and technical support policy; d) the plant protection product management policy; and e) policy on advancing credentials and networking mechanisms.

a. The Integrated Pest Management (IPM) Policy

The NPPC as the **apex national referral and coordinating center and the technically competent authority in matters of plant protection** for all activities concerning plant protection activities in the country, will oversee all issues concerning plant protection. The overall outcome expected from implementation of this overriding policy statement is improvement and enhancement of plant protection services as a result of enhancing performance and productivity of professionals, the plant protection institution and that of every stakeholder in the value chain. For achieving these lofty goals effectively, the NPPC will employ the latest developments in science and technology through use of digital tools and platforms, such as automated pest detection and monitoring systems and others as mentioned under the specific policies.

The advancement that will be made as a result of adoption of digital tools and platforms - in awareness and education of IPM principles and practices and adoption of IPM practices at different levels, from policy to R&D to field implementation, will be far-reaching. Particularly, impacting on health and wellbeing; environment and economics outcomes of communities/societies – the lives and livelihoods of people in general.

In pursuit of this overriding policy objective, the NPPC will be guided by the IPM policy that is covered under 2 sections: 1) General; and 2) Specific, in all its plant protection activities.

1. General

- i. Strengthen capacities and capabilities of plant protection professionals and NPPC as a national institution for steering plant protection activities in the country.
- ii. Be responsible for providing policy and strategic level advisory services to the Royal Government in matters of crop protection.
- iii. Undertake reviews and revisions of the vision document and plant protection related standards, and legislations as may be deemed necessary for catering plant protection services confidently and effectively, with prior approval and/ or instruction from the Ministry of Agriculture and Livestock.
- iv. Institute operational and implementation mechanisms to identify bottlenecks and enhance performance and productivity of plant protection professionals, the NPPC as a plant protection institution and partners in the pp service value chain.
- v. Establish conducive professional work ecosystems towards enhancing entrepreneurial capabilities and informal professional interactions – making feedbacks and exchanges easier.
- vi. Institute Early Warning and Rapid Response mechanisms to mitigate pest epidemics.
- vii. Ensure implementation of standard plant protection services through standardizing processes and procedures in the conduct of plant protection activities.
- viii. Mobilize resources (*financial and technical*), establish mechanism for collaborations to undertake initiatives for facilitating seamless functioning of the plant protection activities with key stakeholders.
- ix. As a national referral and coordinating center and as the technically competent authority in matters of plant protection, be the designated authority for setting standards related to WTO SPS (*International Standards for Phytosanitary Measures -ISPMs*) and

food safety standards related to pesticide residues and/or pest organisms' contamination or toxins with regards to Codex Alimentarius requirements.

2. Specific

Five broad policy areas are identified to harmonize and align plant protection activities in relation to the future of plant protection program and its contribution to growth and development of agri-food industry. These policy approaches are aligned with IPM approaches as elucidated through the IPM pyramid. The underlying emphasis is laid on developing the competencies of plant protection professionals and NPPC as an institution to generate and render high quality pp services.

i. The Integrated Pest Management (IPM) R&D policy

- a) Employ automated detection and monitoring technologies (*AI, IoT, geospatial information, pest information, remote sensing, and unmanned aerial vehicles - UAV*) for advancing IPM R&D activities.
- b) Establish IPM R&D coordination mechanisms to include research on local, regional and national level pests for harmonization of R&D activities - ensuring food security and sufficiency in collaboration with ARDCs and NES.
- c) Develop and maintain a critical mass of competent plant protection professionals and promote professional work culture & code of conduct, including institution of mentoring activities.
- d) Strengthen diagnostic capacities and facilities for accreditation.
- e) Advance IPM R&D to include both applied and basic research activities.
- f) Undertake IPM R&D in major crops and pests of concern and establish crop loss assessments.
- g) Advance IPM R&D activities in bio-controls and bio-pesticides.
- h) Institute mechanisms for carrying out regular IPM R&D planning and review meetings/workshops, with key partners (*ARDCs, NES, RUB - Royal University of Bhutan*)
- i) Strengthen professional and institutional competencies including diagnostics (*following proper standard operating procedures (SoPs) all pp activities – with standards and protocols*) for delivering quality pp services.
- j) Initiate collaborative plant protection activities with regional and international institutions and professionals, including hosting international seminars, workshops and conferences, to enhance credentials and confidence of the plant protection professional and NPPC as an institution – *towards improving credentials and contributing to science and global economy.*
- k) Establish standard protocols for assessment of plant protection products.

ii. The crop pests' information management system and dissemination policy

- a) Institute pest surveillance activities in collaboration with the ARDCs and NES to develop pest information system that are important at local, regional and national levels for enabling appropriate R&D prioritization.

