Plant Health Biosecurity in Agriculture of South Asia

Editors

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SAARC

SAARC Agriculture Centre (SAC)

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SAARC Agriculture Centre (SAC) Dhaka Bangladesh held a 3 (three) days regional consultation meeting on “Agricultural biosecurity for plant health in South Asia”, 19-21 August 2025. National focal point experts from SAARC Member States, along with scientists of national and international research organizations and different universities working on different aspects of Plant Health Biosecurity in Agriculture of South Asia, participated in this meeting.

Editors

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Foreword

Protecting health of plants is vital for human health, food security, trade, economy, and environment. Healthy plants constitute the foundation for all life on earth. Plants are under constant attack from pests, and diseases. Crop losses caused by pathogens, insects and weeds are estimated to reduce global agricultural productivity between 20-40 percent. Biosecurity advocates a strategic and integrated approach to meet the consumer expectations in relation to the food safety, safeguarding the resources and protecting environment and biodiversity.

SAARC Member States are fortunate to be free from many serious plant pests, due to effective quarantine measures and geographic isolation from the rest of the world. But agricultural sector and its related industries, landscapes and biodiversity of this region are under threat from different types of pests. Therefore, it is overall consensus to consider that the increasing emergence of plant pests and diseases is not only associated with the appearance of new pests but also to the recently emerged pest dissemination mainly from trade and human transport.

Prevention remains the most cost-effective and critical measure focusing on minimizing the entry pathways of quarantine pests. Border and post border surveillance is very important. Digital transformation has also accelerated biosecurity efficiency. Future strategies for South Asia, agricultural biosecurity must address both existing vulnerabilities and emerging global risks. A comprehensive, forward-looking approach is essential to protect food security, maintain export competitiveness, and safeguard biodiversity. It should be emphasized priority to strengthen diagnostic laboratories, upgradation of Plant National Quarantine Stations (NPQS) and Departments of Agriculture facilities according to the international standards.

SAARC Member States also need to strengthen and expanding surveillance networks. Integrating AI-supported trap monitoring systems, remote sensors, and climate – based predictive models which can significantly improve early warning capabilities. Policy reforms are also helpful for better agricultural biosecurity. Regional collaboration needs to be expanded. Shared pest alerts, joint surveillance programs and harmonized phytosanitary standards can be helpful in SAARC Member States to respond quickly to transboundary pest threats. As pest pressures intensify globally due to climate change, such collaboration becomes indispensable. Maximum financial support by the governments to the concerned departments, upgradation of laboratories and sufficient human resource availability and their training and public awareness campaigns including farmers, traders and travelers, can play an important role in the better agricultural biosecurity management.

This piece of publication is the outcome of regional consultation meeting on "Agricultural Biosecurity for Plant Health in South Asia". I hope, it will be helpful for the better understanding of agriculture related biosecurity issues in South Asia and for the adoption of best managements practices to save the SAARC Member States against agricultural biosecurity issues. This book will be useful for the scientists, Plant Protection Departments authorities and Extension workers for better understanding of the agricultural biosecurity related issues and their better management in this region.

At the end, I congratulate all the team of SAC, especially Dr Sikander Khan, Senior Program Specialist (Crops) for preparing this publication, compiling all the papers presented in the regional consultation meeting, "Agricultural Biosecurity for Plant Health in South Asia".

Dr. Md. Harunur Rashid

Abbreviations

ADB	Asian Development Bank
ADS	Agriculture Development Strategy
AEZ	Agriculture Economic Zone
AGDP	Agricultural Gross Domestic Product
APPPC	The Asia and Pacific Plant Protection Commission
ARDC	Agriculture Research and Development Centre
BBTV	Banana Bunchy Top Virus
BFDA	Bhutan Food and Drug Authority
BMPs	Best Management Practices
BSM	Biosecurity Measure
CABI	Centre for Agriculture and Biosciences International
CEMDs	Centre of Excellence in Molecular Diagnostics
CIPs	Controlled Import Permits
CPM	Commission on Phytosanitary Measures
CRC	Controlling the Desert Locust in Central Region
CTV	Citrus Tristeza Virus
DAE	Department of Agriculture Extension
DFTOC	Department of Food Technology and Quality Control
DIP	Destructive Insects and Pests
DLS	Department of Livestock Services
DoA	Department of Agriculture
DPP	Department of Plant Protection
DPPOS	Directorate of Plant Protection, Quarantine and Storage
ELISA	Enzyme -Linked immune sorbent assay
EM	Electron microscopy
F.Y	Fiscal Year
FAO	Food and Agriculture Organization of the United Nations
FAW	Fall Army Worm
FBR	Federal Board of Revenue
FFS	Farmers Field School
FMD	Foot-and-Mouth Disease
GALS	Giant African Land Snail
GAP	Good Agricultural Practices
GDP	Gross Domestic Product
GIS	Geographic Information System
GMOs	Genetically Modified Organisms

IAS	Invasive Alian Species
IAs	Inspection Authorities
ICAR-NBPGR	ICAR-National Bureau of Plant Genetic Resources
IFAD	International Fund for Agricultural Development
IP	Import Permit
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
IRA	Import Risk Analysis
ISPMs	International Standards for Phytosanitary Measures
KPI	Key Performance Indicator
KPT	Karachi Port
LIA	Legislative Impact Assessment
LMOs	Living Modified Organisms
MAP	Maldives Agribusiness Program
MAPs	Medicinal and Aromatic Plants
MDP	Mini Dry Port
MNFS&R	Ministry of National Food Security & Research
MoAL	Ministry of Agriculture and Livestock
MoALD	Ministry of Agriculture and Livestock Development
MoFE	Ministry of Forestry and Environment
MoH	Ministry of Health
MoU	Memorandum of Understanding
MRL	Maximum Residue Limit
MT	Metric Ton
NAFSA	National Agri-Trade and Food Safety Authority
NFTOC	Department of Food Technology and Quality Control
NPPC	National Plant Protection Centre
NPPO	National Plant Quarantine Organization
NPPOs	National Plant Protection Organizations
NPQS	National Plant Quarantine Service
NTIS	Nepal Trade Integration Strategy
OIE	Office of Evaluation & Inspections
P.M	Phytosanitary Measure
PABD	Plant and Animal Biosecurity Division
PARC	Pakistan Agricultural Research Council
PBS	Pakistan Bureau of Statistics
PC	Phytosanitary Certificate
PCE	Phytosanitary Capacity Evaluation

PCR	Polymerase Chain Reaction
PGR	Plant Genetic Resources
PFAs	Expansion of Pest Free Area
PIC	Prior Informed Consent
PQPMC	Plant Quarantine and Pesticide Management
POPs	Persistent Organic Pollutants
PQ	Plant Quarantine
PPQR	Pakistan Plant Quarantine Rules
PPP	Public Private Partnership
PRA	Pest Risk Analysis
PRD	Pesticide Registration Division
PSI	Pre-Shipment Inspections
PSW	Pakistan Single Window
QPs	Quarantine Pests
RO	Release Order
PLRV	Potato Roll Virus
RNPs	Regulated Non-Quarantine Pests
RT-PCR	Reverse Transcription Polymerase Chain reaction
RPPOs	Regional Plant Protection organizations
SAARC	South Asian Association for Regional Cooperation
SAC	SAARC Agriculture Centre
SACs	South Asian Countries
SIDS	Small Island Developing State
SIFC	Special Investment Facilitation Council
SOCC	Seed Quality Control Centre
SOP	Standard Operating Procedure
SPS	Sanitary and Phytosanitary Measure
SWAC	South-West-Asia
ToR	Terms of Reference
UNDP	The United Nations Development Programme
VHT	Vapor Heat Treatment
WB	World Bank
WHO	World Health Organization
WOAH	World Organization for Animal Health
WPM	Wood Packaging material
WTO	World Trade Organization

Contents

Chapter 1

Biosecurity and Plant Health in Agriculture of South Asia

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Introduction

Healthy plants are the foundation of all life on earth. They provide food, clean air, livelihoods, and ecological stability. Yet, globally, crop losses from pathogens, insects, and weeds reduce agricultural productivity by an estimated 20–40 percent annually. Biosecurity in agriculture refers to the measures taken to prevent the introduction and spread of diseases, pests, and other harmful organisms in agricultural settings, protecting livestock, crops, and the environment. It is a preventive method that can be used to minimize the negative impacts of plant diseases and pests on biodiversity, international trade, food security and the natural environment. It includes a range of practices meant at minimizing risks linked with disease outbreaks and their potential negative effects on food production and the economy. It also refers to a standard operating procedure (SOP) applied to minimize the risk of the introduction and spread of disease-producing agents (Tanquilut et al., 2020).

The framework of biosecurity is based on identifying all potential entry and transmission pathways of pathogens and subsequently formulation of combined procedures to seal those pathways (Anderson et al., 2014). Implementation of biosecurity measures around the world can help to strengthen global standards of plant health while also raising awareness of the challenges of safeguarding the global economy and environment. Safe trade of healthy plants and plants products across borders is a key component in ensuring food security across the globe. Protecting biosecurity would help to ensure that biodiversity and the environment are safe from plant pests and diseases. It is important to maintaining global food security, facilitating safe trade and protecting the environment. It encompasses the policy and regulatory framework to analyze and manage risks in the sectors of plant life and health and related environmental concerns. (Khetarpal and Gupta 2007; Waage and Mumford 2008; Khetarpal et al., 2009).

Agricultural biosecurity refers to the integrated set of policies, regulatory measures, and practices designed to prevent the introduction and spread of harmful organisms in agricultural systems. It protects crops, livestock, biodiversity, and the natural environment from biological threats that can cross borders through international trade, travel, and the movement of people and goods. The framework is rooted in identifying all potential entry and transmission pathways of pathogens, and formulating coordinated procedures to block those pathways. Agricultural biosecurity — the system of measures designed to prevent the introduction, establishment, and spread of harmful pests and diseases is one of the most critical challenges facing South Asia's agricultural sector. Home to over 2 billion people, the SAARC region is heavily dependent on agriculture for food security, livelihoods, and economic growth. In South Asia, where agriculture supports the economies and food systems, the threats posed by pests, diseases, and invasive species are particularly consequential.

The SAARC region comprising Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka — is fortunate to be free from many serious plant pests and diseases due to effective quarantine measures and, in some cases, geographic isolation. However, the increasing pace of global trade, changing climate conditions, and growing movement of people and goods is rapidly eroding these natural protections. New and emerging pests are threatening the agricultural base of each SAARC Member State, so all these states need to further strengthen their agricultural biosecurity by using the latest technologies.

In response to these growing threats, the SAARC Agriculture Centre (SAC) organized a three-day regional consultation meeting on "Agricultural Biosecurity for Plant Health in South Asia" held virtually from 19 to 21 August 2025. National focal point experts from SAARC Member States, alongside scientists from national and international research organizations and universities, participated in the meeting to assess the current biosecurity situation and develop forward-looking recommendations.

Objectives

This article aims to provide a comprehensive synthesis of the findings of that consultation. Specifically, it seeks to:

- Describe the current state of agricultural biosecurity in SAARC Member State, with emphasis on common and country-specific challenges;
- Document how individual member states are institutionally organized to address plant biosecurity;
- Identify the key constraints that limit effective biosecurity management;
- Present actionable, evidence-based recommendations to overcome these constraints and strengthen regional biosecurity systems;
- Serve as an accessible resource for researchers, farmers, policymakers, and development organizations working on food security and plant health across South Asia.

Methodology

This article is based on a synthesis of primary and secondary sources generated through the SAARC Agriculture Centre's regional consultation meeting on Agricultural Biosecurity for Plant Health in South Asia, held from 19–21 August 2025 in virtual mode.

Data Collection

The primary sources of information used in this article include:

- **Country Papers:** Focal points of six SAARC Member States including Bangladesh, Bhutan, Maldives, Nepal, Pakistan, and Sri Lanka along with other nominated scientists of these states participated in this meeting and presented their country papers and also submitted their detailed country papers. These papers described the state of plant biosecurity, legislative frameworks, institutional arrangements, biosecurity threats, current measures, and constraints in their respective countries.
- **Technical Presentations:** During this three-day meeting, addition to the national focal points, invited scientists made technical presentations covering country-specific biosecurity situations, emerging threats, and best practices.
- **Expert Discussions:** Group discussions during the consultation sessions allowed participants to identify shared priorities, compare approaches, and develop consensus on recommendations.
- **Meeting Proceedings:** Official proceedings, resolutions, and recommendations of the regional consultation meeting were documented and form a key component of this synthesis.

Synthesis Approach

Content from country papers, presentations, and discussions was analysed thematically. Common issues shared across multiple member states were identified and presented alongside country-specific situations. Best practices and innovative approaches were highlighted to illustrate examples of effective responses. Constraints were categorized by type (technical, institutional, financial, regulatory, and awareness-related), and recommendations were organized accordingly to provide clear guidance for different audiences.

This article is written targeting the multiple audiences, researchers and technical specialists but also to policymakers, extension workers, farmers' organizations, and development partners.

Biosecurity and Plant Health Issues: Common and Country-Specific

Common Issues Across SAARC Member States

Despite differences in geography, economic development, and institutional capacity, SAARC Member States share a striking set of common biosecurity challenges. These include:

Transboundary Pest Threats

Highly mobile species like the Desert Locust (Schistocerca gregaria), Fall Armyworm (*Spodoptera frugiperda*), and various fungal rusts are capable of crossing international boundaries rapidly. These transboundary pests require coordinated, regional responses that go beyond what any single country can manage alone.

Invasive Alien Species

Invasive alien species (IAS) represent one of the most serious and growing threats to biodiversity and agricultural systems across South Asia. Like Giant African Land Snail (*Achatina fulica*) has established in Bhutan, and Sri Lanka. Parthenium weed (Parthenium hysterophorus) affects crop fields and human health across multiple countries. Water Hyacinth (*Eichhornia crassipes*) clogs irrigation canals in Sri Lanka. Papaya Mealybug (*Paracoccus marginatus*) has caused extensive crop losses in Sri Lanka and beyond. Once invasive species become established, eradication is extremely costly and often impossible.

Climate Change and Shifting Pest Dynamics

Climate change is dramatically altering pest and disease distribution patterns. Warming temperatures are allowing pests to expand into new geographic areas previously too cold for their survival. Changing rainfall patterns are creating new conditions favourable to fungal diseases and vector-borne pathogens. Extreme weather events weaken crop plants, making them more susceptible to pest attack. At the same time, climate change is making it more difficult to predict and prepare for new pest threats.

Weak Diagnostic Capacity

Across the region, laboratories are underfunded and often lack modern diagnostic tools, such as PCR machines, rapid detection kits, DNA barcoding capabilities, and molecular sequencing technologies. Without accurate and rapid pest identification, appropriate management responses are delayed. Many quarantine stations still rely on visual inspection and morphological identification, which is slow and prone to error, particularly for new or unusual pests.

Outdated or Incomplete Legal Frameworks

Several SAARC Member States are working from outdated plant quarantine legislation, which needs updating to address modern threats such as online plant trade and e-commerce pathways.

Limited Human Resource Capacity

A shortage of trained quarantine inspectors, molecular biologists, pest risk analysts, entomologists and plant pathologists are a universal constraint across the region. Many countries lack sufficient specialists at border entry points to conduct thorough inspections. Capacity building and continuous training are needed at all levels, from customs officials to laboratory technicians to extension workers who interact directly with farmers.

Low Public Awareness

Farmers, traders, and travellers often unknowingly serve as vectors for pest and disease spread. Informal seed and plant material exchange across borders in common in South Asian agricultural communities which is a significant pathway for disease introduction. Public awareness about biosecurity risks remains low, and campaigns to change behaviours among key risk groups are insufficient in most SAARC Member States.

Country-Specific Issues

Beyond common challenges, each SAARC Member State faces unique biosecurity situations shaped by geography, agricultural systems, economic development level, and institutional history.

Country	NPPO Body	Key Legislation	Major Biosecurity Threats
Bangladesh	Plant Quarantine Wing, DAE	Plant Quarantine Act 2011, Rules 2018	Citrus canker, Citrus thrips, Fall Armyworm, invasive pests
Bhutan	Bhutan Food & Drug Authority (BFDA)	Biosecurity & Food Safety Strategy	Giant African Land Snail, Citrus Greening (HLB), Fall Armyworm, Wheat Rust
Maldives	Ministry of Agriculture & Animal Welfare (no formal NPPO)	Plant Protection Act No. 12/2011	Coconut beetle, Hispid beetle, Whitefly, limited diagnostic capacity
Nepal	Plant Quarantine & Pesticide Management. Centre (PQPMC)	Plant Quarantine & Protection Act	Cross-border pest incursions, 69 alien species, Fall Armyworm
Pakistan	Dept. of Plant Protection (DPP)	Plant Quarantine Act 1976, PPQR 2019	Desert Locust, Citrus Greening, Cotton Leaf Curl Virus, Wheat rusts
Sri Lanka	National Plant Quarantine Service (NPQS), DOA	Plant Protection Act No. 35 of 1999	Parthenium weed, Giant African Snail, Papaya Mealybug, Fall Armyworm, Fruit fly

Bangladesh

Bangladesh is predominantly agrarian, with agriculture contributing approximately 11.55% of GDP and employing 44.42% of the labor force. The country faces risks from citrus canker (*Xanthomonas axonopodis*) and citrus thrips (*Thrips palmi*), which have caused significant trade losses estimated at BDT 19 crore annually. The spread of quarantine pests is threatening biodiversity and economic wellbeing. Biological diversity in Bangladesh makes it particularly vulnerable to invasion by new pests. The country has made progress with online systems for phytosanitary certification but still struggles with infrastructure gaps, weak cold-chain systems, and insufficient accredited laboratory capacity.

Bhutan

With only about 3% of its land suitable for cultivation, Bhutan’s small agricultural sector is disproportionately affected by biosecurity threats. Citrus greening disease (Huanglongbing, HLB) has severely damaged the country’s citrus industry, a major source of rural income. The Giant African Land Snail has established in the Gyalpozhing and Lingmethang areas. Fall Armyworm and Wheat Rust are emerging threats. The country’s biosecurity challenges are compounded by limited infrastructure, limited pest risk analysis capacity, and inadequate molecular diagnostic technology.

Maldives

As a Small Island Developing State (SIDS) composed of 1,192 islands spread across 900 km of ocean, the Maldives faces uniquely difficult biosecurity challenges. Agriculture contributes only 1.1% of GDP, and the country is highly dependent on food imports. The absence of an established NPPO creates critical gaps in coordination, regulation, and response. There is no diagnostic laboratory, limiting the country’s ability to test imported plant materials. Local island councils bear plant protection responsibilities without the technical knowledge or resources to fulfil them effectively. Coconut beetle infestations in the 1980s–90s demonstrated the catastrophic consequences of inadequate biosecurity response.

Nepal

Agriculture is the backbone of Nepal’s economy, and its diverse topography supports a wide variety of crops. A total of 69 alien species of fauna have been recorded, including 20 insect species. Nepal faces significant biosecurity challenges from weak diagnostic and surveillance capacity, cross-border pest incursions from both India and China, limited coordination among agencies, and climate change-driven pest shifts. Despite a complex institutional framework involving multiple ministries and departments, overlapping mandates and weak inter-agency coordination undermine effectiveness.

Pakistan

Pakistan's agriculture contributes 23.5% of GDP and employs over 37% of the labour force. Major threats include the Desert Locust (requiring constant cross-border coordination with India, Iran, and Afghanistan), Cotton Leaf Curl Virus, Citrus Greening Disease, and wheat rusts. While Pakistan has a sophisticated institutional framework through the Department of Plant Protection (DPP), the system is hampered by outdated core legislation, fragmented provincial responsibilities, and scale challenges in extension services.

Sri Lanka

Sri Lanka's Island geography provides some natural protection but also creates unique vulnerabilities as pests establish easily once they arrive. Over 30% of the workforce depends on agriculture. Biosecurity threats include Parthenium weed, the Giant African Snail, Papaya Mealybug, Banana Bunchy Top Virus, fruit fly species (*Bactrocera dorsalis and B. zonata*), and Fall Armyworm. The fruit fly problem is particularly damaging to trade, causing consignment rejections in key export markets. Sri Lanka has one of the region's more developed biosecurity systems but still faces chronic underfunding, staffing limitations, and emerging challenges from e-commerce and online plant trade.

How SAARC Member States are Addressing Biosecurity Challenges

Despite the scale and complexity of biosecurity challenges, SAARC Member States have made substantial progress in building institutional capacity, modernizing regulatory frameworks, and implementing both traditional and innovative biosecurity measures. The following section documents key approaches and initiatives by country and common themes.

Legislative and Regulatory Measures

All six countries covered in this article have established plant quarantine legislation and have designated National Plant Protection Organizations (NPPOs) responsible for enforcing phytosanitary rules. Most are signatories to the International Plant Protection Convention (IPPC), committing them to implement International Standards for Phytosanitary Measures (ISPMs). Several have recently updated their legislative frameworks.

- **Bangladesh:** Passed the Plant Quarantine Act 2011 and Plant Quarantine Rules 2018, establishing a clearer regulatory framework for imports and exports. An online automation system for phytosanitary certificate issuance has been developed, allowing importers and exporters to apply remotely without visiting offices physically.
- **Bhutan:** The Bhutan Food and Drug Authority (BFDA) operates under the Civil Service Reform Act 2022. The country has a Biosecurity and Food Safety

Strategy anchored in four principles: risk analysis, shared responsibility, evidence-based decision-making, and inclusiveness. BFDA is also designated as Bhutan's SPS enquiry point under the WTO-SPS Agreement.

- **Maldives:** While an NPPO has not yet been formally established, the government has authorized and registered over 180 pesticides and 170 biopesticides. The country has been actively engaging in regional meetings and seeking technical assistance from FAO and IPPC to strengthen its plant protection framework.
- **Nepal:** The Plant Quarantine and Pesticide Management Centre (PQPMC) serves as Nepal's NPPO. The Department of Food Technology and Quality Control (DFTQC) serves as the national SPS Enquiry Point. Nepal has invested in upgrading food and agricultural laboratories toward international accreditation standards.
- **Pakistan:** Pakistan's DPP has recently integrated with the Pakistan Single Window (PSW) digital platform, transforming paper-based permits into an electronic system. On May 2, 2025, the Government promulgated the National Agri-Trade and Food Safety Ordinance, establishing the National Agri-Trade and Food Safety Authority (NAFSA) to merge the Animal Quarantine Department and the DPP into a single, unified authority with an expanded mandate covering food safety and trade facilitation.
- **Sri Lanka:** The National Plant Quarantine Service (NPQS) operates under the Plant Protection Act No. 35 of 1999. Sri Lanka has integrated into the IPPC e-Phyto system for phytosanitary certification, reducing documentation errors and enhancing traceability. The Plant Quarantine Import Management System (PQIMS) is being developed for real-time digital processing of import permits and inspection records.

Border and Post-Border Surveillance

All SAARC Member States maintain some form of border surveillance at key entry points, though the scope and capacity vary significantly. Common measures include document verification (import permits and phytosanitary certificates), physical inspection of consignments, sampling and laboratory testing, quarantine treatment of high-risk material, and re-export or destruction of non-compliant consignments.

Pakistan's DPP maintains Plant Quarantine Outposts at all major international entry points, including seaports (Karachi, Port Qasim), international airports (Karachi, Lahore, Islamabad), and land borders with India (Wagah), Afghanistan (Torkham, Kharlachi), Iran (Taftan), and China (Sust). Sri Lanka concentrates surveillance at Bandaranaike International Airport, Colombo Seaport, and Jaffna Port, with post-border surveillance extending into agricultural regions and nurseries. Bangladesh has developed 15 Plant Quarantine Laboratories at quarantine stations across the country, supplemented by a Reference Plant Quarantine Laboratory at the head office.

Technology and Digital Transformation

Digital technologies are increasingly transforming biosecurity systems across the region:

- **Molecular Diagnostics:** PCR testing, ELISA, and DNA barcoding are being adopted in Sri Lanka, Pakistan, and Nepal to speed up and improve the accuracy of pest identification.
- **Geographic Information Systems (GIS):** Pakistan uses GIS and satellite imagery with FAO support for Desert Locust surveillance. Sri Lanka uses GIS for spatial mapping of fruit fly hotspots and detection of invasive weeds.
- **Electronic Phytosanitary Certificates (e-Phyto):** Bangladesh and Sri Lanka have implemented or are developing e-Phyto systems, in line with the IPPC e-Phyto Solution, reducing paper-based administrative bottlenecks.
- **AI and Remote Sensing:** Pakistan is piloting drone and remote sensing technologies for early detection in high-value crop zones. Bhutan is exploring ecological niche modelling for pest risk mapping.
- **Single Window Systems:** Pakistan's integration with the Pakistan Single Window (PSW) has significantly streamlined trade clearance processes.

Integrated Pest Management (IPM) and Biological Control

Several SAARC Member States have embraced Integrated Pest Management as a more sustainable alternative to reliance on chemical pesticides. Pakistan's National IPM Program, developed in coordination with CABI, has demonstrated 30% reductions in pesticide use and 10-25% yield increases in participating farms. Sri Lanka is investing in biological control research, with programs on parasitoids for mealybugs and entomopathogenic fungi for soil pests. Bhutan's National Plant Protection Centre (NPPC) is in the early stages of developing bio-protection measures as a climate-smart agricultural solution.

Farmer Field Schools and Extension Programs

Farmer Field Schools (FFS) are a key platform for biosecurity knowledge transfer at the farm level. They are operational in Pakistan, Nepal, and Bangladesh, allowing farmers to learn pest recognition, reporting, and management skills through practical, field-based training. Nepal also uses Plant Clinics to disseminate pest and disease management knowledge. Extension programs play a vital role in translating scientific knowledge about emerging pests into practical guidance for farmers.

Regional and International Collaboration

SAARC Member States have engaged in various regional and international collaborations. For example, Pakistan coordinates with neighbouring countries and FAO on Desert Locust management under the FAO Commission for Controlling the Desert Locust in South-West Asia (SWAC). Similarly, Sri Lanka and Bangladesh have both engaged with the IPPC and the Asia and Pacific Plant Protection Commission (APPPC) on phytosanitary standards. Likewise, Bhutan is participating in an Adaptation Fund project for GALS eradication, supported by the Bhutan Trust Fund for Environmental Conservation. The Maldives leverages the diagnostic and technical capabilities of neighbouring countries like India and Sri Lanka.

Constraints Limiting Effective Biosecurity Management

Despite significant progress, a consistent set of constraints limits biosecurity effectiveness across SAARC Member States. Understanding these constraints is essential for designing targeted and effective interventions.

Infrastructure and Equipment Gaps

Quarantine stations, border checkpoints, and diagnostic laboratories across the region are inadequately equipped. Many lack basic tools such as microscopes, PCR machines, fumigation chambers, cold storage facilities for specimens, and rapid test kits. In the Maldives, there are currently no laboratories with the capacity to test imported plants and plant parts. In Nepal, many quarantine posts lack modern diagnostic tools, making pest detection slow and inaccurate. Bangladesh lacks sufficient treatment plants and packing houses to handle the volume of agricultural trade. Without appropriate physical infrastructure, even well-trained staff cannot perform effective biosecurity work.

Human Resource Shortages and Skill Gaps

The availability of trained specialists including plant pathologists, entomologists, molecular biologists, pest risk analysts, and quarantine inspectors falls far short of what is needed. Several countries report difficulty retaining skilled staff. In Nepal, specialized training for quarantine officers in molecular diagnostics, epidemiology, and pest risk analysis is limited. In the Maldives, the shortage of trained personnel capable of using GIS, digital databases, and modern analytical tools severely restricts the ability to detect and respond to emerging threats in real time.

Outdated and Fragmented Legal Frameworks

Several SAARC Member States are operating under outdated primary legislations. Beyond the age of laws, there are also significant problems of legal fragmentation. In Nepal, multiple laws governing plant health, animal health, pesticides, and food safety are not harmonized, leading to overlapping mandates and implementation gaps. In Pakistan, the primary Plant Quarantine Act dates to

1976. Even where laws are relatively modern, enforcement capacity at border points remains weak due to resource constraints and coordination challenges. In the Maldives, the Decentralization Act does not clearly define the legal responsibilities of local councils regarding plant protection, creating confusion and inaction.

Financial Constraints

Chronic underfunding is the most pervasive constraint across the region. Limited government budgets constrain laboratory upgrades, staffing expansion, procurement of diagnostic tools, and development of surveillance systems. Like, Sri Lanka notes that many key facilities still rely on outdated equipment affecting testing efficiency. Similarly, Bangladesh struggles with insufficient public-private partnership models that could mobilize additional investment. The Maldives faces competing priorities for its scarce resources. Without dedicated and sustained financing, improvements in biosecurity capacity are difficult to achieve or maintain.

Weak Surveillance Systems

Timely detection of new pest incursions requires strong surveillance systems. Across the region, surveillance systems are fragmented, rely too heavily on reactive reporting rather than proactive monitoring, and lack digital integration for real-time data sharing. Like, Nepal's surveillance system has limited use of digital platforms for pest reporting. Similarly, Maldives lacks any national system for agricultural pest surveillance, relying primarily on reports from island councils after problems have already developed.

Limited Inter-Agency and Regional Coordination

Effective biosecurity requires coordination among multiple agencies: agriculture, health, customs, environment, and trade ministries, as all these play their roles. In most member states, coordination among these agencies is weak, which needs to be strengthened. Similarly, there is also need of strengthening coordination on the SAARC level.

Low Awareness Among Stakeholders

Farmers, traders, travellers, and shipping agents often unintentionally introduce or spread pests because they lack knowledge about biosecurity risks. Informal trade in seeds, planting materials, and fresh produce is a major pathway for pest and disease introduction. Low awareness makes regulation and voluntary compliance difficult. Education and outreach campaigns remain limited in scope and reach across the region.

Recommendations to Overcome Biosecurity Constraints

Based on the findings of the regional consultation and country papers, the following recommendations are proposed. They are organized by theme and aimed at different audiences including policymakers, institutions, researchers, and the farming community.

Strengthen Legal and Regulatory Frameworks

- **Modernize primary biosecurity legislation:** All member states should review and update their primary plant quarantine and biosecurity laws to reflect current threats, international standards (IPPC, WTO-SPS Agreement, Codex Alimentarius, WOAH), and emerging pathways such as online plant trade and e-commerce.
- **Develop national biosecurity policies:** Countries should develop comprehensive national biosecurity policies that integrate plant health, animal health, food safety, and environmental protection under a unified framework to minimize overlapping mandates and promote a One Health approach.
- **Clarify institutional mandates:** Legal reforms should clearly define the roles and responsibilities of all agencies involved in biosecurity, including local government bodies, to eliminate confusion and ensure accountability.
- **Establish formal NPPOs where absent:** In the countries, where still no NPPO exists, it should be stablished in that country.

Invest in Infrastructure and Technology development

- **Upgrade diagnostic laboratories:** All SAARC Member States should prioritize upgrading national plant biosecurity laboratories to international accreditation standards, investing in PCR machines, rapid test kits, DNA sequencing capabilities, and molecular diagnostic tools.
- **Modernize quarantine stations:** Border quarantine posts, particularly at international airports, seaports, and major land entry points, should be equipped with modern inspection facilities, fumigation chambers, rapid diagnostic tools, and cold storage capacity.
- **Build phytosanitary treatment infrastructure:** Invest in treatment facilities such as Vapour Heat Treatment, Cold Treatment, Hot Water Treatment, and irradiation facilities to meet the strict requirements of key export markets.
- **Expand digital platforms:** Develop and fully implement electronic phytosanitary certification (e-Phyto) systems, integrated digital platforms for permit issuance and consignment tracking, and real-time pest surveillance data-sharing systems.
- **Apply precision technologies:** Scale up the use of GIS, remote sensing, AI-driven monitoring systems, drone surveillance, and climate-based predictive models for early detection and mapping of pest outbreaks.

Develop Human Resources

- **Invest in specialist training:** Develop and implement systematic training programs for quarantine inspectors, laboratory technicians, pest risk analysts, molecular biologists, and extension officers. Training should be offered both in-country and through regional exchange programs.
- **Build university capacity:** Encourage universities and research institutions to develop specialized programs in biosecurity, pest risk analysis, molecular diagnostics, epidemiology, and food safety to produce the next generation of biosecurity professionals.
- **Train customs and border officials:** Provide biosecurity awareness and basic pest identification training to customs officials, immigration officers, and border security personnel who interact with incoming goods and travelers.
- **Build capacity at local government level:** There is need of strengthening of capacity building at local governments levels in all SAARC Member States to enable effective early detection and reporting.

Improve Surveillance and Early Warning Systems

- **Establish national pest surveillance networks:** All member states should develop national pest surveillance networks integrating field officer observations, farmer reporting (through plant clinics and mobile tools), sentinel sites, and remote sensing for continuous monitoring of emerging threats.
- **Create regional early warning systems:** There is need of creation of early warning regional network system to enable real-time pest alert sharing among SAARC Member States. Joint surveillance programs and shared databases on pest status should be developed.
- **Conduct baseline surveys:** Countries (particularly the Maldives), lacking baseline data on endemic, invasive, and emerging species, need to prioritize comprehensive baseline surveys to inform future risk assessment and policy decisions.
- **Integrate climate change projections:** Pest surveillance and risk models should incorporate climate change projections to anticipate how pest distributions and outbreak probabilities will shift under future climate scenarios.

Strengthen Inter-Agency and Regional Coordination

- **Create multi-sectoral coordination mechanisms:** Each Member State should establish or strengthen a formal, permanent multi-sectoral biosecurity coordination body that routinely brings together agriculture, health, customs, environment, and trade agencies to harmonize regulations and coordinate responses.

- **Expand SAARC regional collaboration:** SAARC Member States should strengthen regional cooperation through shared pest alerts, joint surveillance programs, harmonized phytosanitary standards, coordinated responses to transboundary pests, and regional capacity-building programs.
- **Establish regional expert rosters:** A roster of South Asian biosecurity and plant quarantine experts should be maintained to facilitate rapid expert deployment and consultations in response to emerging threats.
- **Pursue bilateral laboratory agreements:** For smaller countries like the Maldives, there is need to negotiate for bilateral laboratory agreements with regional countries (India, Sri Lanka) for quick and cost-effective diagnostic testing support and pre-approved sample-sharing protocols for emergencies.

Secure Sustained Financing

- **Allocate dedicated budget lines:** Governments should allocate dedicated, multi-year budget lines for plant quarantine infrastructure, laboratory development, research, surveillance systems, and human resource development.
- **Engage international development partners:** Member states should actively pursue funding from international development organizations (FAO, World Bank, ADB, IFAD, UNDP etc) for biosecurity capacity building and infrastructure development.
- **Promote public-private partnerships:** Private sector engagement should be encouraged, particularly in areas such as diagnostic laboratory services, cold chain management, treatment facilities, and packing houses.
- **Leverage regional funds:** SAARC mechanisms and regional development banks should be explored as sources of financing for regional biosecurity infrastructure and joint programs.

Raise Public and Stakeholder Awareness

- **Develop comprehensive awareness programs:** Governments should develop and implement multi-year, targeted biosecurity awareness campaigns for farmers, traders, importers, exporters, travellers, and customs officials. Campaigns should use multiple communication channels including radio, mobile phones, social media, and community meetings.
- **Strengthen Farmer Field Schools:** Scale up FFS programs to reach more farmers with practical pest recognition, reporting, and basic management skills. FFS should specifically address biosecurity risks associated with seed exchange and the movement of plant material.
- **Incorporate biosecurity in school curricula:** Introduce basic concepts of plant health, invasive species, and biosecurity into school curricula to build a long-term culture of biosecurity responsibility.

- **Use Good Agricultural Practices (GAP):** Promote adoption of GAP among farmers, with specific attention to biosecurity-relevant practices such as certified seed use, proper sanitation, and compliance with phytosanitary requirements for export.

Conclusion

Agricultural biosecurity is a fundamental requirement for food security, economic stability, and environmental health in South Asia. The SAARC region's agricultural systems, which support the livelihoods and food security of over 2 billion people face growing threats from pests, diseases, and invasive species that are amplified by globalization, increasing trade, and climate change.

The regional consultation documented in this article demonstrates both the progress that SAARC Member States have made and the significant work that remains. Countries have developed legislative frameworks, established institutions, built some diagnostic capacity, and begun adopting digital and precision technologies. However, critical gaps remain in infrastructure, human resources, surveillance, inter-agency coordination, financing, and public awareness.

Prevention remains the most cost-effective biosecurity strategy. Once pests are established, management costs increase enormously and outcomes are uncertain. Investing in strong border and post-border systems, robust diagnostic laboratories, and effective early warning networks is far cheaper than attempting to eradicate or manage established invasive pests.

Regional cooperation is essential. Pests and diseases that affect one SAARC Member State will inevitably threaten its neighbours. Shared surveillance networks, harmonized phytosanitary standards, joint early warning systems, and coordinated responses to transboundary threats are not optional enhancements — they are essential components of an effective regional biosecurity system.

The recommendations in this article provide a roadmap for action across multiple dimensions: legal reform, infrastructure investment, human resource development, surveillance improvement, inter-agency coordination, financing, and awareness raising. The path forward requires sustained commitment from governments, continued investment from development partners, active engagement of the private sector, and the participation of farmers and communities as frontline biosecurity stewards.

With strong governments support, adequate resources, and meaningful regional collaboration, SAARC Member States can build the biosecurity systems needed to protect their agriculture sector and ensure food security for future generations.

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Chapter 2

Agricultural Biosecurity and Plant Health in Bangladesh

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Introduction

Bangladesh is predominantly an agrarian country. Due to its very fertile land and favorable weather, a large number of crops grow abundantly in this country. During the FY 2023-24, the share of agriculture sector in the country`s GDP was about 11.55% (BBS, 2024) and it employs around 44.42% of total labor force (Source: Labor Force Survey 2023 Final Report).

Table 1. Major Field crops grown in Bangladesh, their area and production

SL	Name	Area (ha)	Production (MT)
1.	Aus Rice	959000	27934000
2.	Aman Rice	5612000	16500000
3.	Boro Rice	11617200	41916100
4.	Jute	692800	7865200
5.	Mustard	1040200	1534200
6.	Vegetables	1187700	25073700
7.	Dried chili	164800	502900
8.	Green chili	164800	1642800
9.	Turmeric	38400	159700
10.	Coriander	45800	63100

Table 2. Major Horticultural crops grown in Bangladesh, their area and production

SL	Name	Area (ha)	Production (MT)
1.	Mango	205034	2508973
2.	Jackfruit	58700	1830131
3.	Litchi	30051	230480
4.	Banana	90001	2438247
5.	Papaya	29000	726890
6.	Guava	32975	613336
7.	Jujube	15484	176473
8.	Coconut	36729	505539
9.	Black Pulm	5402	45308
10.	Pine apple	21480	580299

Source: Department of Agricultural Extension, FY- 2024-2025

Plant Biosecurity

Biosecurity in agriculture refers to the measures taken to prevent the introduction and spread of diseases, pests, and other harmful organisms in agricultural settings, protecting livestock, crops, and the environment. It encompasses a range of practices aimed at minimizing risks associated with disease outbreaks and their potential negative impacts on food production and the economy.

Biosecurity refers to a standard operating procedure (SOP) applied to minimize the risk of the introduction and spread of disease-producing agents (Tanquilut et al., 2020). The underlying framework of biosecurity is based on identifying all potential entry and transmission pathways of pathogens and subsequently formulation of combined procedures to seal those pathways (Anderson et al., 2014).

International Standard for Phytosanitary Measure

An international standard adopted by the Conference of FAO, the Interim Commission on Phytosanitary Measures or the Commission on Phytosanitary Measures, established under the IPPC [ISPM 5; CEPM, 1996; revised CEPM, 1999].

Quarantine pests are important threats to ensure phytosanitary measures in Bangladesh. Biological diversity of Bangladesh is more vulnerable to the invasion of new pests. The emerging pests may be invasive or existed in Bangladesh without notice and now appearing as prominent. Farmers are facing problems because most of these pests are difficult to control without chemical pesticides. The spread of quarantine pests is now recognized as one of the major treats to the plant biosecurity or regulatory plant health, biodiversity and economic wellbeing of Bangladesh.

Biosecurity has emerged as a major global issue. Harmful plant pests and diseases can impact on food safety, trade, market access, market development and, ultimately, the profitability and sustainability of plant industries.

Plant pests and diseases which seriously impact on agricultural industry in other countries upon entry into Bangladesh would harm the quality of home plant products. If Bangladesh fails to produce safe plant products, entry into international markets (especially vegetables and fruits) won't be possible. So, the country faces a trade loss of Tk 19 crore per annum e.g., Citrus canker (*Xanthomonas axonopodis*), and Citrus thrips (*Thrips palmi*) (Exporters Association, 2010).

Phytosanitary Measure (PM)

Any legislation, regulation or official procedure having the purpose to prevent the introduction or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests [ISPM 5: revised IPPC, 1997].

Sanitary and phytosanitary (SPS) measures

SPS measures are biosecurity measures designed to protect human, animal or plant life or health from the introduction, establishment and spread of pests and diseases, additives, toxins and contaminants in food and feed.

Bio-Security Measure (BSM)

BSM is the implementation of a segregation, hygiene, or management procedure (excluding medically effective feed additives and preventive/curative treatment of animals) that specifically aims at reducing the probability of the introduction, establishment, survival, or spread of any potential pathogen to, within, or from a farm, operation or geographical area.

International Standards for Phytosanitary Measures (ISPMs)

ISPMs are the standards adopted by the Commission on Phytosanitary Measures (CPM), which is the governing body of the IPPC. The IPPC is the only standard setting organization for plant health. In addition, these standards, guidelines and recommendations are recognized as the basis for phytosanitary measures applied in trade by the Members of the World Trade Organization under the Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement). Both contracting and non-contracting parties to the IPPC are encouraged to implement these standards. Standards in themselves are not regulatory instruments but come into force once countries establish requirements within their national legislation. Requests for specific information on import requirements should be addressed to the national plant protection organizations (NPPOs) of the country of import. This page, under the IPPC website is dedicated to the Standards for Phytosanitary Measures (ISPMs). It includes all adopted ISPMs International (Training manual 2024).

International Plant Protection Convention (IPPC)

IPPC is an international plant health agreement that aims to protect cultivated and wild plants by preventing the introduction and spread of pests. International travel and trade are greater than ever before. As people and commodities move around the world, organisms that present risks to plants travel with them.

Currently, the IPPC Strategic Framework 2020-2030 provides the "blueprint" plan for the IPPC's work programme to help contracting parties elevate their phytosanitary capacity by using the right tools and receiving the relevant technical support to advance plant health and respond to existing and emerging phytosanitary challenges. It reflects the strategic mission, vision and goal of the IPPC, and describes the operational elements that will help deliver these aspirations. The IPPC's strategic framework also aims to boost food security, promote agricultural productivity of a thriving plant health community, improve global trade in plants and plant-based products and contribute to the attainment of the United Nations Sustainable Development Goals. According to FAO:

- Plant pests and diseases cause economic losses of about USD 220 billion annually.
- More than 240 million containers are shipped between countries, carrying different kinds of goods, including plant products. Containers can carry pests in form of seeds, snails, slugs, soil, spiders and other biosecurity risks on their interior or exterior.
- About 80 percent of all consignments moving in international trade include some form of wood packaging material (WPM). WPM made from raw wood is a pathway for pest spread.