- b) Establish a system of regular pest monitoring and reporting to real time pest information services to Extension and farmers towards facilitation of early warning and actions, and for reducing calendar spraying activities.
- c) Advance pest monitoring and detection system through employment of automated detection and monitoring systems.
- d) Maintain a national referral information management system on crop pests for keeping record and information sharing.
- e) Maintain updates of Regional and International plant protection events and activities of relevance to Bhutan on NPPC website and social media platforms.

iii. **The transfer pp technology, pest management & technical support policy**

- a) Develop capacities for employing the most recent advances in science and technology (*Earth Observation Technology (remote sensing), Artificial Intelligence (Neural networks), IoTs, Big data, unmanned aerial vehicles (UAV), Cloud computing, geospatial data – drone technology*) to effectively advance IPM activities related to pest monitoring, diagnostic, and management.
- b) Advocate IPM approaches to all stakeholders from the perspective of agri-food systems underlying the principles of sustainability (*being socially acceptable, economically viable and environmentally safe*).
- c) Promote IPM principles and practices to extension personnel, farmers and other clientele.
- d) Enhance capacities and skills of Extension personnel and farmers in IPM activities, through both on-site activities and digital platforms.
- e) Strengthen collaborations and networks with key plant protection stakeholders (*ARDCs, NES, Farmer groups/cooperatives/associations, and Commercial growers*) for effective pp service delivery.
- f) Establish a mechanism to deliver regular plant protection advisory and technical backup services in the field.
- g) Develop a system of early pest risk assessment, communication and management in collaboration with the ARDCs and the NES, including early warning activities and emergency response during epidemic situation – *Rapid Response System for Pest Management*.
- h) Undertake regular reviews of crop losses to pest organisms for establishing management response in collaboration with NES, ARDCs and farmers to obtain crop loss reduction targets.
- i) Educate and build capacities of farmers and Extension personnel to reduce risk associated with synthetic pesticides through training, education and advocacy activities as per international code of conduct.

iv. **The plant protection product management policy**

Reduce risk and reliance on synthetic pesticides as per the SGD goals and international code of conduct on synthetic pesticide management approaches through adoption of the following key policies:

- a) Utilize digital tools and platforms to effectively manage plant protection product and its information system – from household level indenting and procurement to distribution and utilization up to the national level.
- b) Implement hazard-based approach to pesticide identification, assessment and procurement of pp products as the first step to pp product utilization in pest management (*following the highly hazardous pesticides (HHPs) characterization by FAO/WHO*).
- c) Where no options are available, adopt risk-based approach to procure and use a synthetic pesticide product, and adopt code of conduct stringently. (*This implies professional capacities, facilities, necessary institutional ecosystems and financial means to carry out environmental - soil, water, atmosphere; and social risk assessments - health of workers, local communities, food and so on for ensuring adequate risk management actions*).
- d) Adopt international code of conduct on pesticides management to reduce risk associated with the products, in particular for child bearing age woman and pregnant and/or lactating ladies.
- e) Institute environmental surveillance programs of synthetic pesticides – undertaking regular field bio-assays for monitoring effects on human and animal health and the environment in collaboration with NES, ARDCs and Department of Public Health (DoPH) and Royal Center for Disease Control (RCDC).
- f) Reduce the number and overall volume of synthetic pesticides with concomitant inclusion and increase in the volume of alternative approaches to pest management, and at the same time improve access and availability of plant protection products.
- g) Upgrade the Plant Protection Product Program to a semi-autonomous status within NPPC for prospecting bio-control options; undertaking R&D for assessing (and accessing) less toxic synthetics pp products; and for advancing bio-chemical R&D and analytical studies (*to advance science and technology to address issues related to human and animal health and the environment*) for developing a strong information base for effecting policy decisions and carrying out risk assessment and management measures in line with international conventions and protocols.

v. **Policy on advancing Credentials and Networking Mechanisms**

- a) Institute a formalized collaborative platform with BFDA, ARDCs, NES, and RUB for sharing and exchanging information and management issues on pest organisms, and planning and implementing common interest activities.
- b) Establish collaborative activities in both applied and basic research with institutions and professionals - within the country, in the region and with international counterparts, in Bhutan relevant crops and pest organisms, and publish findings in renowned international plant protection journals.