International trade is the spine of many national economies; making food available, yet it allows for the easier introduction and spread of pests.

Therefore, as the only international convention for plant health, the IPPC adopts International Standards for Phytosanitary Measures (ISPMs), which play an essential role in harmonizing how countries manage the international trade of plants and promoting global cooperation on trade facilitation (https://www.ippc.int/en/strategic-objectives/plant-health-safe-trade/).

Growing interest in Biosecurity is a result of major international developments such as globalization of the world economy, the rapid increase in volume of communications, transport and trade, technological progress and growing awareness of problems faced by biological diversity and environment. Members require effective efficient improved and updated international frameworks and standards to support appropriate national action. Members also require national frameworks to regulate manage and control biosecurity for food and agriculture.

The SPS Agreement allows WTO members to set their own standards on food safety and animal and plant health. But these standards must be based on science, applied only to the extent necessary to protect human, animal or plant life or health, and not arbitrarily or unjustifiably discriminate between countries where identical or similar conditions prevail.

Members are encouraged to use international standards, guidelines and recommendations but may adopt higher levels of protection if there is scientific justification for it, or if they are based on appropriate assessment of risks. The SPS Agreement allows countries to use different methods of control, inspection and approval procedures to verify compliance with adopted standards. Transparency regarding governments' SPS regulations is a key provision to avoid unnecessary barriers to trade (WTO SPS Agreement).

Policies, Rules & Regulations on Biosecurity in Bangladesh

1. The plant quarantine act 2011
2. The plant quarantine rules 2018
3. National Agriculture Policy 2018
4. National Organic Agriculture Policy 2016

Institutional arrangements for biosecurity and their rules and responsibilities in Bangladesh for plant health management

Plant quarantine wing of Department of Agricultural Extension under Ministry of Agriculture act as National Plant Quarantine Organization in Bangladesh. The Director plant quarantine wing act as the head of plant quarantine wing as well as NPPO of Bangladesh. NPPO of the country maintains international trade by following above mentioned act, rules, policy as well as International Plant Protection Convention (IPPC) guidelines. Bangladesh became a signatory of FAO International Plant Protection Convention (IPPC) in 1974. The country is also a member of Asia Pacific Plant Protection Commission (APPPC) in 1978 to formulate rules and regulations and to prevent spread of destructive insect pests.

There are three sections at head quarter including:

1. Import section,
2. Export section,
3. Quarantine rules, policy & laboratory section

Plant Quarantine Wing was separately formed in 2014. Before that, it was a section of Plant Protection Wing of DAE under Ministry of Agriculture.

- The wing has 30 Plant Quarantine Stations & Packing House.
- Plant Quarantine Stations in Land Port – 20
- Plant Quarantine Stations in Sea Port – 03
- Plant Quarantine Stations in River Port – 01
- Plant Quarantine Stations in Air Port – 03
- In Land Container Terminal-02
- Central Packing House-01

Main Functions of National Plant Protection Organization (NPPO) of Bangladesh

- Enforcement of the Plant Quarantine Act 2011 and plant quarantine rules 2018.
- Incorporation of new Rules and Policies according to the IPPC, International Agreement, Protocol, Convention, etc. as a signatory of WTO.
- Promote Plant Quarantine Activities to maintain biosecurity at the Entry/Exit Points.
- Issuance of Online Import Permit Certificate (IP), Phytosanitary Certificate (PC), Release Order (RO), to Regulate the Plants and Plant Products, Pests, Beneficial Organisms and Packing Material.
- Recording Interceptions of Pests and Diseases.
- Arranging various Training of the Stakeholders to Facilitate Export & Import.
- Maintaining a Linkage with Other Research Institutions, Universities as well as Other Related Organizations.
- Conduct PRA, Pest Listing Activities, Online Contract Farming & Traceability System.
- Regular Field Monitoring of the Contract Farmers Field and Maintaining the Pest Free Area or Pest Free Site.
- To conduct treatment formalities for disinfestations or disinfection of pests of the consignments of plants or plant products and their containers, packing materials, conservation stores or conveyances.
- To Conduct Activities Regarding Post-Entry Quarantine of Plants or Plant Products and to Implement the Phytosanitary Measures.
- To Exchange Technical Information, Opinion and Report with Recognized International, Regional or Other National Plant Protection Organizations and

to Keep Abreast of the Latest Advancements in the Field of Plant Protection and Quarantine.

- To Conduct Activities Regarding Diagnosis, Detection and Identification of Particular Pests. Working in Partnership with Clients by Providing Programs and Services that Reflect the Needs of Industry and Community.
- All Plant Quarantine Stations issue Phytosanitary Certificate during export of plants and plant products.
- Issue Release Order (RO) for entry of agriculture products if the importers fulfill the conditions of IP (Import Permit).
- Import permits are issued only from Head Quarter and Plant Quarantine Stations, Sea Port, Chattogram. About 70-75% export-import activities are done through PQS, Sea Port, Chattogram.
- Necessary inspection, phytosanitary treatments and other quarantine activities.

Plant quarantine laboratory

We have a Reference Plant Quarantine Laboratory in our Head Office, a Plant Quarantine Lab in Central Pack House, Shampur and 15 Plant Quarantine Laboratories in 15 Plant Quarantine Stations. But most of them are not well equipped and lack of skill manpower.

Constraints for Biosecurity of NPPO in Bangladesh

Existing acts, rules and regulations on biosecurity of Bangladesh should be reformed considering facing the challenge of regional and international trade. Following measures can be taken into account:

- Inadequate Infrastructure of plant quarantine stations.
- Scarce of Manpower Shortage & Skill Gaps.
- Weak Cold Supply Chain Management System.
- Insufficient Treatment Plant & Packing Houses.
- Absent of Pest and disease diagnosis rapid testing kit.
- Limited International Standard of Surveillance system.
- Lack of Public-Private Partnership (PPP) model development.
- Insufficient Accredited Laboratory for rapid testing of plant and plant products.

Way forward

- Upgrade Infrastructure of plant quarantine stations.
- Regular Training of the Quarantine Officials & Stakeholders.
- By Updating the Surveillance System.

- Invest in Research & Innovations Area.
- Invest More for the Rapid Test Kits & Modern Accredited Laboratories.
- Engage the Private Sector to Modernize the Cold Chain Management System.
- Establish More Treatment Plants & Packing Houses.

Recommendations for fostering plant quarantine activities

The agricultural trade of Bangladesh is struggling to meet international SPS standards due to inadequate and expensive testing facilities, weak border quarantine systems and compliance awareness. High tariffs and regulatory restrictions limit market entry for many agricultural products. Many plant products are not structured for export due to fragmented supply chains. SAARC countries can share resources, knowledge, experience and risks in order to preserve biosecurity in the production, trading, export, import of plant and plant products harmonizing sanitary and phytosanitary (SPS) standards among the countries. There is a need of emphasizing on critical sanitary and phytosanitary (SPS) compliance gaps regarding biosecurity that hinder regional and international trade. It is crucial to strengthen regional pest risk management systems, transportation, packaging, enhance contract farmer adaptation of Good Agricultural Practices (GAP), traceability protocols and market linkage.

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Agriculture Biosecurity in Bhutan

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Introduction

Only about 3% of Bhutan's total land area is suitable for agricultural cultivation. Despite this limitation, agriculture remains a vital sector, producing a variety of crops. Among these, cereals account for the highest share of production, while fruits contribute the least. According to the Statistical Year book of Bhutan 2025, the production figures are as follows: Potato: 37,778 MT, Apple - 2,102 MT, Mandarin - 20,830 MT, Arecanut-14,405 MT, Vegetables, 13,827 MT and Cereals 72,177 MT respectively.

These outputs collectively sustain Bhutan's projected population of 784,043 people in 2025. Given this context, agricultural biosecurity is of paramount importance to protect the limited agricultural base from the threat of pests and diseases. To safeguard agriculture from emerging pest threats, the Bhutan Food and Drug Authority (BFDA) is mandated to implement plant biosecurity measures and enforce Sanitary and Phytosanitary (SPS) measures as the designated enquiry point, thereby facilitating the safe trade of plants and plant products.

In fulfilling this mandate, BFDA works in close collaboration with the National Plant Protection Centre (NPPC), Ministry of Agriculture and Livestock (MoAL), which provides the technical expertise for pest risk assessment and management. The NPPC serves as the nodal agency for all plant protection activities in Bhutan, including research and development, pest surveillance, and management programs.

The Bhutan Food and Drug Authority (BFDA) is the National Plant Protection Organization of Bhutan (NPPO) under the Ministry of Health, also functions as Official Contact Point for International Plant Protection Convention (IPPC).

With the Civil Service Reform Act of Bhutan 2022, the restructuring exercise reflects the BFDA's commitment to achieve the mission of excellence in protecting and advancing the health and safety of the Nation. BFDA is also designated SPS enquiry point for Bhutan for implementation of SPS Agreement responsible for dissemination of information to public, exporters and importers on SPS regulations.

The Plant and Animal Biosecurity Division (PABD) under BFDA has the mandate to:

a) Ensure quality and safety of food and feed.

b) Protect biodiversity, environment and agricultural system from pests and diseases, invasive species and genetically modified organisms.

c) Facilitate smooth import and export of agricultural produce through fulfilment of sanitary and phytosanitary (SPS) requirement.

In the 13 FYP, one of the key activities is to improve biosecurity risk preparedness and response capability of BFDA officials in the management of plant biosecurity incident responses jointly with the technical department. KPI for BFDA in the 13 FYP to sustain >90% proportion of exotic livestock and agriculture pests and diseases prevented.

The Bhutan Biosecurity and Food Safety Strategy and Action Plant also underpin fours underlying principles for the continuous improvement of the Bhutan's biosecurity capability;

i) Risk analysis paradigm,

ii) Shared responsibility,

iii) Evidence-based decision making,

iv) Inclusiveness and transparency.

State of Plant Health in Bhutan

Highlight on emerging pest and quarantine challenges

With the globalization of agricultural trade, pest risks are continuously increasing, posing serious threats to both agriculture and the environment. Bhutan is currently facing challenges from the invasion of invasive species such as the Giant African Land Snail (GALS), as well as devastating pest outbreaks like citrus greening disease, which has severely affected the country's citrus industry.

In addition, pest incidences such as Rhynchocoris poseidon (*citrus shield bug*) and Byturus tomentosus (*raspberry beetle*) have created further challenges, hindering the marketing and export of key fruits such as mandarin oranges and apples to certain international markets.

Due to the transboundary nature of pest movement, the country has witnessed the emergence of pests such as Fall Armyworm and Wheat Rust diseases. In response, the NPPC has initiated timely surveillance programs to monitor their spread, assess their destructive impact, and strengthen management measures within the country.

Further, NPPC timely reviews its management strategies to adopt user-friendly and environmentally sustainable treatments. In line with the global shift towards reducing dependence on chemical pesticides and promoting bio-protection as a climate-smart agricultural solution, NPPC is also exploring research on biological control. Currently, it is at the initial stage of collecting and identifying potential bioagents and evaluating antagonistic bioprotective measures to control the spread and maintain it below the economic threshold level.

Bhutan has been experiencing pressure on biosecurity pest risk from emerging pests including weeds and invasive alien species due to increased trade and movement of people globally. Some of the pressing and priority emerging pests that require attention are listed in the Table 1.

Table 1. Some of the pressing and priority emerging pests in the country

Sl. No.	Common Name	Botanical Name	Impact
1.	Citrus greening (HLB) Bacterial disease	*Candidatus liberibacter asiaticus*	Widespread and wipe out citrus industry Medium-high entry potential
2.	Giant African Land Snail (IAS)	*Achatina fullica*	Gyalpoizhng/Lingmethang/Aut sho
3.	Tomato leaf miner Insect pest (IAS)	*Tuta absoluta*	Quarantine pest Absent in Bhutan Entry (seedling, fruits, etc)
4.	Fall Armyworm Insect (IAS)	*Spodoptera frugiperda*	Highly destructive Inspection & monitoring
5.	Spruce bark beetle	*Ips Schmutzenhoferi* *holzschuh*	Eastern Himalayan spruce and Pinus species Destructive pest (west & central) Low-medium risk (introduction and spread)

There are SPS issues recorded in particular to pest/disease associated with trade apple and mandarin such as *Rhynchocoris Poseidon* (citrus shield bug) and *Byturus tomentosus* (Raspberry beetle) etc.

Current Biosecurity measures/Risk Management System

International Quarantine Measures
Biosecurity continuum
Pre-border measures

Prior approval and import permit must be obtained from BFDA before importing the plant consignment. In some cases, the import of consignment must meet pest risk analysis (PRA) before granting approval of import. Quarantine risk are mitigated.

Border measures

At the frontline, ICP Royal Bhutan Police verify the document and consignment and allow for entry. Implement the memorandum of understanding (MoU) that exist between BFDA and ICP RBP. At the mini-dry port (MDP), the Regulatory and quarantine inspector of BFDA carryout import inspection at the border comprising document verification and consignment checking as per the import requirements. Document such as Import permit issued by BFDA and Phytosanitary certificate issued by exporting country are checked at arrival of plant consignment. Sampling and further diagnosis/analysis will be done as when required in relevant laboratories. The consignment must meet standard and phytosanitary requirements.

Post-border measures

Plant consignment which does not comply with the regulations and also requiring further examination, testing and treatment are put under quarantine. The samples are referred to the National Plant Protection Centre (NPPC) which is the apex institution responsible for plant protection program for further pests, diagnosis and analysis. For post entry growth test, BFDA collaborate with Agriculture Research and Development Centre (ARDC).

Internal (Domestic) Quarantine Measures

Any pest outbreak in the region, the Ministry of Agriculture and Livestock or local government based on the advisory from technical department (DoA) issues a notification, following which BFDA initiate implementation of domestic quarantine. The plant consignments are inspected and disinfected before lifting any materials from the infested zones. Local government and community usually partake in the campaign and containment program.

Currently, innovative GALS eradication program is ongoing with the support of Adaptation Fund Project through Bhutan Trust Fund for Environmental Conservation. Expected outcome are: Validate trapping system, develop strategies and models, and awareness generation, capacity building of community and stakeholders to manage and target eradication of GALS at Lingmethang and Gyalpozhing.

Further BFDA is imposing internal quarantine on citrus germplasm movement within the country to protect the citrus industries unless the germplasm is known to train [ported from certified farms or nursery].

Capacity of the National Plant Protection Organization (NPPO)

Risk-based inspection of import inspection is conducted by competent BFDA officials with accrued knowledge and skills over the period. Optimal use of limited tools, equipment and facilities. Risk analysis is conducted with limited PRA analyst pre-screening and prevention of destructive pest and disease.

Awareness and community engagement through people-public partnership in plant biosecurity

Frequent awareness and education on plant biosecurity are organized as and when funds are made available. One of the impactful events organized recently was celebrating the International Day of Plant Health on 12 May 2025 at Gyalpozhing, Mongar support through Adaptation Fund in effort to manage and eradicate Giant African Land Snails (GALS) infestation in the area. Biosecurity is a shared responsibility and the attempt was made with the people-public partnership with the engagement of local government and community which will be pursued for successful achievement.

Biosecurity Policy and Regulations

The Bhutan Food and Drug Authority (BFDA) as National Plant Protection Organization (NPPO) of Bhutan and Official Contact Point of International Plant Protection Convention (IPPC) strives to protect and safeguard the biodiversity, agriculture and environment in country and also contribute to global prevention of introduction and spread of pests. Implement national phytosanitary laws and regulations in harmony with the international framework and standards;

International framework and phytosanitary legislation

- International convention (IPPC) - Article Text 1997 and ISPMs standards (46 adopted now) are harmonized.
- WTO-Agreement on the Sanitary and Phytosanitary Measures effort to align.

National policy and legislation (Implementing Tools)

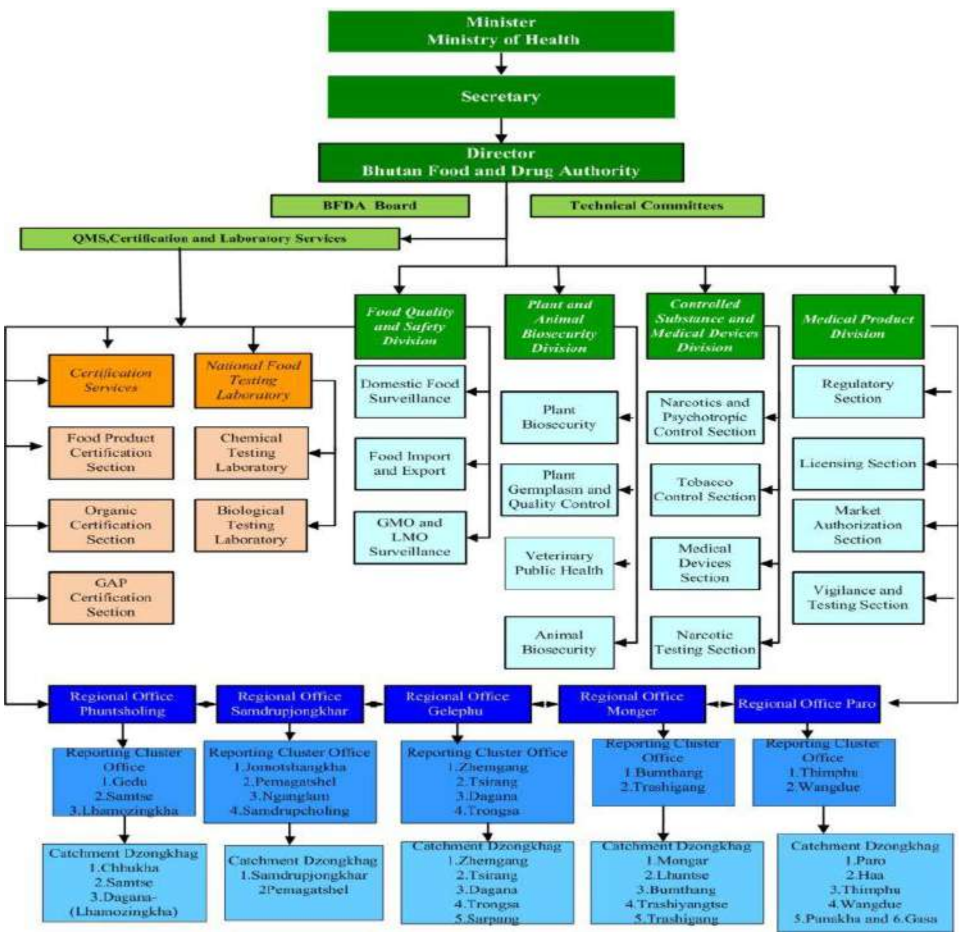
- Biosecurity policy of the Kingdom of Bhutan, 2010.
- The Plant Quarantine Act of Bhutan, 1993.
- Plant Quarantine Rules and Regulations of Bhutan, 2018.
- The Seed Act of Bhutan, 2000.
- Seed Rules and Regulations of Bhutan, 2018.

- The Pesticide Act of Bhutan, 2000.
- Pesticide Rules and Regulations of Bhutan, 2019.
- Bhutan Biosecurity and Food Safety Strategy and Action Plan 2021-2028.
- Guidelines and manuals (Plant Quarantine Manual 2021, Plant biosecurity contingency plan 2021).

BFDA is entirely implementing the Plant Quarantine regulations in the country, however enforce only the regulatory functions of all other related RNR Acts and regulations. The concerned technical agency develops the policy and regulations in consultation with regulatory agency.

1. Institutional Arrangements for biosecurity roles and responsibilities

1.1. Organogram



1.2. Plant Quarantine arrangement

The Plant Biosecurity Section of the PABD lead by Chief Regulatory and Quarantine Officer undertake implementation of plant biosecurity mandates with the following current setup;

Plant Section, PABD, Head Office

- Focal for Plant biosecurity
- Focal for Seed certification
- Focal for Agro-chemicals

The plant focal perform their roles and responsibilities as per the functions and ToR defined.

Regional Offices

- Support Plant Section in developing realistic plans and programs.
- Perform as per the functions (Refer to functions).
- About 55 plant quarantine officials.

Major Functions of Plant Biosecurity Section

1. Develop policy, regulations, standards, guidelines and other documents related to plant biosecurity and quality in harmony with international and national legislations and framework through consultation and participatory process.
2. Conduct biosecurity assessment through a science-based approach and international best practices (Pest Risk Analysis) for the import of plants, plant products and regulated articles.
3. Issue import authorization for plants, plant products, agro - inputs, and regulated articles.
4. Regulate invasive alien species (IAS) and Living Modified Organism (LMOs).
5. Implement and manage plant quarantine measures (Inspection, phytosanitary treatment - disinfection, disinfestation, fumigation, heat treatment, etc.).
6. Implement and manage domestic quarantine measures for plant pest and diseases as per the specific pest and disease prevention, control and eradication program (Plant biosecurity contingency plan).
7. Conduct surveillance and compliance monitoring of plants, plant products and regulated articles (Pest surveillance for imported consignment) - NPPC carry out field surveillance.

8. Register nursery operators for certification of seeds and enforcement of biosecurity measures and quality standards.
9. Facilitate export of plant and plant products through inspection, testing, treatment and certification services as per Phyto-sanitary requirements.
10. Issuance of export certificate and Phytosanitary for wood, timber and non-wood forest products.
11. Create awareness program on Plant Biosecurity to the relevant stakeholders.
12. Build Competence of the officials in the different areas of Plant Biosecurity and (KSA).
13. Liaise with relevant agencies at the National, Regional and International level relating to plant biosecurity and quality (communication skills), number of correspondences and collaborations)-Participation in the IPPC commission meeting and APPPC regional workshop.

Country's initiatives on enhancement of Plant biosecurity

Plant biosecurity is gaining significance with globalization and trade of agriculture commodities and plant genetic resources.

- Established Heat Treatment facilities at PAQS, Phuentsholing.
- Initiated Bhutan to join IPPC ePhyto Solution through STDF support.
- Ecological Niche Modeling to assist pests' projection and risk mapping through Adaptation Fund Project.
- Data management analysis and reporting capability (Risk based and evidence based regulatory measures/decision).
- NPPC under DoA has initiated research study for few biological controls to combat the pests as many bioagents can survive across different ecological conditions.

Stakeholders' management

These stakeholders have crucial role in risk management of ensuring agriculture biosecurity in the county;

- Ministry of Agriculture and Livestock (Department of Agriculture, National Plant Protection Center, National Biodiversity Centre).
- Ministry of Energy and Natural Resources (Department of Forest and Park Services).
- Integrated Check post, (Royal Bhutan Police).
- Department of Revenue and Customs.

- Bhutan Exporters Association.
- Association of Wood Based-Industry.
- Farmers.
- Farmers group and Cooperatives.

Policy recommendations to strengthen plant quarantine

Civil Service Reform Act of Bhutan 2022-Structural change (MoH), Current policy and regulations must be updated for effective regulatory enforcement;

- Conducting Legislative Impact Assessment (LIA) of relevant regulations.
- Revision of Plant Quarantine Act 1993.
- Revised Plant Quarantine Rules and Regulations 2018.

International Plant Protection Convention (IPPC)-Legal provision for National Plant Protection Organization (NPPO) and participation (APPPC membership). Establishment of plant biosecurity advisory committee.

Harmonization with the International Standards & requirements (Sanitary and phytosanitary requirements-SPS Enquiry Point, Plant Quarantine and Phytosanitary measures.

Constraints/challenges

- Lack of plant biosecurity advisory/scientific committee.
- Limited pest risk analyst.
- Limited digitalization and technology leverage.
- Testing and diagnosis laboratory pest and pathogen.
- Inadequate quarantine infrastructure and facilities (inspection deck, screening facilities, treatment facility, etc.).
- Insufficient SPS information at regional and international level on procedure and standards.

Way forward within the country

- Strengthen national plant quarantine system, risk analysis and research laboratories with modern tools and equipment.
- Need to establish SPS committee in the country.
- Data management for evidence-based decision making.
- Digitalization and leverage of technology (ePhyto Solution/e-certification).

- Outsource treatment services to private sector & Collaboration with stakeholders.
- Improve stakeholders' linkage and community engagement in reducing biosecurity threats (shared responsibility).
- SAC office could facilitate the sharing of innovations and technologies, which are of user-friendly pest surveillance detection tools - such as ODK mobile applications.
- SAC office to develop a common database on emerging and quarantine pests among SAARC member countries.

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Agricultural Biosecurity for Plant Health in Maldives

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Introduction

Agriculture in the Maldives is predominantly on small scale and subsistence based, practiced on scatted island where arable land is scarce. Though agriculture is a minor sector in the country's economy compared to fisheries and tourism, it plays important roles in rural livelihood and food security. According to 2019 data, the contribution of agriculture sector in the GDP of the country was 1.1%. Men primarily practice commercial agriculture, which focuses on high-value commodities including bananas, papayas, chili, cucumbers, and pumpkin for resort markets (UNDP, 2021).

Field crops are generally grown on open land with minimal mechanization. Millets and sorghum are among the traditional field crops, although now cultivated in limited quantities. Sugarcane is grown for local use, while coconuts are a major field crop found on almost every island, vital for producing oil, coir, and copra. Horticulture is a more vibrant sector of Maldivian agriculture, especially in home gardens, community farms and private farming islands that are used to grow a wide variety of fruit and vegetables. Some of the key horticultural crops include pumpkin, watermelon, banana, chili, papaya, and breadfruit.

Historically, before the introduction of modern aviation and sea transport, the Maldivian agriculture and forestry experienced no significant pest issues. As the country and its islands became more accessible via aviation with the opening of its airport in 1960, the island nation’s natural geographic barriers that protected the fragile ecology became significantly exposed to introduction of exotic pests and pathogens. The transport of people and goods from foreign countries without implementing biosecurity at ports continued until 2007. The Ministry of Fisheries and Agriculture being overwhelmed with increasing pest outbreaks sought to implement biosecurity at major ports by establishing the Plant and Animal Quarantine Unit in 2007 and began the drafting of the National Plant Protection Act which came to light on 2011.

Invasive species, pest outbreaks, and climate change all posed challenges to Maldivian agricultural biosecurity. Over time, the introduction of non-native plants, pest insects and plant pathogens has damaged the fragile island ecosystems. The Maldives subsidized imports of agricultural inputs such as seeds and seedlings which led to the introduction of more than 323 non-native species for cultivation, accounting for more than 55% of the total plant species in the country in 2015. (MEE, 2015). According to Mohamed, I. A. (2024), Pest outbreaks, such as the coconut beetle infestation in the 1980s and 1990s, have already demonstrated the susceptibility of local crops due to poor pest control infrastructure. Furthermore, climate change exacerbates biosecurity issues by raising sea levels, increasing soil salinity, and exposing islands to extreme weather, which disrupts agricultural activities and water availability. Recognizing these issues, the Maldivian government has implemented several programs to improve sustainable agriculture and strengthen biosecurity.

One of the most notable is the Maldives Agribusiness Program (MAP), which began in 2020 with funding from the International Fund for Agricultural Development (IFAD). MAP targets nearly 6,000 smallholder households with the goal of promoting climate-resilient farming, strengthening agricultural policies, and improving market access (Ministry of Agriculture, 2020). Recent partnerships have also contributed to the improvement of agricultural infrastructure. For example, the Agriculture Economic Zone (AEZ) project, developed in collaboration with Chinese enterprises, proposes to construct farmland parks, transportation centers, and processing zones on reclaimed ground. China also sent equipment in April 2025, such as soil test kits and insect diagnostic instruments, to help the Maldives improve its biosecurity and climate resilience.

The Government of the Maldives, in partnership with international stakeholders, has taken significant steps to enhance agricultural biosecurity. The Ministry of Agriculture and Animal Welfare has established a solid policy framework centered on the National Fisheries and Agricultural Policy (2019-2029), which prioritizes biodiversity protection, disease control, and sustainable input usage. The policy promotes agroecological practices and local production of inputs like fertilizers, pesticides, and animal feed in order to reduce import dependence and mitigate biosecurity hazards. To safeguard the agricultural sector, the Maldives has strengthened border controls in response to its significant dependence on imported food and agricultural inputs. Phytosanitary Import inspections are conducted under the oversight of the Ministry of Agriculture and Animal Welfare to ensure adherence to national regulations and laws.

Between January and April 2025, authorities documented the importation of more than 3.8 million plants. In addition, the country manages a national agrochemical registry that currently includes over 180 authorized pesticides and 170 biopesticides. This initiative supports the reduction of hazardous chemical usage while encouraging the adoption of safer, more sustainable pest control alternatives.

Over the years, the increased introduction of non-native plant species has resulted in stricter quarantine measures, tighter pesticide laws, and better compliance with international standards such as the IPPC and the Rotterdam Convention. Therefore, with the engagement with international stakeholders the Maldives aims to increase agricultural biosecurity by distributing diagnostic devices such as avian flu test kits and soil analyzers to local councils.

Furthermore, the government is making great progress through farmer training programs, international conferences and workshops, and national public awareness campaigns. Despite ongoing issues with diagnostic capacity and logistics, these actions show a growing commitment to building a more secure and sustainable farm sector.

Biosecurity laws. Regulations, policies and strategies and assess national standards for phytosanitary measures for plant quarantine

Biosecurity related laws in the Maldives

To ensure the safety and sustainability of its agricultural sector, the Maldives has implemented a well-structured legal and institutional system aimed at preventing the spread of pests, diseases, and chemical risks. This system is anchored by four main components including plant health management, quarantine enforcement, pesticide oversight, and long-term policy planning.

The Maldives Plant Protection Act (Act No 12/2011) was enacted on 12 December 2011. The primary goals of this Act are to regulate sanitary measures for plants and plants parts as well as protecting the plants from various types of diseases and pests. In Addition, the Act aims to implement the IPPC (International Plant protection convention) framework. This legislation empowers the Minister of Fisheries and Agriculture with the responsibilities of supervising the NPPO (National Plant Protection Organization), setting up quarantine stations, designating ports for importation, appointing inspectors with sanitary and quarantine enforcement powers at designated ports of entry, enforcement of compliances at designated ports of entry, and sample collection. Furthermore, this Act imposes fines for violations.

Enacted on 08 December 2019, The Agricultural Pesticide Control Act (Act No. 21/2019) regulates the import and export, sale, manufacture, use and the disposal of agricultural pesticides. In support of the Act, the agricultural pesticides control regulation (2021/R-12) was introduced. This regulation details rules for issuance of import/export permits, packaging and labeling of goods, disposal and warehousing, transportation, maintenance of register books, and enforcement procedures.

Biosecurity regulations, biosecurity policies and strategies approved by Maldives

For the Maldives, an isolated and vulnerable state, agricultural biosecurity is much more than a technical issue. It involves critical issues of national resilience and food security. In order to sustain the health and profitability of the agricultural sector, the government has implemented two laws aimed at safeguarding the agricultural biosecurity of the Maldives from pests, diseases, and other contamination. These legislative measures seek to address prevention of plant pests and diseases through stringent inspection protocols and quarantine measures at entry points such as ports and airports. In the Maldives, conducting agricultural biosecurity programs is restricted by structural and logistical limitations.

Conducting agricultural biosecurity programs in the Maldives is challenged by several structural and logistical limitations. As a small land nation with limited arable land and dispersed islands, large scale agricultural development is constrained. With the focus on tourism and fisheries sector has diverted the attention and resources from agriculture due to these two sectors (Tourism and fisheries) bringing more economic benefits to the country. In addition, institutional capacity in terms of trained personnel, extension services, and technical expertise remained limited. Therefore, we are unable to conduct extensive agricultural biosecurity programs in Maldives.

Monitoring and surveillance of these geographically dispersed islands becomes a challenge in terms and of human resource and financial constraints. The awareness and therefore the corporation from local councils vary and the lack of sufficient coordination among stakeholders remains a challenge for biosecurity programs. The very limited human resource of the current Ministry of Agriculture and Animal Welfare is not adequate in capacity to challenge the task of raising awareness on plant health and biosecurity, implement and coordinate biosecurity programs and monitor imports and border control posts.

Rising temperatures, erratic rainfall patterns, and other effects of climate change are having direct adverse impacts on crop health and productivity in the Maldives, while simultaneously increasing the risk of pest and disease outbreaks. Notably, there have been multiple instances of infestations caused by the Hispid beetle (*Brontispa longissima*) and whitefly (*Trialeurodes vaporariorum*) across the country.

In response to such emergency pest situations, the Ministry of Agriculture and Animal Welfare allocates specific budgets and develops response toolkits. These toolkits typically include comprehensive information on the pests' life cycles, identification methods, and management or eradication strategies. However, the country's limited technical expertise and lack of diagnostic laboratory infrastructure hinder the effectiveness of these efforts.

To overcome these challenges, the Maldives benefits from the vital support of international and regional organizations such as the Food and Agriculture Organization (FAO), the International Plant Protection Convention (IPPC), and other regional bodies. These organizations provide essential technical expertise, capacity-building training, policy development assistance, and financial support. One key initiative under this collaboration is the FAO-supported revitalization of the Maldivian coconut industry. This project specifically aims to combat the rapid spread of pests and diseases, particularly the Hispid beetle found in coconut palms. It also focuses on managing biotic stresses, enhancing productivity, and rejuvenating the overall coconut industry in the Maldives. Some of the key recommendations to mitigating future pest invasions by the FAO teams include significant reinforcement of the national plant quarantine system. This includes conducting Pest Risk Analyses (PRA) for each palm species imported, applying appropriate phytosanitary measures to each consignment, and establishing robust post-entry quarantine facilities and public engagement through regular awareness campaigns for farmers and communities.

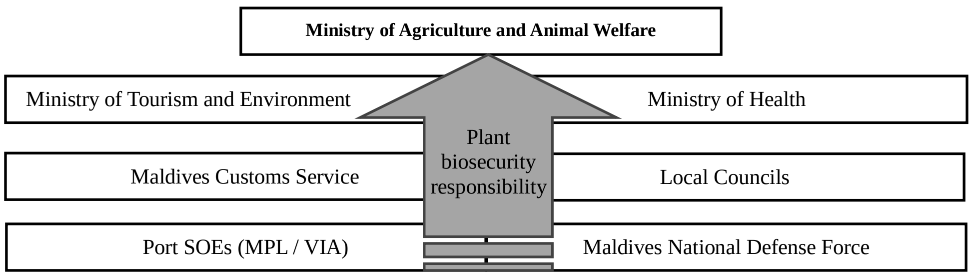
The Ministry of Agriculture and Animal welfare of Maldives have been conducting yearly pest surveillance programs. This program includes visiting agricultural islands such as AA.Thoddoo and HDh.Hanimaadhoo, and onsite inspections for any pests and plant diseases and generating a report based on the results and findings of the inspections.

The existing biosecurity laws and regulations are insufficient and lack specific provisions to address key biosecurity issues. These gaps have made it impossible for the nation to achieve international phytosanitary standards and weakened coordination among government departments. In addition, it has resulted in insufficient surveillance systems and slow response systems to control pest outbreaks.

The outdated legal frameworks have created a situation where there is absence of compliance mechanisms and enforcement which hinders accountability among importers, farmers, and other stakeholders. Also, it leads to weak port surveillance. Different types of agrochemicals and plants and plant parts enter through designated ports and harbors. According to the data from the Ministry of Agriculture and Animal welfare, in between January to April 2025, there was 405 individual shipments arrived at Maldives, however, 37 of them, comprising 4,700 plants and plant parts, were found to be non-compliant with national laws. Due to lack of enforcement of the laws and regulations and the current existing penalties for non-compliance are minimal, offering little deterrence against repeated or large-scale violations. This develops a culture of non-compliance, according to which rules are violated without any punishment, eroding the credibility of regulatory institutions.

Institutional arrangement for biosecurity and their roles and responsibilities for plant health management

Maldivian authorities are challenged with the lack of sufficient capacity in technical facilities for testing and diagnosing plant pathogen and pests. The Ministry of Agriculture and Animal Welfare takes the lead when concerned with plant biosecurity along with the Ministry of Tourism and Environment, each with their respective authorities and mandates which are often conflicting or ambiguous. Neither ministry have any established plant health laboratory. The only laboratory with descent capacity appears to be the National Health Laboratory run by the Maldives Food and Drug Authority, which is under the Ministry of Health. The Ministry of Agriculture and Animal Welfare, formerly Ministry of Fisheries, Marines Resources and Agriculture has established the Hanimadhoo Agricultural Center and the Plant and Animal Quarantine Unit though it has yet to establish the National Plant Protection Organization (NPPO) and the National Plant Health Laboratory as required is the Plant Protection Act (Act No 12/2011).



The Hanimadhoo Agricultural Center tests agricultural methods, train farmers and keeps surveillance for pest and disease emergence on farms dispersed on the many islands of the Maldives. The Plant and Animal Quarantine Unit established at Velana International Airport, inspects plants and animals imported into the country at select major ports as they lack the capacity to serve all major ports. Currently import of plants and regulated plant products are only permitted for import via the Male Sea Port and Velana International Airport.

Island councils are also key stakeholders national plant biosecurity as they are charged with pest control within their island and associated uninhabited islands. The Ministry of Agriculture and Animal Welfare provides only technical support. Each island is the jurisdiction of the respective island council and it is their responsibility address the plant biosecurity of their islands. As the councils lack technical knowledge on plant pests and diseases early detection is often not possible. Plant health is considered low priority even on agricultural islands as councils have sparse resources which they allocate to island development and people’s welfare. Plant disease and pest events are often reported to the Ministry of Agriculture and Animal Welfare by the councils if the issue is of immediate nuisance. Most plant pest or disease outbreaks are reported by concerned farmers.

The absence of the National Plant Protection Organization creates gap in coordination and corporation among concerned stakeholders in national plant biosecurity and the absence of the National Plant Health Laboratory leads to lack of testing, standardizations and quality assurance. Communication with stakeholders and border control agencies of other countries in the region is not adequate due to the absence of a dedicated national plant health organization who will open channels of coordination among regional plant biosecurity stakeholders through constant communication and long-term focal points.

The Ministry of Agriculture and animal welfare strives with limited resources and to curb pest introduction through the Plant Animal Quarantine Unit surveilling the border entry and the Plant Protection Section along with Hanimadhoo Agriculture Center receives reports from farmers and carries out field visits to monitor pest and disease cases throughout the country. Record of imports, disease and pest events and farm registrations are maintained but not published as official data.

The Ministry of Agriculture and Animal Welfare has joined several regional meetings and forums and continues to look forward for opportunities to engage and communicate with national agencies and stakeholders of the region.

Key Stakeholder	**Roles and Responsibilities**
Ministry of Agriculture and Animal Welfare	• Monitors pest outbreaks • Inspect imported commodities at ports • Issue and regulate import and export permits
Ministry of Tourism and Environment	• Monitor uninhabited islands • Monitor ecological reserves and wetlands • Implements CITES for imports and exports
Ministry of Health	• Inspects food commodities • Operates the National Health Lab • Monitors human health and disease
Maldives Customs Service	• Lead agency in facilitating inspection of imports
Ports and Ports SOEs	• Provides access and facilities to carry out inspections at sea ports and airports
Maldives National Defense Force	• Regulates pesticide imports and issue permits • Assist in removal or disposal of potentially lethal organisms
Maldives Police Service	• Assists in keeping public order whilst implementing biosecurity measures
Local Councils	• Carry out monitoring of islands, forests and farmlands • Maintain registry of local farmers • Maintain records of pest and disease outbreaks • Report outbreaks • Implement outbreak control measures

Constraints

The Maldives is a Small Island Developing State (SIDS) with scarce land and high dependency on imported agricultural products. As such, it is important that Maldives should maintain an effective biosecurity measure that requires safeguarding the nation's agriculture, biodiversity, and public health.

In the Maldives, the absence of baseline data on endemic species, invasive and emerging fauna and flora is critical. There is limited information on the pathways through which pests are introduced through imports and their subsequent spread within the country. Usually, the Ministry relies on reports from Island Councils or local communities, which are often received after the outbreak of pests or the application of diseases. This reactive approach hinders timely risk assessment and the preparation of pest profiles that are tailored to the national context.

Additionally, Maldives is also particularly susceptible to adverse impacts of climate change including extreme weather events, which impacts the spread and activity of pests and diseases and makes the problem even worse. However, since the absence of national pest surveillance, weak inter-agency reporting and response networks, there is a limited information on how the climate change impacts these agricultural pests and diseases, and without a proper understanding of the situation, the policies may be either too lax, allowing dangerous incursions or overly restrictive,

Moreover, the Maldives is at great risk from the effects of climate change, such as extreme weather conditions, which could alter agricultural pest distribution, activity, and intensity of impacts from these pests, thus compounding the problem. But in the absence of national system of agricultural pests' surveillance, and with limited coordination among relevant agencies for reporting and response, Maldives has no data to consider the potential impacts of climate-based changes on agricultural pests and diseases. In these circumstances, we might take the wrong route when developing policy options; that is, we might either be too lenient and let harmful incursions in, or we might deny access and support to appropriate and effective management response options.

Like many developing nations, Maldives lacks the physical infrastructure necessary to implement comprehensive quarantine and inspection systems. Currently there are no laboratories to test imported plants and plants parts, limiting the capacity for accurate diagnostics, pathogen detection, or genetic analysis of the pests found on these plants.

Implementing cutting-edge surveillance technologies is proving to be an extremely difficult task for the Maldives in the long run. The Maldives faces a severe shortage of trained personnel capable of tracking biological risks using digital databases, such as GIS, and other contemporary analytical techniques, which severely restricts the ability to detect and respond promptly to emerging threats such as agricultural pests.

The enforcement of existing biosecurity laws and regulations might be inconsistent due to the lack of inter-agency coordination, funding, political imbalance, lack of procedures in place to manage risk assessment, imports, and exports management, and respond to a crisis.

One of the challenges the Maldives in establishing a technologically advanced surveillance grid for real-time biological threats in real time is the Shortage of trained personnel's capable of using digital databases, geographic information systems (GIS), and other modern analytical tools. Therefore, this leads to significant limits in the capacity to identify and address new risks in a timely manner.

In addition, there is often very minimal awareness of regulatory frameworks within and outside an organization. Because of the limited enforcement activity, farmers, traders, and shipping agents might unintentionally break rules because they do not know of them and there is no incentive to follow them.

Conclusions and recommendations

Agricultural biosecurity is a critical component of protecting the nation's agriculture, economy and environment from various agricultural pests and related diseases. Therefore, as a small island nation it is imperative that the Maldives develop a national plant biosecurity framework that is robust and well-coordinated.