B. Operational Level

At the Operational level, two area of focus are identified: 1) Management structures; and their 2) Operational functions. Through such a focus, appropriate processes, procedures and platforms could be identified and utilized effectively and efficiently to address pain points for enhancing performance and productivity – the idea of doing more with less.

At the Management Structure levels, key stakeholders are identified. Then, at the Operational Function level, their roles and responsibilities are captured succinctly and coherently. The aim here is that each of the players at their functional levels will be able to clearly understand challenges, identify sources to solutions, and develop solutions at their specific levels. However, these seemingly distinct operational levels are not necessarily exclusive functionally. The development activities will require all players to function as one unit, like chain for instance. Through such rigorous processes, individual activities (*from IWPs to APA*) will be aligned with organizational goals and targets for further contributing to the higher developmental goals and targets, measured in **impacts and outcomes rather than outputs alone** – the underlying goal of IPM approach.

a. Management Structure

Within the overall organizational structure, for the smooth functioning of the plant protection program and its activities, an Operational Management Structure is presented. Within this management structure, four groups of professionals are identified based on their specific functions. However, the presentation of these distinct groups in a hierarchical manner does not imply the relative importance of one over the other. It only reflects the specificity of the functions that needs to be performed by a particular group. The four groups identified here:

i. Management Administration (MA) Team

The MA team will include the Program Manager (Specialist Head), Administration and Finance personnel and the Management Advisor (*s/he is selected by the Program Manager (Specialist Head); could be Technical Chair or any senior professional or specialist. S/he will act as an advisor, while the core mandate will be technical as s/he will also have her/his role as Head of Programs including as Technical Chair*).

ii. Program Management (PM) Team

The team here will comprise of Program Manager (Specialist Head) as the Chair, Program Heads, and regional pp personnel as member of the PM team. The team will also include MA team.

iii. Technical Team

The technical team will comprise of Technical Chair (*elected by the technical team amongst senior professionals*), Program Heads, regional pp personnel and professionals (*including Specialist(s)*). The participation of Program Manager (Specialist Head) in this forum will be in the capacity of a member.

iv. Specific Programs

The specific programs will include all professionals under a program (*including specialist(s)*) with linkage to the regional pp personnel. The NPPC comprise of 7 technical programs – Plant

Pathology Program, Entomology Program, Weed Science Program, Vertebrate Pest Program, Plant Protection Product Program, Pest Surveillance Program, and Laboratory Services Program.

b. Operational Functions

Towards delivering on the policy statements, it is important to identify and act on operational level functions identified for (*but not limited to*) the 4 groups within the management structure. Three major areas of focus are identified: a) human resource (*competency*), work culture (*integrity & accountability*), and institutional capacity (*quality standards*) that will interact with each other. For achieving the policy objectives, strategic management in these 3 areas by the 4 groups under the management structures in their specific areas will be imperative.

Therefore, efforts are made here to clearly and coherently bring out the operational level functions of the 4 professional groups within the management structure. These functions, once put into action, are expected to elicit strategic interventions that will harmonize, facilitate and standardize processes and procedures towards improving and advancing all aspects of plant protection services.

The resultant impact of these achievements will cascade at implementation level. The challenge here will be identifying and consistently acting upon the identified functions for translating policy aspirations into meaningful implementation level impacts and outcomes.