Increase in imports has made Maldives highly vulnerable to the introduction of invasive pest and various plant diseases. This has led to immersive pressure on the quarantine and inspection operations to protect the nations plant health and biosecurity. However, with the limited resources, inadequate technical capacity and increasing imports hinders progress. Strategic policies to counter potential biosecurity risks should be explored and the current gaps in the system should be identified before a crisis becomes imminent.

Such a strategic policy could include conducting Phytosanitary Capacity Evaluation (PCE) developed by International Plant Protection Convention (IPPC). By conducting the PCE, the Maldives provides an opportunity to examine it's legal, institutional, and technical capacities of the country's National Plant Protection Organization (NPPO).

To strengthen the biosecurity, proper legislatives and regulatory frameworks need to be developed. Maldivian policy needs to move towards drafting and subsequently implementing a National Seed Act that addresses variety registration, seed certification, import/export regulation, and labeling as well as penalties for non-compliance.

Policies should be aligned to capture the objectives of the national plant protection act by establishing the National Plant Protection Organization charged with observing plant biosecurity and implementing and coordinating control measures.

New Integrated reporting systems which account for efforts should provide better opportunities for analysis of interception data in the future. Better data collection and data sharing policies should allow the NPPO to collect relevant updated data from different stakeholders and centralize for more intelligent approaches to biosecurity risks.

Monitoring agricultural related diseases and pest across hundreds of widely scattered islands is logically complex and recourse intensive, on top of that, the Decentralization Act in the Maldives (Act No. 7/2010), does not clearly define the legal responsibilities of local councils regarding plant protection or biosecurity. There is a lack of alignment between decentralization and the Plant Protection Act, creating confusion and inaction. Therefore, Maldives can amend the laws to define clear division of responsibilities between national and local governments in agriculture and plant protection.

Given its small size and limited resources, the Maldives can greatly benefit from regional collaboration in agricultural diagnostics. Neighboring countries such as India and Sri Lanka have advanced testing capabilities and experience in Agricultural related pathogens and disease management. Therefore, Bilateral Laboratory Agreements and MOU with regional labs for quick and cost-effective testing support establish pre-approved sample sharing protocols for emergencies.

To conclude, it is vital for the Maldives to establish a national plant biosecurity agency as the National Plant Protection Organization and evaluate current phytosanitary standards and measure the gaps in legal and regulatory frameworks. The NPPO should coordinate among key government agencies and push for reform to clarify and enhance the active role and responsibilities of island councils in national plant protection. These reforms should establish the NPPO as the lead agency in relevance to national plant biosecurity and should clarify mandates of key stakeholders to eliminate clashes. The NPPO should be responsible for building capacity and developing human resource in relevant fields whilst operating a National Plant Health Laboratory to study and test for hazards. And the NPPO should liaise with regional and international bodies and strengthen relations while communicating with NPPOs of other countries to establish an intelligent pre border biosecurity approach which can anticipate potential risks.

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Agricultural Biosecurity for Plant Health in Nepal

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Introduction

Agriculture remains the backbone of Nepal's economy, contributing about 23.9% to the national GDP and employing over 60% of the population, specifically in rural areas (Yogi et al., 2025; MoF, 2024). The country's diverse topography from the lowland *Terai* plains to the mid-hills and the high Himalayan regions creates a wide range of agro-climatic zones that support the cultivation and production of a variety of crops. Major cereal crops include rice, maize, wheat, millet, and barley, which form the staple diet and are critical for food security. Rice is the principal crop, predominantly grown in the fertile *Terai* plains and extending up to 3000 masL of *Jumla* district during the monsoon season, while maize and millet are more common in the hilly regions. Besides cereals, pulses, oilseeds, and cash crops such as sugarcane, jute, tobacco, and cotton are also grown, particularly in the Terai region (MoALD, 2024).

Moreover, Nepal has been growing fruits and vegetables besides cereals, oilseeds and cash crops and their productivity is increasing due to increases in summer fruits and vegetables production area at the cost of other crops preferably cereals, modernization, and precision technology (Gregerson et al., 2025, Table 1). The major summer fruits are mango, banana, litchi, guava, areca nut, papaya, pineapple grown in southern plain while winter fruits are apple, pear, walnut, apricot, peach and plums, mandarin oranges mostly cultivated in mid to high hills. Other highly traded horticulture crops are large cardamom and tea mostly exporting to India, Bangladesh and China among others. The area under newly emerging fruits like avocado, kiwi and dragon fruits is increasing.

However, out of the total 147,181 square kilometer land area of Nepal, agricultural land is only 28.04% of total land use that is 4127554.02 hectares (out of which 21% is under cultivated and 7% is uncultivated), forestry 29%, shrub land 10.6%, grassland, and pasture 12% and water 2.60% (MOALD, 2024).

Table 1. Major Field crops and Horticultural crops grown during last three years in Nepal

Sl. No.	Name of crops	2021-22		2022-23		2023-24	
		Area (ha)	Production (MT)	Area (ha)	Production (MT)	Area (ha)	Production (MT)
1.	Paddy	1477378	5130625	1447789	5486472	1438989	5724234
2.	Maize	985565	3106397	940256	2976490	916044	3193869
3.	Wheat	716978	2144568	697762	2098462	681851	2035559
4.	Potato	198256	3410829	203816	3487816	211505	3521794
5.	Sugarcane	62567	3159634	62833	3130109	55440	2760495
6.	Oilseeds crops	260645	287344	244046	270482	239033	262561
7.	Fruits crops	129532	1416750	139478	1527700	139246	150870
8.	Vegetables	289839	4153157	302135	4376077	311885	4440116

Source: MoALD, 2024

Within this sector, high-value commodities such as citrus fruits and herbal products—including non-timber forest products (NTFPs) and medicinal and aromatic plants (MAPs) have been identified as priority crops in Nepal. They are also recognized as major exportable commodities under the Nepal Trade Integration Strategy (NTIS) 2023 and the Agriculture Development Strategy (ADS) 2015-2035. These commodities present significant opportunities for income generation, rural employment, and trade diversification. Nepal produces approximately 317,494 metric tons of citrus fruits from 33,829 hectares of productive orchards (MoALD, 2024). The citrus sector alone contributes 1.41% to the nation's agricultural gross domestic product (AGDP) (Joshi, 2023).

Issues of Biosecurity

Biosecurity is a strategic and integrated approach to analyzing and managing possible risks to human, animal and plant life and health, and associated risks to environment, based on the recognition of critical linkages among them. Biosecurity brings together policy and regulatory frameworks for risk management across the sectors of food safety, animal health and plant health to manage risks collectively. Biosecurity comprises of a set of measures designed to protect agriculture, the environment and people from exotic or emerging pests and pathogens, pesticide and antibiotic residues and genetically modified organisms. The measures are applicable at the national, regional and individual firm or farm levels (Panta et.al, 2014).

Nepal has great diversity in land-geography, temperature, and climate which makes it a suitable habitat for organisms from different parts of the world. The biological invasion has raised problems in biodiversity conservation, agricultural production, and ecosystem services in Nepal. Invasive pests can result in reduced production of agricultural commodities and thus reflect in income which increases risk in the economy, food security, and native biodiversity (Shrestha, 2016). A total of 69 alien species of fauna have been reported in Nepal among which twenty species are insects (Budha, 2014).

Among countries threatened by invasive alien species (IAS), the agriculture sector ranks third as Nepal is highly reliant on the import of agricultural products (Paini et al., 2016). Table 2 depicts some of the important invasive pests in the agricultural crops during a period of over six decades (PQPMC, 2024) and Table 3 reveals outbreaks of insect pests, diseases in crops and incurred production losses in Nepal (Shrestha, 2007).

Table 2. List of important invasive pests introduced in Nepal for over six decades (1962-2024)

Sl. No.	Common name	Scientific name	Year of introduction
1.	African giant land snail	*Achatina fulica* Bowdich	1930-1940
2.	San Jose scale	*Quadraspidiotus perniciosus* (Comstock)	1962
3.	Potato tuber moth	*Phthorimaea operculella* (Zeller)	1966
4.	Chinese citrus fly	*Bactrocera minax* (Enderlein)	1984
5.	Tomato leaf miner	*Tuta absoluta* (Meyrick)	2016
6.	Coffee leaf rust	*Hemelia vestatrix* (Berk and Br.)	2016
7.	Fall armyworm	*Spodeoptera frugiperda* J.E. Smith	2019
8.	Chilli thrips	*Thrips parvispinus* Karny,	2024
9.	UG 99 race TTKTT of wheat rust	*Pucccinia gramisnis f.sp. tritici*	2024
10.	Taiwanese thrips or Southeast Asia thrips	*Thrips parvispinus*	2024

Table 3. Outbreak of pests and estimated losses of agriculture commodities in Nepal

Sl.No.	Crop infested	Causal organism	Estimated loss (%)
1.	Paddy	*Nilaparvata lugens* (Insect) *Pyricularia oryzea* (Fungus) *Brevennia rehi* (Insect), *Aleurolobus* spp. (Insect)	30-50 30-70 15-25
2.	Cole crop	*Plasmodiophora brassicae* (Fungus)	20-50
3.	Citrus spp.	*Phytopthora* spp. (Fungus) CTV	20-30 20-60
4.	Maize	*Podoptera* spp. (Insect)	20-50
5.	Apple	*Venturia inequalis*, *Donidiella aurantii*, *Phytopthora* spp.	20-30
6.	Legume	*Helicoverpa armigera* (Insect)	20-80
7.	Sugarcane	*Hieroglyphus* spp. (Insect)	20-60
8.	Ginger	*Fusarium* spp.	15-20
9.	Potato	*Bemisia tabaci* (Insect)	20-40
10.	Tomato	CMV	40-80
11.	Cucumber	*Aulacophora foveicollis* (Insect)	20
12.	Chilli	*Thrips tabaci* (Insect)	20-40
13.	Cardamom	Virus	30-40

Agricultural biosecurity is a critical concern for Nepal in safeguarding food security, ensuring the sustainability of farm production, and protecting the livelihoods of millions of people who depend on agriculture. With increasing globalization, cross-border trade, and climate change, the risks of pest and disease introduction, establishment and spread have grown significantly. Nepal continues to face significant biosecurity challenges**,** including:

- **Weak diagnostic and surveillance capacity**: Limited laboratories and trained human resources hinder timely detection and response to invasive pests and diseases.
- **Cross-border pest incursions**: Open and porous borders with India make it difficult to prevent the entry of harmful pests and pathogens.
- **Limited coordination among agencies**: Departmentalization of plant health, animal health, food safety, and customs weakens enforcement of quarantine system.

- **Inadequate awareness among farmers and traders**: Many stakeholders are not well-informed about biosecurity risks or compliance requirements.
- **Resource and infrastructure constraints**: Lack of modern quarantine facilities, risk analysis systems, and digital tracking tools affects the effectiveness of SPS implementation.
- **Climate change impacts**: Unavoidable rise in temperatures and shifting rainfall patterns create favorable conditions for pest outbreaks and trans-boundary spread.

Institutional Arrangement for Biosecurity

Nepal has made notable progress over the past decade in strengthening its Sanitary and Phytosanitary (SPS) system to comply with international trade obligations. Building on the Agriculture Development Strategy (ADS) 2015 - 2035 and related national policies, the government has prioritized the development of SPS infrastructure and the alignment of domestic regulations with internationally recognized standards.

(a) The **Plant Quarantine and Pesticide Management Center (PQPMC):** The government of Nepal has designated the PQPMC as Nepal's National Plant Protection Organization (NPPO), plays a key role in this process. It regulates plant health risks arising from international trade and oversees the import, distribution, and use of pesticides for pest management both in the field and at post-harvest stages. A major achievement has been the review and enforcement of the Plant Quarantine and Protection Act, 2007 (amended in 2023) and Regulation**,** 2024**,** which provide the legal foundation to regulate the introduction of plant and planting materials, plant products, and soil.

The terms and references of PQPMC are as follows:

- To implement Plant Quarantine and Protection Act, 2007 (first amendment 2023) and Plant Protection Rules, 2024
- To prepare necessary procedures/guidelines/standards and protocols in accordance to those specified in the Act and Rules and implement them as approved.
- To establish and implement formal mechanisms of inter-agency coordination with government bodies/research institutions/universities and private sector related to plant health.
- To facilitate the trade of healthy products by minimizing the risk to the health of the plants/biological diversity within the border territory of Nepal during the international trade of plants and plant products.
- To formulate policies related to plant quarantine and prepare and implement national import requirements.

- To perform and review the pest risk analysis (PRA) of plants and plant products to be imported on a regular basis.
- To prepare and update keep information about the pests' presence within the country to facilitate the export market.
- To operate and manage plant quarantine offices established at entry points.
- To conduct specific activities as a focal point of International Plant Protection Convention (IPPC) and Asia Pacific Regional Plant Protection Commission (APPPC).
- Work as the National Plant Protection Organization (NPPO) of Nepal and implement the activities prescribed by the act.
- Provide technical support to implement internal quarantine according to the demands of the provincial and local levels in order to identify the non-quarantine pests that should be regulated within the country and regulate their movement, control and management.
- To conduct awareness creation activities regarding emerging pests, invasive species and various quarantine pests.
- To operate the Central Plant Health and Diagnostic Laboratory as a National Reference/Referral Laboratory to ensure the plant health of the imported items, necessary laboratory testing, diagnosis, certification and issuing Notification of Non-Compliance as required.
- To conduct post entry survey and quarantine as required.
- To certify plant health based on the requirements of the country of import of exported products.
- To conduct awareness programs related to biosecurity and plant health.

(b) The Department of Food Technology and Quality Control (DFTQC) continued to serve as the national SPS Enquiry Point, with expanded responsibilities that included coordinating with relevant ministries, collecting and disseminating SPS-related information, and managing communication with international trading partners and the WTO. Similarly, the investments have been made to strengthen technical capacity, including upgrading several food and agricultural laboratories to work toward international accreditation. The DFTQC, the PQPMC, Department of Agriculture, and Department of Livestock Services have been benefited from targeted training and equipment upgrades, often with the support of development partners, aiming to improve testing accuracy, certification, and traceability in food supply chains (MoICS, 2025).

The major terms and references of DFTQC are as follows.

- Food Inspection (Industry & Market) and compliance
- Licensing of food industries

- Food standardization and harmonization
- Communication on the SPS related rules, regulations and standards
- Expert import certification of food
- Creation of consumer awareness activities

C) Department of Agriculture (DoA) under Ministry of Agriculture and Livestock Development (MoALD) has been working on integrated pest management and disease pest outbreak management. Moreover, Central Agricultural Laboratory under DoA conduct survey and surveillance, plant pest diagnosis, and Rapid Bioassay of Pesticide Residue. The department of agriculture and its sister organizations are believed to work on post boarder quarantine among other organizations particularly focusing on pest outbreak management.

The major terms and references of DoA are as follows:

- Management of pest outbreak and other national important crop pests.
- To capacitate province and local government staffs in the field of plant protection.
- To formulate, amend, and implement policy, standard in the field of plant protection and their regulation.
- To coordinate and work on emergency plant pest management.
- To coordinate and cooperated on integrated pest management.

Plant Biosecurity Measures in Nepal

Nepal has been working to strengthen its plant biosecurity framework to safeguard agriculture from trans-boundary movement and spread of pests and diseases. These measures are guided by the Plant Quarantine and Protection Act, 2007 (amended in 2023), and Regulation, 2010 (amended in 2024).

Prevention of Disease Transmission

i. Quarantine offices: The quarantine offices and check posts at international borders, airports, and dry ports serve as the first line of defense in safeguarding Nepal's biosecurity. These facilities regulate the entry of planting materials, plant products, and soil to prevent pest and pathogen introduction. For this, it has nineteen subsidiary quarantine offices located in the Nepal-India and Nepal-China customs borders as well as in international airports under PQPMC to inspect, verify, and issue entry permits and Phytosanitary Certificates for the import and export of plant and plant products.

Quarantine offices located at Indo-Nepal border

i. Quarantine Office, Kakarbhitta, Jhapa

ii. Quarantine Office, Birgunj, Parsa
iii. Quarantine Office, Bhairahawa, Rupandehi
iv. Quarantine Office, Nepalgunj, Banke
v. Quarantine Office, Gaddachauki, Kanchanpur.
vi. Quarantine office, Bhantbari, Sunsari
vii. Quarantine Office, Biratnagar, Morang
viii. Quarantine Office, Malangawa, Sarlahi
ix. Quarantine Office, Jaleswor, Mahottari
x. Quarantine Office, Krishnanagar, Kapilwastu
xi. Quarantine Office, Jhulaghat, Baitadi
xii. Quarantine Check post, Trinagar, Kailali
xiii. Quarantine Check Post, Suthauli, Kapilbastu

Quarantine offices located at China-Nepal border:

i. Quarantine Office, Tatopani, Sindhupalchowk
ii. Quarantine Office, Lomanthang, Mustang
iii. Plant Quarantine Office, Timure, Rasuwa

Quarantine offices located at International Airport

i. Quarantine Office, Tribhuvan International Airport, Kathmandu
ii. Quarantine Office, Pokhara International Airport, Pokhara
iii. Quarantine Check Post, Gautam Buddha International Airport, Bhairahawa

ii. Disease Diagnosis: In Nepal, Central Agricultural Laboratory under Department of Agriculture, Sanitary and Phytosanitary lab of PQPMC, quarantine labs in each quarantine offices and check posts, Plant Pathological labs under Nepal Agriculture Research Council (NARC), provincial plant protection labs in seven provinces and plant pathology labs at each Agricultural Universities provide diagnostic services for pests and diseases. Capacity in molecular diagnostics, serological assays, and microscopy is being developed, although resources and skilled manpower remain inadequate.

Extension and Information Outreach

In Nepal, Plant Clinics**,** Farmer Field Schools (FFS)**,** and regular agricultural extension programs play a vital role in disseminating knowledge on pest and disease management to farmers. Increasingly, digital platforms, mobile applications, and radio programs are also being used to share real-time pest and disease alerts, ensuring timely access to critical information at the community level. In addition, regular meetings and workshops with exporters and importers are organized to provide updates on international phytosanitary measures and to build awareness of trade-related requirements. These interactions also contribute to the review and amendment of prevailing acts and regulations, helping to align Nepal's biosecurity framework with global standards.

Biosecurity Laws of Nepal

Biosecurity in Nepal is primarily governed through a set of acts, regulations, and **institutional frameworks** that address plant health, animal health, food safety, and pest management. These legal instruments are designed to safeguard agriculture, biodiversity, and public health while also ensuring compliance with international trade obligations.

Table 4. The related plant biosecurity laws of Nepal

Sl. No.	Law/Policy	Issued year	Amendment year	Key Focus
1.	Plant Quarantine and Protection Act & Rules	2007, 2010:	2023, 2024	Prevent pest/disease entry, manage quarantine, and align with IPPC & WTO/ SPS.
2.	Technical guidelines for survey and surveillance and Risk Analysis of crops pests	2014	2025	In accordance with this guideline; > 170 PRA report based on commodity pathway for importing agriculture commodities, > 10 pest survey protocols have been introduced
3.	Protocol of quarantine treatment of MBR fumigation in Nepal	2025	X	Build the SPS compliance with ISPM 15 and ISPM 43
4.	Pesticide Management act and regulation	1991, 1994 (superseded)	2019, 2024	• Provision of registration of bio-pesticides and gave priority to register bio-pesticides. • Provision of facilitate warehouse for storing the date expire, band and obsoleted pesticides in 7 provinces. • Date expire, band and other spoiled pesticides should bring back in the same company (country) by importer. • Producers are also given responsibility about no residue products produce and bring in to the market.
5.	Plant clinic operation guidelines	2024	X	It is policy guideline to conduct plant clinic in all 3 tiers of government and also it focus on the flow of pest database from local farmer community to central level which helps to make national pest database of country, easy for doing PRA, pest preparedness activities

Sl. No.	Law/Policy	Issued year	Amendment year	Key Focus
6.	Rapid bioassay of pesticide residue testing guideline	2018	X	Rapid monitor of pesticide residues on fresh vegetable and fruits ready for marketing, to ensure the availability of safe foods, to reduce the impact of hazardous pesticide on human, animal, plant and environmental health
7.	Nepal Good Agriculture Practice Implementation guideline	2018	X	Food safety and quality production, worker protection and welfare, ensure safe food availability, export promotion replacing import
8.	Biological and botanical pesticides production, use and subsidy directive	2017	X	Increase the use and availability of biological pesticides, promote the production of biological pesticides to private sectors and promotion of biological pesticide as an alternative of chemical pesticides

Source: Bhatta et al., 2024

In addition to the above-mentioned acts and regulations, several other laws are equally important in establishing a sound and comprehensive biosecurity system for Nepal.

These include:

i. Seed act, 1988 (amended in 2022) and Regulation, 2024

- Ensures the quality, safety, and Phytosanitary compliance of seeds imported and traded in Nepal.
- Requires seeds to be imported only after pest risk analysis and certification.
- Supports biosecurity by restricting entry of uncertified or pest-contaminated seed lots.

ii. Animal Health and Livestock Services Act, 1998

- Provides the legal foundation for animal quarantine services at border points.
- Prevents trans-boundary movement of zoonotic diseases and livestock pests.
- Complements plant biosecurity by addressing the One Health approach, recognizing the interconnection between plant, animal, and human health.

iii. Food Act, 1967 (amended 2023), Food Regulation, 1970 (fifth amended 2007) and Food hygiene and quality act, 2024

- Establishes the legal framework for food safety and quality control.
- Mandates inspection of food imports and domestic production for contaminants, pesticide residues, and microbial pathogens.

- Supports agricultural biosecurity by addressing risks along the farm-to-fork chain.

iv. Environment Protection Act, 2019

- Provides broad legal backing for the protection of ecosystems, biodiversity, and natural resources.
- Indirectly contributes to biosecurity by addressing the risks of invasive alien species and environmental degradation.

v. Institutional Framework

- The Plant Quarantine and Pesticide Management Center (PQPMC) acts as Nepal's National Plant Protection Organization (NPPO).
- The Department of Food Technology and Quality Control (DFTQC) acts as SPS national enquiry point and ensures food safety.
- The Department of Livestock Services (DLS) manages animal health and quarantine activities.

Note: Together, these agencies coordinate biosecurity enforcement under Nepal's SPS framework.

Institutional arrangement for biosecurity and their roles in Nepal

Biosecurity in Nepal is implemented through a multi-agency framework**,** with institutions working at the intersection of plant health, animal health, food safety, and environmental protection**.** These institutions operate under national legislation and international agreements such as the WTO-SPS Agreement**,** IPPC**,** OIE/WOAH and Codex Alimentarius.

In the area of plant biosecurity**,** the Plant Quarantine and Pesticide Management Center (PQPMC) enforces the Plant Quarantine and Protection Act and its Regulation, monitors the import and export of plants and plant products, and regulates pesticides. It also oversees pest risk analysis and operates quarantine offices and checkpoints at international borders, airports, and dry ports.

For animal biosecurity**,** the responsibility lies with the Department of Livestock Services (DLS**)**. The department manages animal quarantine posts across the country and enforces measures to prevent the introduction and spread of trans-boundary animal diseases and zoonotic infections. It also leads surveillance, vaccination, and disease control programs and acts as Nepal's focal point to the OIE/WOAH (DLS, 2025).

The Department of Food Technology and Quality Control (DFTQC) plays a central role in ensuring food safety and quality control**.** It regulates food imports and exports, monitors pesticide residues and contaminants, and coordinates with the Codex Alimentarius for setting and updating food safety standards. Together with the Ministry of Health and Population, it also contributes to public health biosecurity through food safety surveillance and control of zoonotic diseases (DFTQC, 2025).

The Seed Quality Control Centre (SQCC) is another important agency within the Ministry of Agriculture and Livestock Development. It regulates the import, testing, and certification of seeds, ensuring that only safe and pest-free seeds enter Nepal. In parallel, research institutions such as the Nepal Agricultural Research Council (NARC) and agricultural universities provide technical support, diagnostic services, and research on pest and disease management, which strengthen the country's biosecurity capacity (SQCC, 2025).

Beyond agriculture, the Ministry of Forests and Environment (MoFE) contributes to biosecurity by implementing environmental protection laws and managing the risks posed by invasive alien species, biodiversity threats, and ecosystem degradation. Similarly, the Department of Customs plays a frontline role in border control by working in coordination with PQPMC, DLS, and DFTQC to regulate the entry of plants, animals, and food products (MoFE, 2025).

Overall, Nepal's institutional framework for biosecurity is broad and covers different sectors. However, there are challenges such as overlapping mandates, weak inter-agency coordination, and limited technical and human resources. Strengthening collaboration across these institutions, guided by a One Health approach**,** will be essential for improving Nepal's biosecurity system and ensuring food security, public health, and sustainable agricultural growth.

Future strategies to enhance institutional biosecurity capacity of Nepal

Strengthening Nepal's biosecurity system requires a comprehensive and forward-looking strategy that integrates legal, institutional, technical, and community-level interventions. At the policy level, there is a need to harmonize the existing legal instruments related to plant health, animal health, food safety, and environmental protection. The development of a national biosecurity policy that brings these sectors under a unified framework would help minimize overlapping mandates and foster a One Health approach. Regular updates to laws and regulations in line with international standards such as the WTO-SPS Agreement, IPPC, Codex Alimentarius, and OIE/WOAH will also be essential to ensure Nepal's compliance with global trade obligations.

Institutional coordination remains a major challenge, and therefore the creation of a central biosecurity coordination authority or platform could strengthen collaboration among key institutions such as the Ministry of Agriculture and Livestock Development (the Plant Quarantine and Pesticide Management Center, the Department of Livestock Services, the Department of Food Technology and Quality Control), the Ministry of Finance (The Department of Customs), the Ministry of Health and Population, and the Ministry of Forests and Environment. This coordination should extend beyond the national level to include regional cooperation with neighboring countries and regional bodies to address trans-boundary pests and diseases.

Equally important is the modernization of infrastructure and facilities. Expanding and upgrading quarantine posts at borders, airports, and dry ports with modern diagnostic equipment will help prevent the entry of pests and diseases. Investment in national and regional reference laboratories, backed by digital information systems for real-time data sharing, will significantly strengthen surveillance and diagnostic capacity. Alongside infrastructure, human resource development is critical. Specialized training for quarantine inspectors, laboratory technicians, extension officers, and customs staff will build the technical expertise needed to enforce biosecurity measures effectively, while universities and research institutes should focus on producing biosecurity professionals with expertise in pest risk analysis, molecular diagnostics, epidemiology, and food safety.

Policy Recommendation to Tighten Quarantine Operation in Nepal

Nepal's growing engagement in international trade and the increasing movement of plants and plant products across borders have heightened the risk of introducing invasive pests and diseases. To address these threats, it is essential to strengthen the country's plant quarantine operations through a comprehensive policy approach. A first priority is to enhance the existing legal and regulatory framework by ensuring full alignment with the International Plant Protection Convention (IPPC) and International Standards for Phytosanitary Measures (ISPMs). This requires regular updates to the Plant Quarantine and Protection Act and its regulations, with a strong focus on pest risk analysis, import certification, and science-based decision-making.

Institutional capacity must also be significantly upgraded. The Plant Quarantine and Pesticide Management Center (PQPMC) should be equipped with adequate financial resources, skilled human capital, and advanced technologies to effectively carry out inspection, surveillance, and certification functions. Border quarantine offices, particularly at international airports, dry ports, and major land entry points, should be modernized with well-equipped laboratories, fumigation chambers, and rapid diagnostic facilities. Such improvements will enable inspectors to detect pests more accurately and make timely decisions on consignments.

In addition, the digitalization of quarantine operations is crucial to increase transparency and efficiency. Developing an integrated digital platform for permit issuance, consignment tracking, pest surveillance data, and laboratory reports would strengthen coordination between customs, quarantine offices, and traders. Furthermore, institutional collaboration with the Department of Customs and security agencies should be reinforced to ensure that all agricultural imports are systematically screened before entering the domestic market.

Capacity-building programs should be expanded to train quarantine officers, laboratory staff, and extension workers in advanced pest detection, risk analysis, and international trade requirements. At the same time, awareness campaigns targeting farmers, traders, exporters, and importers are necessary to improve compliance with quarantine regulations. A strong emphasis should be placed on regional and international cooperation to share information on emerging pest threats and harmonize inspection procedures with neighboring countries.

Finally, long-term sustainability will depend on adequate and stable financing. The government should allocate dedicated budget lines for quarantine infrastructure, research, and capacity development, while also mobilizing support from international development partners and promoting public–private partnerships. By implementing these measures, Nepal can establish a more robust, transparent, and internationally credible plant quarantine system that safeguards agriculture, protects biodiversity, and enhances the country's competitiveness in global trade.

Constraints of Biosecurity in Nepal

Nepal faces several scientific barriers in strengthening its biosecurity framework. The country's capacity for research on pest biology, epidemiology, and risk assessment remains limited, resulting in a lack of updated scientific data to guide evidence-based policies. Pest Risk Analysis (PRA) is still underdeveloped, often relying on secondary data from other countries rather than locally generated research. Limited access to advanced diagnostic tools and molecular techniques further constrains the accurate and timely identification of invasive pests and pathogens.

From a technical perspective, Nepal struggles with inadequate infrastructure and skilled manpower**.** Quarantine checkpoints, laboratories, and diagnostic facilities are insufficiently equipped to handle the increasing volume of imports and exports. Many quarantine posts lack modern tools such as PCR-based diagnostics, rapid detection kits, and fumigation chambers, making pest detection slow and inefficient. In addition, the shortage of well-trained quarantine officers, inspectors, and laboratory specialists hampers technical capacity. Weak surveillance systems and limited use of digital platforms for pest reporting also restrict the country's ability to detect, monitor, and respond to emerging biosecurity threats in real time.

On the regulatory side, Nepal's biosecurity measures are challenged by fragmented legal frameworks and weak enforcement mechanisms**.** While there are multiple laws governing plant health, animal health, pesticides, and food safety, they are not always harmonized, leading to overlaps, inconsistencies, and implementation gaps. The Plant Quarantine and Protection Act has been revised, but enforcement at border points remains weak due to resource constraints and coordination challenges with customs and law enforcement agencies. Moreover, penalties for non-compliance are often insufficient to deter illegal imports or bypassing of quarantine procedures. Limited inter-agency coordination among the Ministry of Agriculture, Department of Customs, and border security forces further weakens the effectiveness of quarantine enforcement.

In summary, the combination of insufficient scientific research, weak technical capacity, and regulatory gaps continues to hinder Nepal's ability to effectively implement biosecurity measures. Addressing these challenges requires strengthening research institutions, modernizing infrastructure, investing in human capital, and harmonizing laws with international standards to ensure a robust and sustainable biosecurity system.

Way Forward

Nepal should adopt a clear national biosecurity vision and policy that integrates plant health, animal health, food safety, and environmental protection under a single strategic framework. A formally endorsed National Biosecurity Policy would provide the legal and institutional coherence needed to reduce overlap between existing acts and to guide investments, capacity building, and international cooperation.

Institutional coordination must be strengthened through a permanent multi-sectoral coordination mechanism that brings together the Plant Quarantine and Pesticide Management Center (PQPMC), Department of Livestock Services, Department of Food Technology and Quality Control, Customs, Ministry of Health, Ministry of Forests and Environment and provincial authorities.

This mechanism should operate routinely (not only during emergencies) to harmonize regulations, agree standard operating procedures for border control, and institutionalize a One Health approach to trans-boundary threats. The PQPMC already functions as Nepal's NPPO and can anchor plant-health coordination within such a platform.

A major priority is upgrading surveillance, diagnostics, and laboratory networks. Nepal must invest in a tiered system of well-equipped national and regional reference laboratories capable of molecular diagnostics (PCR, sequencing), rapid field tests, and pest identification, together with standardized data reporting to a centralized information system. Strengthened surveillance should combine field officer networks, farmer reporting (plant clinics and mobile reporting), sentinel sites, and remote-sensing/GIS tools for early detection and mapping of outbreaks.

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Agriculture Biosecurity for Plant Health in Pakistan

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Introduction

Pakistan’s agriculture sector is the backbone of the national economy, contributing approximately 23.5% to the Gross Domestic Product (GDP) and providing employment for over 37% of the total labor force. It serves as the largest source of foreign exchange earnings and feeds both the massive rural and urban populations. This foundational importance has led the government to emphasize modernization through mechanization, improved water management, certified seeds, and the expansion of credit facilities, reinforced by targeted investments under the Special Investment Facilitation Council (SIFC) (Pakistan Bureau of Statistics (PBS); Agriculture Statistics., 2025).

Despite sustained governmental emphasis, the sector’s overall growth in Fiscal Year (FY) 2025 was limited to 0.56%. This modest resilience was primarily driven by the livestock sub-sector, which recorded robust growth of 4.72%. Conversely, the core engine of agricultural production the crop sub-sector witnessed significant negative growth, declining by -6.82%. This decline was most pronounced in important crops (including Wheat, Rice, and Maize), which plummeted by -13.49% from the previous year’s performance. (Pakistan Bureau of Statistics (PBS) Agriculture Statistics., 2025.)

The sharp contraction in the important crops sub-sector suggests that the country's primary farming systems are highly vulnerable to external pressures, particularly weather-related adverse challenges. This high degree of susceptibility to abiotic stress implies that crop production lacks robust climate resilience. In such an environment, the introduction or establishment of a highly virulent biotic threat (a new pest or disease) would not merely cause localized losses; it would act as a critical force multiplier, potentially triggering economic destabilization far exceeding typical localized pest damage. The systemic fragility exposed by the yield decline serves as a critical indicator of the system’s high exposure to biosecurity breaches (USDA, 2024; Grain and Feed Annual Pakistan).

Table 1. Key Agricultural Sector Performance and Production Metrics (FY 2025 Provisional)

Sector/Crop	Contribution/Production Value	FY 2025 Performance (%)	Biosecurity/Resilience Context
Agriculture (Overall)	23.5% of GDP	0.56% Growth	Strategic importance; resilience reliant on non-crop sectors.
Crop Sub-Sector (Overall)	N/A	-6.82% Growth	High vulnerability to abiotic stress; ripe for biotic threats.
Important Crops Sub-sector (Overall)	N/A	-13.49% Decline	Extreme economic exposure; yield decline compounds pest losses.
Rice Production	9.72 M. T	-1.38% Decline	Yield dropped from 2,713 kg/ha to 2,494 kg/ha, indicating pressure.
Sugarcane Production	84.24 M. T	-3.88% Decline	Decline attributed primarily to reduced rainfall and high temperature.
Maize Production	8.24 M. T	-15.4% Decline	Significant decline indicates high susceptibility to localized weather/input constraints.

Field Crops Production Profile (Major and Minor Crops)

The major field crops Wheat, Rice, Sugarcane, Cotton, and Maize dominate the agricultural landscape. Analysis of the 10-year production trend (2015-2025 detailed in Appendix A) reveals fluctuating performance, often dictated by weather, input costs, and global market dynamics.

Major Crops (Wheat, Rice, Maize)

Rice: The -1.38% decline in production despite an area increase highlights sustained yield pressure, likely from water scarcity and biotic stress factors, making biosecurity interventions critical for stabilizing this export crop.

Maize: The steep 15.4% decline in production highlights its high vulnerability, exacerbated by transboundary pests like the Fall Armyworm (FAW) (Iqbal, J. et al., 2023).

Wheat: Production is officially estimated at 29 million tons in 2025, about 5 percent above the five-year average, supported by government incentives. However, dry weather conditions caused crop losses in rainfed areas, and persistent diseases remain a major threat.

Table 2. Rice Production and Yield Trends

Indicator	Unit	FY 2024 (Previous)	FY 2025 (Provisional)	Growth (%)	Biosecurity Relevance
Area Cultivated	Million Hectares	3.64	3.90	+7.2%	Increased exposure area raises risk of widespread outbreaks.
Production Volume	Million Tonnes	9.86	9.72	-1.38%	Decline despite larger area suggests yield pressure (biotic/abiotic stress).
Average Yield	Kg/Hectare	2,713	2,494	-8.0%	Yield drops highlights vulnerability to environmental and pest issues.

Source: Pakistan Economic Survey (2025)

Minor/Other Crops (Tobacco and Oilseeds)

The 'Other Crops' sub-sector, which includes oilseeds (like Sesame and Tobacco), registered a positive growth of 4.78% in FY 2025, partially offsetting the decline in important crops. This stability is essential for diversification but must be protected from crop-specific biosecurity threats.

Table 3. Production Status of Key Minor/Cash Crops (Sesame & Tobacco Context)

Crop Category	FY 2025 Trend	FY 2025 Impact	Biosecurity Relevance
Sesame (Oilseed)	Contributes to "Other Crops" growth (+4.78%)	Oilseeds are a crucial alternative cash crop to offset Important Crops decline.	Diversification potential, but new crops introduce new pest pathways / risks.
Rapeseed & Mustard	Production declined by 44.5%	Decline due to reduced area sown, exposing low-priority crops to instability.	High volatility in minor crops creates systemic vulnerability.
Tobacco	Production retained its level	Stable production suggests resilience in supply chain/management compared to other minor crops.	Requires persistent monitoring against specific pests (e.g., Begomoviruses).

Horticultural Crops (Fruits and Vegetables)

Horticultural crops, including fruits (Citrus, Mango, Apple) and vegetables (Potato, Onion, Tomato, Chilies), are vital for domestic nutrition, economic diversification, and high-value exports. The sector's inherent vulnerability to pests and diseases is heightened by the stringent phytosanitary requirements of international markets. The successful negotiation to gain market access for exporting Citrus to Mongolia demonstrates the direct link between effective biosecurity measures and sustained profitability. Biosecurity failure in this high-value sector leads not only to domestic loss but also to immediate, costly barriers to trade. (Ministry of Commerce (MoC., 2024).

Table 4. Key Horticultural crops (citrus/kinnow & mango) trade status and biosecurity nexus

Crop / Policy Focus	Production Status & Export Value	Policy Achievement	Biosecurity Risk Nexus
Citrus (Kinnow)	Top fruit in terms of production. Ranks 13th globally (FAO, 2018).	Market access secured for Citrus exports to Mongolia, Russia and Indonesia.	Export market access is contingent upon the absence of major diseases like Citrus Greening (HLB).
Mango	Major export commodity with high post-harvest requirements.	Sector seeks advanced Vapour Heat Treatment (VHT) compliance for global market access.	Strict quarantine pests (e.g., Fruit Flies) and specific diseases (e.g., Malformation) directly inhibit high-value exports.
Horticulture (General)	Largest agricultural source of foreign exchange earnings.	Policy targets stringent adherence to global phytosanitary standards (e.g., MRLs).	Export trade demands zero tolerance for quarantine pests and strict residue analysis compliance.

Table 5. Production trends for key vegetables (onion & potato)

Crop	FY 2024-25 Production Trend	Context	Biosecurity Relevance
Onion	Production increased by 20.4%.	Crucial essential commodity; recent high-volume growth.	High economic value necessitates intense surveillance for pests like onion thrips and diseases like downy mildew.
Potato	Production increased by 1.5%.	Major staple vegetable, provides stability to the 'Other Crops' sector.	Vulnerable to seed-borne diseases and storage pests, requiring high standards of quarantine.
Chilies	Production declined by 15.3%.	High volatility and susceptibility to localized weather/diseases.	Decline indicates specific crop vulnerability requiring targeted biosecurity/climate adaptation strategies.

Table 6. Consolidated production/yield summary for major crops, fruits, and vegetables

Crop/ Product	Latest Production Volume/Estimate	Unit / Trend (FY 2025)	Yield/Productivity Comment
Wheat	29.0 (Forecast)	Million Tonnes (5% above 5-yr avg)	Yields above average in irrigated areas; dry weather losses in rainfed areas.
Rice	9.72	Million Tonnes (-1.38% Decline)	Average Yield: 2,494 kg/ha (-8.0% drop).
Maize	8.24	Million Tonnes (-15.4% Decline)	Significant volume decline; vulnerable to FAW pest outbreaks.
Onion	1.8	Million Tonnes (+20.4% Production Increase)	Major production increase, increasing its economic importance.
Potato	8.32	Million Tonnes (+1.5% Production Increase)	Stable production; critical staple vegetable.
Tobacco	77	Million KG (Stable)	Production level maintained compared to the previous year.

Crop/ Product	Latest Production Volume/Estimate	Unit / Trend (FY 2025)	Yield/Productivity Comment
Citrus (Kinnow)	0.3	Million Tonnes	Production is threatened by the uncurable Citrus Greening Disease.
Mango	1.8	Million Tonnes	Production significantly impacted by Die back (48.9%) and Malformation (34.5%).

Main Agricultural Biosecurity Issues and Economic Effects

High-Consequence Pest and Disease Threats

The agricultural sector faces a dynamic spectrum of biotic threats.

a) **Established High-Consequence Diseases:** Among the established, high-consequence diseases is Citrus Greening (Huanglongbing), caused by the bacterium *Liberibacter*, which severely impacts citrus production. This disease is currently considered uncurable and poses an existential threat to the valuable citrus export market. For cotton, the dominant species of Begomovirus, Cotton Leaf Curl Multan Virus (CLCuMuV), is a major constraint on yield *(*Tipu, T. et al., 2020 and Begum, I. et al., 2023).

b) **Shifting Pest Complexes:** The general insect pest complex of crops has undergone a tremendous change over the last two decades, attributed to changes in cropping patterns, the introduction of high-yielding cultivars, and altered insecticide use. This necessitates the continuous monitoring and review of the pests and their succession for developing effective pest management strategies (Shafqat, M.F. et al., 2024).

c) **Transboundary Threats:** The persistent challenge of Locust swarms requires dedicated operational capabilities within the Department of Plant Protection (DPP). Fall Armyworm (FAW) poses a significant transboundary threat, causing severe damage to maize and stimulating widespread synthetic pesticide use (Shafqat, M. F. et al., 2024).

Quantifying Effects on Agriculture, Products, and Food Industry

Quantifying the economic damage caused by pests and diseases is essential for developing safe, economical, and sustainable pest management strategies. Crop loss assessment is considered the best way to demonstrate the benefits (avoidable losses) gained from applying sound plant protection measures.

The economic impact extends beyond primary yield loss:

1. **Agriculture:** Cumulative yield losses for Wheat alone are estimated to range from 4% to 16% in hotspots, primarily due to rusts and aphids.

2. **Products and Exports:** Losses impact export eligibility due to stringent Maximum Residue Limits (MRLs) and requires mandatory residue analysis. For high value fruits like Kinnow, Citrus Greening causes off-flavor, misshapen, inedible fruit, and yield loss, immediately jeopardizing export contracts.
3. **Food Industry:** Quality degradation stemming from pest damage (e.g., FAW-infested maize supporting fungal growth) or excessive pesticide contamination affects processing efficiency, storage life, and consumer safety standards, leading to domestic price hikes for essential food items.