For addressing the concerns mentioned, a deeper level more detailed operational functions are identified and presented for action for each of the 4 groups under the management structures. As experience is gained in time, the level of professionalism and sophistication will significantly improve in Leadership and Management, thereby enabling plant protection program to function smoothly for enhancing institutional and professional performances and vice versa. As a result, the plant protection program is expected to provide the necessary ecosystem for institutional and professional performance, culminating into delivery of high quality plant protection services.

i. Management Administration (MA) Team

Overall, the Program Manager (Specialist Head) with the support of MA team will be responsible for the smooth functioning of National Plant Protection Program in general and the NPPC in particular. The key functions will concern developing competencies; ensuring motivations; establishing collaborations - within and across the programs; ensuring adherence to professional quality standards; and addressing broader level bottlenecks to plant protection service delivery. Particular attention and focus will be given to enhancing interactions between the professionals, within and across programs, to bring out the synergies and complementarities. For instance, facilitation of professional and personal interaction and discourses. The role of MA team is to “keep the flock together” and grow them together – demonstrating that the whole is more than sum of its parts. It is all about understanding and handling the organizational and operational subtleties (functional) with tact and professionalism without losing focus and direction on the goals and targets.

ii. Program Management (PM) Team

The PM team here will be responsible for activities including, but not limited to, review and endorsement of plans, budgets, and implementation processes of 5 year plans under NPPC annual work-plans. Hence, the team will be responsible for finalization of NPPC annual work-plans, APA & IWPs. The team will also review progress on annual plant protection activities. The team will conduct APA and IWP assessments, identify areas of improvement and provide necessary mentoring and/ or corrective measures. In short, the PM team is responsible for visioning, direction, guidance, assessment (standard aspects), improvements and advancement of plant protection services – leveraging and multiplying professional and system’s potentials. The bottom-line here is about enhancement of competence, best practices, team building and collaborative approach.

iii. The Technical Team (TT) – 2x yearly meeting

Overall, the technical team will be responsible for planning, budgeting, and implementation of 5 year plans under NPPC annual work-plans – which includes prioritization, implementation, assessment, and reporting of all plant protection activities. In addition, the team here will review APA and IWPs, progress monitor and report, mentor and provide guidance to the junior staff at the NPPC, regional and Dzongkhag levels (*as and when required & applicable for Extension personnel*). These activities are expected to impact knowledge, skill, and confidence. Planning, organizing, skilling and communicating workflow processes for empowering staff and meeting expectations of clientele is at the heart of the role of the technical team.

iv. Specific Programs

Within the specific programs, in general, planning, prioritization, budgeting and implementation of 5 year plan activities specific to the program will be undertaken. Priority activities and resources will be identified and aligned with budget. Gaps in capacities and resources will be identified and necessary interventions will put in place. Aligning with the 5 year plan, within the identified priorities, APA and IWPs will be developed and aligned with budget. Implementation modalities for each activity will be planned with timeline and focus. Focus and attention will be given to following standards, protocols or specific instructions for improving professional competence and ensuring quality pp services. Therefore, progress monitoring of activities, review and reporting, mentoring, submission of research papers, project proposals and various initiatives will be the focus areas. In addition to the above activities, regular and routine training workshops, seminar, specific briefing and sharing of information resources at program level will ensure standards and quality of plant protection services.

C. Implementation Level

At the implementation level, (*within the context of the management structure and its operational level functioning as an organization*), the focus here will be on how to progress, maintain, and improve the plant protection activities that are identified as priority areas of focus. This will include constantly improving the knowledge and skills of the human resource, keeping the motivational momentum, and enhancing collaboration and communication, within and across the programs of

NPPC, plant protection program and allied agencies. The outcomes at this level will test the **strength and quality of human resource, work culture and institutional capacities**.

i. Procedure for implementation of plant protection activities

The general functions, roles, and activities; and processes and procedures highlighted under the operational level are aligned for gaining traction during the implementation process of plant protection activities. In coherence with the Operational level functions, an implementation procedure for plant protection activities, including management aspects are presented in figure 8 for clarity.