Table 7. Quantified crop loss estimates due to pests and diseases (Selected examples)

Crop	Pest/ Disease Agent	Estimated Yield Loss (%) / Monetary Value	Loss Context
Wheat	Cumulative (Stripe Rust, Leaf Rust, Aphids)	4% to 16%	Cumulative Field Yield Loss (Hotspots in central Punjab and northern Sindh).
Wheat	Leaf Rust (*Puccinia recondita*)	5% to 57%	Experimental Yield Loss (Dependent on variety and disease severity).
Citrus (Kinnow)	Citrus Greening (HLB - *Liberibacter*)	Causes serious economic losses (disease uncurable)	Leads to off-flavor, misshapen, inedible fruit, and yield loss, directly threatening the export market.
Mango	Die Back / Malformation	34.5% to 48.9%	Major disease incidence reported by growers, resulting in less profit/production.
Pulses (Cowpea)	Pulse Beetle (*C. maculatus*)	3.7% (Maximum)	Storage Weight Loss (In 1.5 months of storage)
Maize	Fall Armyworm (FAW)	Millions of USD in losses	Severe damage post-2019 introduction; drives high management costs.

Source: Munir, Q. M., & Hussain, B., 2024

Biosecurity Threats Amplified by Climate Change

Global weather changes introduce a substantial layer of complexity to biosecurity planning. Pakistan is ranked among the top ten climate-affected countries, despite contributing less than 1% to global greenhouse gas emissions.

a) **Altered Threat Profile:** Long-term climatic data suggest that the rate of introduction or establishment of new pests and diseases may be rising, fundamentally altering the national threat profile. The persistence of severe challenges, such as climate-induced shifts in pest populations, is recognized as a major impediment to achieving sustainable pest management.

b) **Modification of Pest Cycles:** Higher temperatures, altered rainfall patterns, and extreme weather events modify the geographical range and reproductive cycles of existing pests and facilitate the rapid establishment of new invasive species that previously could not survive local conditions.

c) **Exacerbated Abiotic Stress:** Climatic events like floods and droughts adversely affect the agriculture sector. This increased abiotic stress reduces crop resilience, meaning that when a biotic threat arrives, the resulting yield loss is significantly compounded. Evaluating the evidence for this change in threat over time, and identifying the probable causes of the shift, is vital for proactive biosecurity strategy development.

Measures Taken by Concerned Departments (DPP)

Extension of Disease Information Outreach and Farmer Education (IPM Programs)

A core strategy for internal biosecurity and sustainability is the promotion of Integrated Pest Management (IPM). The National IPM Programme, often implemented through Farmer Field Schools (FFS), has achieved remarkable success:

- **Pesticide Reduction:** Documented case studies show a reduction in pesticide use by 30%.
- **Yield Increase:** Yield increases range from 10% to 25% in implementation zones.
- **Biocontrol Deployment:** The use of biological control agents, such as *Trichogramma* wasps and *Beauveria bassiana* fungi, has resulted in yield improvements of up to 18% and reduced reliance on chemical inputs.
- **Digitalization:** The successful integration with the Pakistan Single Window (PSW) represents a major leap, shifting from manual, paper-based permits to an electronic system that provides a single interface for traders and cuts down clearance time. Adoption CABI Horizon Scanning and PRA tools and integration with its pest data centre.
- **Enhanced Pest Surveillance:** Improved use of GIS and satellite imagery, particularly in collaboration with the FAO, for more accurate and timely surveillance of the Desert Locust.
- **Infrastructural Development:** Establishment of advanced phytosanitary treatment facilities (e.g., Vapour Heat Treatment, Hot Water Treatment, Cold

Treatment, Heat Treatment and Irradiation facilities) that meet the strict quarantine requirements of high-value markets.

Development of New Management Strategies and Tools

Future strategies emphasize the potential of precision agriculture technologies to move from general chemical control to targeted, effective interventions.

- **Advanced Surveillance:** The use of drones, remote sensing, and Artificial Intelligence (AI) driven monitoring systems for enhanced pest surveillance has offered significant potential for early detection and rapid response.
- **Policy Direction:** Policy recommendations reflect this direction, stressing the need for providing institutional support, improving farmer capacity, and investing in advanced tools such as biopesticides and genetically modified organisms (GMOs). Enactment of PPQR 2019 and National Agri trade and Food safety Ordinance 2025 will be game-changer in the region.

Biosecurity Laws, Regulations, Policies, and Strategies

Foundational Biosecurity Legislation and Standards

a) Biosecurity laws in the country.

The legal foundation for plant biosecurity in Pakistan rests primarily on the Plant Quarantine Act of 1976 (PQA 1976), which empowers the government and the NPPO (DPP) to regulate the import, export, and internal movement of plants and plant products. The regulatory system is supported by the Agricultural Pesticides Ordinance 1971 and Rules 1973, which governs the use and regulation of chemical inputs, including mandatory residue analysis required for trade compliance.

The PQA 1976's operational effectiveness is realized through the Pakistan Plant Quarantine Rules (PPQR), 2019. The PPQR 2019 serves as the critical operational rulebook for the NPPO, detailing specific phytosanitary import requirements, definitions, and precise procedures for obtaining Controlled Import Permits (CIPs). Critically, the Rules include specific regulations for commercial imports, bio-control agents, Genetically Modified Organisms (GMOs), and plant germplasm. It grants the federal government, through the DPP, the power to:

1) Prohibit or restrict the import or export of plants, plant products, soil, or any other regulated articles.
2) Establish and regulate quarantine facilities, including post-entry quarantine stations.
3) Prescribe treatment methods (e.g., fumigation, heat treatment) for infested or potentially infested articles.
4) Establish pest lists and prescribe fees for services.
5) Impose penalties for violations of the Act and its rules.

The Pakistan Plant Quarantine Rules (PPQR), 2019: A Deep Dive

The PPQR 2019 updated and modernized the 1967 rules, providing the detailed, operational procedures necessary to enforce the 1976 Act. This document is crucial as it incorporates the principles of Pest Risk Analysis (PRA) and aligns Pakistan's regulatory practices with the IPPC's International Standards for Phytosanitary Measures (ISPMs). It governs everything from the application process for Import Permits (IPs) and Controlled Import Permits (CIPs) to specific requirements for high-risk commodities like planting material and genetically modified organisms (GMOs).

A. Specific Pests and Weeds under PPQR 2019

The core of phytosanitary regulation lies in the identification and regulation of threats, categorized into various schedules.

Schedule-I: List of Quarantine Pests

Schedule-I lists Quarantine Pests (QPs). A QP is a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and under official control (as per IPPC definition). Their entry is generally prohibited unless a specific Pest Risk Analysis (PRA) deems a high-security procedure viable.

Illustrative Examples of Schedule-I Pests:

- ***Trogoderma granarium* (Khapra Beetle):** A globally regulated, devastating pest of stored commodities, particularly grains. Pakistan maintains zero tolerance for this pest in imports, despite its historical presence, to protect its massive grain stores.
- ***Bactrocera spp. (*Exotic Fruit Flies):** Species like the Mediterranean Fruit Fly (*Ceratitis capitata*) or highly virulent strains of the Oriental Fruit Fly complex not yet established in Pakistan. They pose an existential threat to Pakistan's fruit industry (mangoes, citrus, etc.).
- ***Rathayibacter toxicus:*** The bacterium causing the annual rye-grass toxicity, a major plant health threat that could contaminate fodder and cereals.
- **Viral Diseases of Temperate Fruits *(e.g., Plum Pox Virus/Sharka):*** Highly damaging viruses that, if introduced, could cripple the pome and stone fruit industries in Baluchistan and Khyber Pakhtunkhwa.
- ***Phytophthora ramorum* (Sudden Oak Death):** A pathogen with a broad host range that could devastate ornamental, forest, and horticultural plants.

Schedule-II: List of Regulated Non-Quarantine Pests (RNQPs)

Schedule-II, lists Regulated Non-Quarantine Pests (RNQPs). These are pests whose presence in plants for planting (planting material) affects the intended use of the plants with an economically unacceptable impact and which are therefore regulated within the territory of the importing contracting party. Import is permitted subject to specific, officially prescribed phytosanitary measures (e.g., official certification, inspection, or specific treatments).

Illustrative Examples of Schedule-II Pests:

- ***Globodera rostochiensis and G. pallida* (Potato Cyst Nematodes):** These nematodes are regulated in potato seed imports. While some strains may be present, the import of seed must be officially declared free from these pests to maintain quality standards and prevent introduction of new pathotypes.
- **Viruses and Viroids in Certified Seed:** Various viruses in potato, sugarcane, or citrus (e.g., Citrus Tristeza Virus (CTV), Potato Leaf Roll Virus (PLRV)). The requirement for specific tolerances or freedom from these pests ensures the viability and commercial quality of the planting material.
- ***Fusarium oxysporum f.sp. vasinfectum* (Cotton Wilt Pathotype):** The presence of certain virulent pathotypes of this fungus in imported cotton seed is restricted to protect local varieties.

Schedule-V: List of Noxious Weeds

Schedule-V lists Noxious Weeds, plants that are highly invasive and destructive to agriculture, environment, and human health. The seeds or propagules of these weeds are strictly prohibited from being imported, primarily as contaminants in seed, grain, or soil.

Illustrative Examples of Schedule-V Noxious Weeds:

- ***Cuscuta spp.* (Dodder):** A parasitic plant that can form dense mats, severely damaging host crops like clover, lucerne, and citrus. Its seeds are highly persistent.
- ***Orobanche spp.* (Broomrape):** Another obligate root parasite, severely affecting crops like tobacco, tomato, potato, and lentils. It poses a grave threat to food security in affected areas.
- ***Striga spp.* (Witchweeds):** Parasitic weeds that are major constraints to cereal production (maize, sorghum) in parts of the world and are strictly regulated to prevent their introduction.
- ***Sorghum halepense* (Johnson Grass):** A highly competitive and perennial weed with deep rhizomes, extremely difficult to control once established.

B. Assessment of National Standards for Phytosanitary Measures for Plant Quarantine.

The DPP is mandated to ensure adherence to the International Standards for Phytosanitary Measures (ISPMs). These standards are developed under the framework of the International Plant Protection Convention (IPPC), negotiated under the WTO-SPS agreement. National adherence to ISPMs is essential for ensuring that Pakistan's agricultural exports remain competitive and avoid international trade restrictions. Amendments have recently been made to the PPQR 2019 specifically to facilitate the "ease of doing business", demonstrating a policy balance between trade facilitation and maintaining phytosanitary rigor.

Table 8. Core Biosecurity Legal Instruments in Pakistan

Instrument	Year Enacted/Notified	Primary Biosecurity Mandate	Key Modern Provisions (PPQR 2019)
Plant Quarantine Act	1976	Foundational control of import/movement of plant materials.	Basis for PPQR 2019 enforcement.
Pakistan Plant Quarantine Rules (PPQR)	2019	Detailed operational procedures and standards for high-risk imports.	Controlled Import Permits (CIPs), GMOs, Bio-control agents, Germplasm.
Agricultural Pesticides Ordinance	1971 (with amendments)	Regulation of chemical inputs; mandatory residue analysis enforcement.	Supports phytosanitary safety and trade requirements (e.g., MRLs).
Agricultural Pesticides Rules	1973	Regulation of chemical inputs; mandatory residue analysis enforcement.	Supports phytosanitary safety and trade requirements (e.g., MRLs).

Improvement and Harmonization of Biosecurity Laws

c) Biosecurity laws improvement, which bring biosecurity up to a level legal footing to environmental protection and health and safety.

The current regulatory framework suffers from fragmentation and reliance on statutes (PQA 1976, Pesticides Ordinance 1971) that predate many modern scientific and trade complexities. To truly elevate biosecurity to parity with environmental protection and public health/safety acknowledging the inter connectedness of threats like Foot and Mouth Disease (FMD) in livestock, Dengue in humans, and sophisticated plant diseases a comprehensive legal instrument is required.

The proposed enactment of a National Agri trade and Food Safety Ordinance 2025 is necessary to consolidate authority, modernize penalty structures, provide the legal foundation for robust cross-sectoral response mechanisms, and ensure sustained high-level enforcement and secure funding for the NPPO. This will align the enforcement capability with the scale of transboundary threats faced by the country.

National Biosecurity Programs and Strategic Implementation

i) Agricultural biosecurity programs to protect the integrity, reliability, sustainability and profitability against threats from different diseases, pests, contaminants and disasters.

National programs are designed to protect the agricultural sector's integrity, reliability, sustainability, and profitability against known and emerging threats. This necessitates a coordinated effort across federal and provincial entities. The emphasis is on building systemic resilience against major disasters (such as climate-induced floods) and biotic threats. The DPP has made significant strides in modernizing its operations:

- **Digitalization:** The successful integration with the Pakistan Single Window (PSW) represents a major leap, shifting from manual, paper-based permits to an electronic system that provides a single interface for traders and cuts down clearance time.
- **Enhanced Pest Surveillance:** Improved use of GIS and satellite imagery, particularly in collaboration with the FAO, for more accurate and timely surveillance of the Desert Locust.
- **Infrastructural Development:** Establishment of advanced phytosanitary treatment facilities (e.g., Vapour Heat Treatment, Hot Water Treatment, Cold Treatment, Heat Treatment and Irradiation facilities) that meet the strict quarantine requirements of high-value markets.

ii) Support programs that readily available, science-based tactics to help prevent, prepare to detect, respond to and recover from known emerging threats.

The adoption and promotion of the National Integrated Pest Management (IPM) Program in coordination with CABI, Pakistan exemplify the use of readily available, science-based tactics. This program strategically moves away from reliance on broad-spectrum chemical controls toward ecological solutions, combining biological, cultural, mechanical, and selective chemical controls to manage pest populations ecologically. These programs directly help farmers prevent losses and prepare for emerging threats by building localized knowledge and capacity through Farmer Field Schools (FFS).

iii) Activities related to surveillance and early detection of high consequence pests and diseases; timely deployment of technologies and human resources to respond, manage and recover from outbreaks

Surveillance activities focus intensely on high-consequence pests. The Department of Plant Protection (DPP) maintains dedicated resources for the continuous Locust survey and control operations in desert areas, requiring close coordination with the FAO and neighboring countries. Furthermore, the strategic deployment of technologies, such as the piloting of drones and remote sensing, is aimed at enhancing early detection in high-value crop zones, allowing for a timely and targeted deployment of human resources to manage and recover from outbreaks. Necessary coordination for in-country pest surveillance, disease control, and data gathering. The provincial Pest Warning and Quality Control units are the ground-level implementing agencies for many of the DPP's advisories.

iv) Regulatory systems developed to support, for critical research regarding crops, pests, diseases and residue analysis to inform concerned departments for further regulations to ensure safety and diversity of agricultural products

The regulatory system actively supports critical research, particularly through the enforcement of the Agricultural Pesticides Ordinance 1971. This ordinance necessitates mandatory residue analysis to ensure compliance with Maximum Residue Limits (MRLs) for agricultural products, especially those destined for export. Research regarding pest dynamics, diseases (like Citrus Greening, and MRL compliance informs regulatory bodies, enabling them to formulate new and necessary regulations that ensure the safety and diversity of agricultural products. Further, On May 2, 2025, the Federal Government promulgated the National Agri-Trade and Food Safety Ordinance, providing for the establishment of the National Agri-Trade and Food Safety Authority (NAFSA). The ordinance aims to merge the Animal Quarantine Department and the Department of Plant Protection (DPP) into a single autonomous authority with an expanded mandate encompassing food safety compliance, enhanced operational efficiency, and strengthened national trade facilitation mechanisms. The Authority is empowered for unrestricted utilization of budgetary resources to ensure the modernization of operational offices, establishment and up-gradation of laboratories, and capacity building of technical personnel.

v) Deployment of new crop production and protection technologies and management systems and science-based outreach to help producers against local, regional and international threats of pests and diseases.

Pakistan Agriculture Research Council (PARC) and DPP Joint research, pest diagnostic and surveillance programs. The strategy involves scaling up the deployment of new, sophisticated technologies. This includes:

- **Precision Agriculture:** Utilizing remote sensing and AI-driven monitoring systems for enhanced surveillance.
- **Biocontrol Agents:** Deploying and promoting the use of locally produced biological control agents (e.g., *Trichogramma* wasps).
- **Outreach:** Science-based outreach through the FFS model ensures that producers are equipped with modern management systems to safeguard their farms effectively against threats.

vi) On-going research to develop a better evidence base for biosecurity strategy.

On-going research is crucial for developing a better evidence base. This includes continuous monitoring and systematic review of changing pest complexes, such as the evolution of new dominant pest species, which is required to develop effective and sustainable pest management strategies. Sustained investments in agricultural research and development are highlighted as necessary to maintain a proactive biosecurity posture. DPP in coordination with PARC, Provincial agriculture departments and international organizations like CABI are conducting research for developing better evidence base biosecurity strategy.

vii) Improvement in the biosecurity measures. Plant health regulations, eradication, best management practices and restoration plans.

Improvements in biosecurity measures focus on several fronts:

- **Best Management Practices (BMPs):** Scaling successful BMPs, particularly those demonstrated by the IPM Program (30% pesticide reduction, 10-25% yield increase).
- **Eradication and Containment:** Strengthening quick-response protocols for eradication efforts following the detection of quarantine pests.
- **Plant Health Regulations:** Continuously updating rules, such as amendments to the PPQR 2019, to align with international standards and trade realities.
- **Restoration Plans:** Developing rapid restoration plans for agricultural livelihoods following major pest outbreaks or environmental disasters, such as the Kissan Package-2022 announced after the 2022 floods.

viii) Border surveillance including checks made of incoming cargo, mail and passengers at airports, seaports and international mail centres as well as surrounding areas. Post-border or onshore surveillance.

The operational core of phytosanitary defense lies in surveillance:

- **Border Surveillance:** The DPP maintains an extensive network of Plant Quarantine Outposts at all major international points of entry, including airports (Islamabad, Lahore, Karachi), seaports, international mail centers, and land crossings (Wagha, Tokham & Taftan Borders). These outposts conduct physical checks of incoming cargo, mail, and passenger baggage to intercept prohibited or high-risk materials.

- **Post-Border (Onshore) Surveillance:** This is executed through a combination of federal survey and control units and strategically localized Locust Outposts (e.g., Multan, Bahawalpur, Rahim Yar Khan). The effectiveness hinges on the technical capacity of provincial agriculture extension networks to identify and report emerging threats outside designated high-security zones.

Table 9. Designated Points of Entry/Exit

Type of Entry Point	Example	Operational Significance
Seaports	Karachi Port (KPT), Port Muhammad Bin Qasim (Qasim)	Handles the majority of bulk and containerized trade, including grains, pulses, cotton, fruits & Vegetable and timber.
International Airports	Jinnah International (Karachi), Allama Iqbal (Lahore), Islamabad International, Bacha Khan International, Sialkot International	Crucial for high-value, perishable commodities (fruits, vegetables), seed, and germplasm imports requiring rapid clearance.
Land Border Stations	Wagah Border (India), Torkham, Kharlachi, Ghulam Khan, Angoor Ada (Afghanistan & Central Asia), Gawader, Taftan (Iran & Central Asia), Sust (China)	Manages cross-border movement via road, especially for fresh produce and livestock feed.

Source: Pakistan Plant Quarantine Rules (PPQR, 2019)

ix) A proactive, long-term, coordinated awareness raising plan, with a clear objective and realistic metrics developed in the country.

While farmer education is strong through IPM programs, a formal, nationwide, and coordinated awareness raising plan is needed. Such a plan must have clear objectives and realistic metrics designed to embed a permanent culture of biosecurity responsibility across all stakeholders: importers, travelers, producers, and transporters. This includes campaigns targeted at minimizing the risk associated with informal seed and grain exchange, which is identified as a key pathway for pathogen spread, particularly for diseases like wheat rust.

x) Biosecurity acts developed, which bring biosecurity up to a level legal footing to environmental protection and health and safety.

As discussed in Section 2.2, the lack of a modern, singular Biosecurity Act is a regulatory weakness. The need for new legislation to bring biosecurity up to a legal footing equal to environmental protection and health and safety remains a critical, unfulfilled strategic objective, ensuring holistic management of complex biological threats.

Institutional Arrangements for Biosecurity and Plant Health Management

National Plant Protection Organization (NPPO) Structure and Mandates

Roles and Responsibilities of the Department of Plant Protection (DPP)

Focus on Detection and Diagnosis Capabilities

The DPP's mandate is defined by its role as a regulatory and advisory body responsible for all facets of plant protection at the national level. Its strategic objectives include:

A. **Exclusion and Containment:** Implementing stringent plant quarantine measures to prevent the entry, establishment, and spread of foreign pests, diseases, and weeds.

B. **Trade Compliance and Facilitation:** Conducting Pest Risk Analyses (PRA) and inspection/certification processes (Phytosanitary Certificates) to facilitate the export of Pakistani agricultural commodities in line with importing countries' requirements, thereby enhancing market access.

C. **Pest Management:** Undertaking large-scale pest control operations, most notably the surveillance and control of the Desert Locust, a trans-boundary pest.

D. **Pesticide Regulation:** Regulating the import, registration, quality control, and safe use of all agricultural pesticides in the country, ensuring environmental and food safety.

E. **Pest surveillance and diagnostics:** National programs for detection, identification, and monitoring of quarantine and non-quarantine pests.

F. **Locust management:** Implementation of the National Locust Control Program and regional cooperation under FAO's Commission for Controlling the Desert Locust in South-West Asia (SWAC).

G. **Capacity Building:** Continuously enhancing human resources, infrastructure (laboratories, treatment facilities), and technical expertise to meet dynamic global phytosanitary challenges.