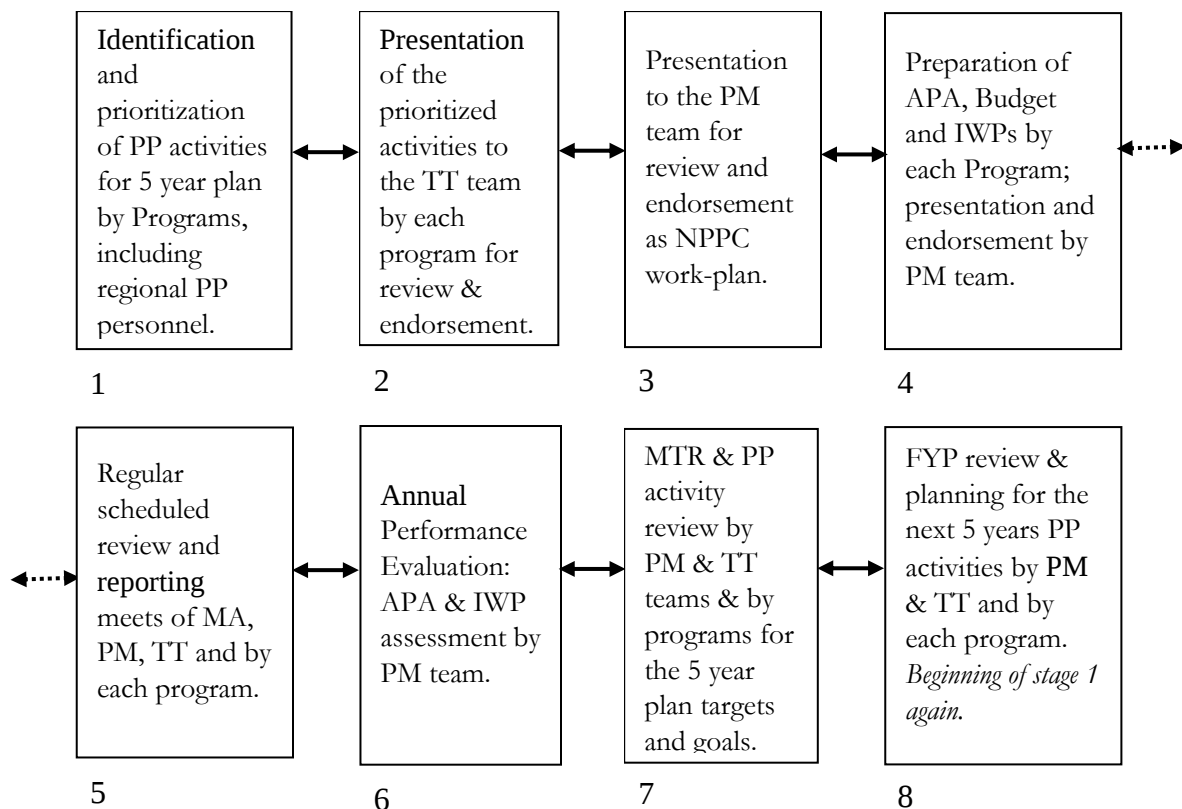


Figure 8: Procedure for Implementation of plant protection activities

Like any development activity, there will be challenges to implementation of plant protection activities as many stakeholders are involved. Success of any plant protection activity is therefore, hinged on managing the interactions among all stakeholders prudently during the implementation processes. The key focus areas here will be in managing financial resources, competence, motivation, and collaboration and communication that underlie the support system among the group – a Management Administration function. A starting point for managing these interactions appropriately will begin at stage 1 (Figure 8) through the engagement of key stakeholders. The next steps with feedback loops, from stage 2 through to 8, will need to progress with conscious effort to improve the processes and strengthen procedures as experiences are gained with time.

ii. General Plant Protection Activity Planning Framework

Following the implementation processes (Figure 8), from the identified priority policy areas, activities for the next five years will be identified and prioritized by each program. These priority activities will be endorsed as per the implementation processes requirements for maintaining and improving standards. After endorsement by the PM team, activities will be reflected in the General Activity Framework for plant protection activities (Figure 9). This will form the basis for drawing-up NPPC work-plan for APA and IWPs. Planning, review, revision, reporting, and evaluation processes will be carried out as reflected under figure 8.

Policy Areas	Program	Program Focus	Year 1	Year 2	Year 3 - 5	Remarks
General IPM policy areas	Mgt Adm and PM team (Institutional ecosystems and mechanisms)	Resources				Focus on enhancing competence of human resource (<i>at personal & professional levels</i>), work culture, and institutional (<i>systems & structures</i>) standards. The bottom-line here is to build a work culture and an ecosystem that will bring JOY and comradeship at work – measured as an Outcome and Impact of excellence in management. <i>End Result: Excellence in management leading to great institution with motivated competent professionals.</i>
		Platforms and mechanisms for networking, performance enhancement and collaboration				
		Competencies (Prof. & NPPC) & Standardization				
		Prof. Work culture, Mentoring, & Monitoring.				
		Early warning and rapid response system				
		Reports, reviews & evaluations.				
		Procurement				
Specific IPM policy areas	Specific Programs & TT team (Technical competencies & work culture)	R&D				
		Technology, pest management & technical support				
		Plant protection product management				
		Credentials and Networking				
		Information management and dissemination				

Figure 9: General Plant Protection Activity Planning Framework

iii. Plant Protection Services

With the implementation of plant protection activities as per the operational modalities and the implementation processes and procedures as reflected under figure 8 and 9, the general plant protection services that are generated and rendered are presented in figure 10. It must be underlined here that the PPP Program services highlighted under Sl. No. 4 are part of IPM technologies.

Sl. No.	Plant protection Programs	Plant Protection activities	Plant Protection Services	PP service Output	PP Service Outcome	PP Service Impact
1	Pest Surveillance	Pest Surveillance	Pest Information Early warning PRA (pest risk analysis)	Reduced crop losses to pest organisms	Adoption of IPM approaches to pest management.	Protection of health of the citizenry, their livelihood and the environment.
2	Laboratory Services	Laboratory (including R&D activities)	Diagnostics & bio-control product Training & Education			
3	Technical Programs (Entomology, Pathology, Weed Science, Vertebrate Pests)	R&D activities: Ento., Patho., Weeds, Vert.)	IPM technologies – Insect/Diseases/Weeds/Vertebrates Training & Education Field visits & advisory			
4	PP Products' Program	PP Products (including R&D activities)	PPP R&D PP product management PPP Info. Mgt. Training and Education			

Figure 10: General presentation of pp programs, their activities and pp services generated and rendered

However, by the specific nature of activities under the program that could not be combined under Sl. No. 3 like other technical programs, and the need to reflect these specific activities, Sl. No. 4 was created separately to accommodate those specific activities.

XI. SUMMARY STATEMENT

For any institution or an organization, a vision brings clarity and focus with purpose and direction. From that standpoint a mission statement identifying the priorities and focus is crafted in that direction. To accomplish the missions drawn, legality expressed in terms of mandate is established for setting functional boundaries. Within the functional boundaries and with the aim of accomplishing the missions, priority areas for actions are identified through policy priority statements. Towards achieving these identified policy priorities, management structures and their operational functions are clearly defined. At the implementation level, the operational functions are superimposed with implementation level priorities (*capturing within the broader goal of strengthening human resource, work culture and institutional capacities*) that are translation of policy priorities for greater efficiency and effectiveness.

From visioning to implementation of activities, accountability at each level is required (*as illustrated under figure 4 and detailed under section X*). Accountability is a function of looking at KPIs (*Key Performance Indicators*) of individuals, programs and an institution as a direct outcome of knowledge, skill and time (*provided for acquiring that skill and knowledge*). Other allied requirements will include work culture (*standards, supportive ecosystem, and so on*) and resources. Therefore, towards achieving the vision and mission goals, it is imperative that all necessary elements are considered to bring out the synergy and complementary effect of a system and individuals (*X + YX effect – section X*).

With all necessary elements considered, advancing science and technology, and innovating integrated pest management solutions with committed resources relevant in the 21st century will be critical to achieving the targets and goals set under this vision document. Pest risk monitoring and management enhanced through a robust system of digital technologies, R&D and collaboration with stakeholders will be critical. For taking such ideas forward, learning from global best players in the field will be critical. The pioneers in the field include Centre for Agriculture and Bioscience International (CABI) with its Pest Risk Information Service (PRISE) system; Pest and Disease Risk Identification and Management (PRIME) project developed as a collaborative activity between Philippine Department of Agriculture and International Rice Research Institute (DA – IRRI PRIME Project); and information on latest advances in the use of Automatic Detection and Monitoring of Insect Pests and Diseases by MDPI (*Multidisciplinary Digital Publishing Institute*).

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