H. **Research:** Conducting and regulating research related to plant health and pest dynamics.

I. **Advisory:** Providing guidance and extension services, often through the promotion of IPM.

Organizational Structure and Regional Presence

The DPP is headed by a Director General, supported by Directors, Deputy Directors and technical officers in specialized wings: Plant Quarantine, Locust Control, Pesticide Registration, Pest Surveillance, and Administration. The Department's headquarters are located in Karachi, with regional offices and plant quarantine stations across the country. The DPP maintains a network of quarantine outposts at points of entry. The primary focus here is on improving the capability for standardized and rapid testing. Measures are continuously being developed to assure quality standards and implement proficiency testing across this network to ensure diagnostic reliability, essential for trade compliance. Major Regional Offices and Stations:

1) Karachi (Headquarters and main seaport quarantine station)
2) Lahore
3) Quetta
4) Peshawar
5) Multan
6) Islamabad
7) Sialkot
8) Gawadar
9) Sust (Pakistan-China border)
10) Torkham (Afghanistan border)

Each regional office is responsible for inspection, sampling, laboratory analysis, and coordination with customs and port authorities.

Operational Divisions of DPP

Plant Quarantine Division

The Plant Quarantine Division of the Department of Plant Protection (DPP) is responsible for regulating the import and export of plants, plant products, and regulated articles in accordance with the International Plant Protection Convention (IPPC) and national phytosanitary laws. Its core functions include pest risk analysis, inspection, certification, and treatment of consignments to prevent the introduction and spread of quarantine pests. The Division also oversees the operation and approval of quarantine stations, fumigation and treatment providers, and ensures compliance with international standards such as ISPMs. Through these functions, the Plant Quarantine Division safeguards national agriculture, facilitates safe trade, and contributes to maintaining Pakistan's compliance with international sanitary and phytosanitary (SPS) obligations (Source: Pakistan Plant Quarantine Rules (PPQR) 2019).

Locust Control Division

The Locust Control Division of the DPP serves as the national focal agency for surveillance, forecasting, and control of desert locusts in coordination with regional and international bodies, including FAO's Commission for Controlling the Desert Locust in the Central Region (CRC). The Division maintains a network of field surveillance units across the locust-prone areas of Pakistan, conducts ground and aerial monitoring, and implements control operations during outbreaks. It also maintains contingency stocks of pesticides, equipment, and trained personnel to ensure rapid response to locust emergencies. By providing early warning, preparedness, and control measures, the Division protects national food security and agricultural production from transboundary pest threats.

Aerial Operations Division

The Aerial Operations Division of the DPP is mandated to provide aerial support for pest control, particularly for large-scale desert locust control and other emergency pest management operations. The Division operates and maintains aircraft and drones equipped for aerial spraying, surveillance, and mapping, ensuring timely and efficient coverage of vast and inaccessible areas. It coordinates closely with the Locust and Plant Protection Divisions to deploy resources based on pest dynamics and risk assessments. In addition to operational duties, the Division plays a vital role in training technical crews, maintaining aviation safety standards, and modernizing aerial application technologies. Its activities significantly enhance the national capacity for rapid and effective pest management interventions.

Pesticide Registration

The Pesticide Registration Division of the Department of Plant Protection (DPP) functions as the national regulatory authority responsible for the evaluation, registration, and management of agricultural pesticides in Pakistan under the Agricultural Pesticides Ordinance, 1971 and related rules. The Division assesses pesticide formulations for efficacy, safety, quality, and environmental impact, ensuring that only scientifically evaluated and approved products are available in the market. It oversees the registration of technical materials, formulations, and bio-pesticides, and regulates their import, manufacturing, distribution, and use in coordination with provincial governments and relevant stakeholders. The Division also represents Pakistan in international chemical conventions and promotes harmonization with global standards, including FAO and WHO guidelines, thereby ensuring sustainable pest management, safe agricultural production, and protection of human health and the environment.

Association with National and International Organizations

National Collaborations

The DPP's effectiveness is amplified by its strong national network:

- **Ministry of National Food Security and Research (MNFSR):** Provides the overarching policy and budgetary support necessary for the DPP's operations.
- **Pakistan Single Window (PSW):** In line with the Pakistan Single Window (PSW) initiative, DPP is transitioning toward a fully digital phytosanitary certification system. The integration with PSW allows traders to apply for import permits, phytosanitary certificates, and release orders online. This digital transformation reduces delays, enhances transparency, and aligns Pakistan with the IPPC's e-Phyto global hub for electronic certification exchange.
- **Centre for Agriculture and Biosciences International (CABI):** Capacity building, Research and knowledge Sharing by Training on pest management and invasive species control.
- **Pakistan Customs/Federal Board of Revenue (FBR):** A symbiotic relationship exists for enforcement. Customs officials rely on DPP's clearance (Release Order/Import Permit) to allow consignments into the country, ensuring that plant quarantine laws are upheld at all borders.
- **Pakistan Agricultural Research Council (PARC):** Joint pest diagnostic and surveillance programs.
- **Provincial Agriculture Departments:** Necessary coordination for in-country pest surveillance, disease control, and data gathering. The provincial Pest Warning and Quality Control units are the ground-level implementing agencies for many of the DPP's advisories.
- **Private Sector and Trade Bodies**: The DPP maintains an open channel with trade bodies to understand market access challenges and adjust regulations to facilitate compliant exports, particularly for high-value commodities like rice, mangoes, and citrus.

International Collaborations

- **Food and Agriculture Organization (FAO):** The relationship is strongest in Desert Locust Control, where the FAO provides technical coordination, forecasting, and resource mobilization. FAO has also assisted the DPP in enhancing technical capabilities and infrastructure development.
- **World Bank (WB) and Asian Development Bank (ADB):** These multilateral institutions have provided financing and technical guidance for large-scale projects, such as the Locust Emergency & Food Security Project, aimed at strengthening the DPP's capacity to manage large-scale threats.

- **Bilateral Engagements with NPPOs:** Direct, technical cooperation with the NPPOs of key trading partners (e.g., China, European Union, USA) is essential for negotiating bilateral phytosanitary protocols that secure and expand market access for Pakistani produce.

Signatory to International Conventions and Forums

International Plant Protection Convention (IPPC)

Pakistan is a long-standing contracting party to the IPPC, a multilateral treaty under the umbrella of the Food and Agriculture Organization (FAO) that aims to secure coordinated, effective action to prevent the spread and introduction of pests of plants and plant products.

Role of DPP: The DPP is formally designated as the NPPO under Article IV of the IPPC. This role involves developing, publishing, and implementing phytosanitary standards, issuing Phytosanitary Certificates (PCs) for exports (ISPM 12), regulating imports (ISPM 20), and conducting Pest Risk Analysis (ISPM 2 and 11).

Standards Implementation: The DPP actively promotes the adoption of International Standards for Phytosanitary Measures (ISPMs), such as ISPM 15 (Regulation of Wood Packaging Material) and ISPM 46 (National Phytosanitary Capacity). DPP officer has been the member of IPPC Standards Committee for 2024-2027.

World Trade Organization (WTO) - SPS Agreement

Pakistan’s accession to the WTO commits it to the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement). This agreement allows countries to implement measures to protect human, animal, and plant life and health, provided these measures are based on scientific evidence (PRA) and are not used as arbitrary barriers to trade.

- **Trade Facilitation:** The DPP ensures that all phytosanitary requirements for Pakistani exports are scientifically justified and meet the importing country's standards, thus minimizing trade disputes and technical barriers.

- **Transparency:** The DPP fulfills Pakistan’s SPS notification obligations, informing the WTO-SPS Committee and its trading partners about new or changed phytosanitary regulations.

The Pesticides Registration Division (PRD) of the DPP is responsible for Pakistan's commitments under global chemical management treaties:

- **Rotterdam Convention (Prior Informed Consent - PIC):** The DPP acts as the National Designated Authority (DNA) for pesticides, managing the flow of information regarding hazardous chemicals and pesticides to ensure that imported chemicals are not banned or severely restricted in other countries.

- **Stockholm Convention (Persistent Organic Pollutants - POPs):** The DPP plays a crucial part in the phase-out, control, and management of Persistent Organic Pollutants (POPs) that have historical use in agriculture (e.g., DDT, Aldrin), thereby safeguarding public health and the environment.

Role in Regional and Global Forums

- **Asia and Pacific Plant Protection Commission (APPPC):** Pakistan is a member of this FAO-affiliated regional body, collaborating on regional standards, information exchange (pest status reporting), and harmonized phytosanitary measures among Asia-Pacific nations.
- **FAO Commission for Controlling the Desert Locust in South-West Asia (SWAC):** As a member, the DPP is actively involved in cross-border coordination, survey data sharing, and joint control strategies with countries like India, Iran, and Afghanistan to manage this highly mobile trans-boundary pest.
- **International Technical Consultations (STDF, IPPC STCs):** DPP technical experts participate in drafting and reviewing new IPPC standards and in technical assistance forums like the Standards and Trade Development Facility (STDF).

The Department of Plant Protection (DPP) serves as Pakistan's official National Plant Protection Organization (NPPO). Its headquarters is in Karachi, with distributed sub-offices and outposts. The DPP's core responsibilities are divided into four major functions:

- **Regulatory:** Enforcement of the PQA 1976, PPQR 2019, and the International Standards for Phytosanitary Measures (ISPMs).
- **Survey and Control:** Dedicated operations for transboundary pests, notably Locust survey and control in desert areas.

Provincial and Regional Stakeholder Roles

Effective national biosecurity is a federal-provincial collaboration. The DPP coordinates with the federal Ministry of National Food Security and Research (MNFS&R) and the respective provincial agriculture departments (Punjab, Sindh, Khyber Pakhtunkhwa, and Baluchistan). Provincial agriculture extension networks are the primary actors responsible for field-level surveillance, dissemination of disease information, and implementation of post-border management strategies, such as the Farmer Field Schools model.

National Network of Biosecurity Laboratories and Objectives

Network of laboratories, developed for the biosecurity purpose and their objectives:

The DPP operates Plant Quarantine Outposts situated at all major international points of entry. These sites function as the initial detection and diagnostic network of public and private internationally ISO 17025 & GLP accredited laboratories.

a) Assure quality standards and proficiency testing.

The paramount objective for this network is to assure quality standards in diagnosis and detection procedures through regular proficiency testing among all DPP facilities. This ensures the certified reliability of diagnostic results, crucial for justifying quarantine decisions and maintaining international trade trust.

b) Improve the capabilities.

Capabilities must be continuously improved, moving beyond traditional microscopy to modern molecular techniques to tackle rapidly evolving and latent pathogens.

c) Expand standardized and rapid testing capabilities.

The network requires significant investment to expand standardized and rapid testing capabilities. Dependence on slower diagnostic methods increases trade friction and biosecurity risk, particularly for pathogens with long latency periods, such as the bacteria causing Citrus Greening. Expanding molecular diagnostic techniques (e.g., real-time PCR) is essential for swift, accurate identification of high-consequence pests and diseases.

d) Train personnel.

A systematic program for training personnel in modern phytosanitary techniques is necessary. This training must cover sophisticated molecular diagnostics, advanced risk analysis methodologies, and standardized sampling and reporting protocols.

e) Improve communications to share data.

Communication infrastructure needs improvement to share data rapidly and securely across the distributed network of quarantine outposts, laboratories, and federal/provincial command centers, ensuring unified risk awareness.

Table 9. Department of Plant Protection (DPP) institutional capacity and network summary

Capacity Dimension	Current Status/Mechanism	Examples (Locations/Programs)
Border Surveillance	Quarantine Outposts at Entry Points	International Airports (Karachi, Lahore, Islamabad), Wagah Border.
Regulatory Enforcement	Plant Quarantine Rules and ISPMs	Controlled Import Permits (CIPs), GMOs, Bio-control agents, Germplasm.
Specialized Control	Survey and Control Units	Locust Outposts (Multan, Bahawalpur, Rahim Yar Khan); National Locust Control Center.
Coordination	Inter-Ministerial and International Links	MNFS&R, Provincial Agriculture Departments, IPPC, FAO.

Coordination, Data Sharing, and Standardization

Status of coordination activities with the different stakeholders in the country, region and different other countries in the world.

Coordination is complex, involving multiple layers:

- **Domestic:** Interaction with federal bodies (MNFS&R, Ministry of Commerce), provincial agriculture departments, and private sector industry bodies (e.g., Karachi Chamber of Commerce & Industry).
- **Regional and International:** Active participation in global forums is maintained, as Pakistan is a signatory to the IPPC and collaborates closely with the FAO, WTO-SPS, and Regional Plant Protection Organizations. This network is vital for managing transboundary threats, notably the regional management of locust movements.

Establishment of national standard operating procedures for diagnostics, sampling and reporting.

A unified national system lacks consistent, universally adopted SOPs across federal and provincial facilities. Establishing national SOPs for diagnostics, sampling, and reporting is critical to achieving consistent quality, certified diagnostic results, and reliable data aggregation across the country.

Create a national data base for monitoring diseases and pest's outbreaks.

A critical institutional and technical gap is the absence of a unified, real-time national database. The creation of such a database is essential for monitoring diseases and pest outbreaks, integrating border interception data, provincial survey findings, and laboratory confirmations to enable evidence-based risk assessment and rapid policy intervention. Currently, DPP relies on CABI Pakistan's National Data Centre, established at the DPP headquarters, Karachi.

Investment and Future Institutional Strategies

Investment in the biosecurity measures.

Investment in biosecurity has historically been reactive rather than strategic. Targeted, substantial investment is crucial, leveraging initiatives like the SIFC to secure funding for modernizing outdated infrastructure and deploying advanced technology to enhance both diagnostic and surveillance capabilities.

Future strategies, for strengthening Institutional biosecurity capacities.

The DPP's future strategy is centered on strengthening capacity and expanding the digital footprint:

1) **Strengthening PRA Capacity:** Investing in dedicated scientific teams and resources to conduct high-quality Pest Risk Analyses for new commodities and emerging threats, ensuring all regulatory decisions are scientifically sound and justifiable under the WTO-SPS Agreement.
2) **Expansion of Pest Free Areas (PFAs):** Officially establishing, maintaining, and reporting Pest Free Areas (PFAs) for key export commodities (e.g., mango, citrus) in accordance with ISPM 4, which is a prerequisite for accessing many high-value markets.
3) **Modernizing Surveillance:** Investing in remote sensing, drone technology, and mobile applications for real-time pest surveillance and reporting to minimize the response time to outbreaks.
4) **Regulatory Harmonization:** Working to further harmonize the Pakistan Plant Quarantine Rules 2019 with the most recent updates to the ISPMs to reduce the risk of non-compliance and trade interruptions.

On May 2, 2025, the Federal Government promulgated the National Agri-Trade and Food Safety Ordinance, providing for the establishment of the National Agri-Trade and Food Safety Authority (NAFSA). The ordinance aims to merge the Animal Quarantine Department and the Department of Plant Protection (DPP) into a single autonomous authority with an expanded mandate encompassing food safety compliance, enhanced operational efficiency, and strengthened national trade facilitation mechanisms. The Authority is empowered for unrestricted utilization of budgetary resources to ensure the modernization of operational offices, establishment and up-gradation of laboratories, and capacity building of technical personnel**.**

Challenges, Achievements, and Future Outlook

Recent Achievements and Digital Transformation

The DPP has made significant strides in modernizing its operations:

- **Digitalization:** The successful integration with the Pakistan Single Window (PSW) represents a major leap, shifting from manual, paper-based permits to an electronic system that provides a single interface for traders and cuts down clearance time.
- **Enhanced Pest Surveillance:** Improved use of GIS and satellite imagery, particularly in collaboration with the FAO, for more accurate and timely surveillance of the Desert Locust.
- **Infrastructural Development:** Establishment of advanced phytosanitary treatment facilities (e.g., Vapour Heat Treatment, Hot Water Treatment, Cold Treatment, Heat Treatment and Irradiation facilities) that meet the strict quarantine requirements of high-value markets.

Challenges in Phytosanitary Security

The DPP faces several ongoing challenges:

a) **Climate Change and Invasive Species:** Global warming and extreme weather events contribute to the unpredictable movement and rapid multiplication of trans-boundary pests like the Desert Locust, placing immense strain on control resources.

b) **Funding and Resource Constraints:** The DPP often struggles with limited budget allocations for high-tech equipment (e.g., molecular diagnostics), highly specialized training, and maintaining its aging fleet of aerial control aircraft.

c) **Illicit Trade and Smuggling:** Porous borders and informal trade routes pose a constant challenge to plant quarantine, potentially bypassing designated points of entry and introducing pests outside of regulatory oversight.

d) **Pesticide Residue Concerns:** Ensuring that exports meet Maximum Residue Limit (MRL) standards in destination markets requires enhanced capacity for monitoring, testing, and regulatory enforcement across the supply chain.

Policy Recommendations and Constraints

Constraints

List different types of barriers including scientific, technical, and regulatory which are hurdles in the full implementation of biosecurity measures in the country.

Scientific and Technical Barriers:

1. **Lack of Advanced Diagnostics:** There is a crucial absence of sophisticated, rapid diagnostic capabilities, particularly molecular testing at entry points, slowing down quarantine decisions.
2. **Specialist Shortage:** A persistent shortage of highly specialized phytosanitary experts skilled in molecular biology and quantitative Import Risk Analysis (IRA) remains a scientific bottleneck.
3. **Fragmented Data:** The absence of a unified, real-time national pest database hinders centralized risk assessment and rapid, coordinated response efforts.
4. **Scaling Limitation:** The lack of institutional facilities and funding required to scale up proven strategies, such as the maintenance and distribution of biological control agents used in IPM.

Regulatory and Legal Hurdles

1. **Outdated Legislation:** Reliance on the Plant Quarantine Act, 1976, which lacks the scope and penalties necessary to deter modern, high-volume biosecurity threats.
2. **Regulatory Tension:** A constant tension exists between the need for stringent quarantine rigor and policy directives aimed at ensuring the "ease of doing business", which can inadvertently compromise technical standards and enforcement capability.
3. **Fragmented Authority:** The legal framework for cross-sectoral threats (e.g., zoonoses, plant, and animal health) is fragmented, complicating unified responses to large-scale, compound biological disasters.

Institutional and Financial Limitations

1. **Inadequate Investment:** Biosecurity investment is often reactive and insufficient to modernize outdated infrastructure, severely limiting the sector’s resilience.
2. **Weak Coordination:** Inconsistent funding and weak coordination mechanisms between the federal NPPO (DPP) and provincial executing agencies delay responses during widespread outbreaks.

Policy Recommendations to Tighten Plant Quarantine Operations

New, integrated reporting systems which account for efforts that should provide better opportunities for analysis of interception data in future.

Policy should mandate the development and implementation of integrated reporting systems across all points of entry (ports, airports, land borders). These systems must capture not only successful interceptions but also the *effort* expended—volume checked, risk-categorization, staff hours, and clearance times. Effort-based metrics provide better opportunities for analysis of interception data, thereby informing evidence-based risk pathway assessments and optimizing resource allocation for future biosecurity strategies.

Improvements in pre-importation prevention measures.

Policy must prioritize strengthening Import Risk Analysis (IRA) capabilities. This involves a shift from reactive commodity-specific checks toward comprehensive pathway analyses that incorporate real-time data on climatic trends and international pest status reports. For high-risk commodities originating from high-risk countries, the introduction of mandatory pre-shipment inspections (PSI) should be strongly considered to prevent potential introductions at source.

To keep the data of new crop diseases and insects which established over the past years. To keep the data of effects/losses due to new pests and diseases on the agroecosystem of the country for the future better biosecurity.

To elevate biosecurity funding, policy must institutionalize the mandatory collection and centralized archiving of quantitative data. This includes systematically recording data detailing new crop diseases and insects established over the past years and developing mandatory protocols to rigorously quantify the economic effects and yield losses resulting from these new pests and diseases on the agroecosystem. Without standardized, reliable economic loss data, biosecurity measures will perpetually struggle to secure sufficient funding against competing priorities.

To monitor the effects of new pests/diseases/weeds, on monoculture/or diverse ecosystem in the future for the better agriculture biosecurity management.

Dedicated research funding should be allocated to generating an evidence base that monitors the impact of new pests, diseases, or weeds with a focus on their differential effects on monoculture versus diverse ecosystems. The findings must be integrated into policy that encourages resilient, diversified farming practices, aligning national strategy with the demonstrated success of ecological management models like IPM.

Policy recommendations to tighten the plants quarantine.

1. **Enact the National Biosecurity Act:** Legislate a comprehensive Act to replace the PQA 1976 and consolidate fragmented laws, raising the legal status of enforcement.

2. **Mandatory Advanced Diagnostics:** Introduce a policy mandating the phased implementation of rapid molecular diagnostics at all major quarantine outposts to reduce clearance times and enhance detection fidelity.

3. **Targeted IRA based on Climate:** Policy should formalize the integration of long-term climatic and geospatial data into the Import Risk Analysis process to proactively identify and manage high-risk pathways amplified by global weather changes.

Way Forward

The strategic direction for Pakistan's agricultural biosecurity must be rooted in legal modernization, scientific investment, and institutional integration to effectively counter escalating transboundary and climate-induced threats.

Strategic Roadmap for Enhanced Biosecurity (2025-2035)

1. **Legal Modernization (Phase I: 2025-2030):** To draft and enact a comprehensive National Biosecurity Act. This step is fundamental to supersede fragmented legislation, consolidate enforcement authority, and strategically position biosecurity as a national security and economic priority.
2. **Investment in Diagnostics (Phase II: 2027-2032):** To secure targeted, substantial funding, potentially through SIFC or international partners, to establish regional Centers of Excellence in Molecular Diagnostics (CEMDs). These centers will be tasked with expanding rapid molecular testing capabilities, assuring proficiency testing, and serving as central hubs for real-time outbreak reporting.
3. **Extension Network Integration (Phase III: Ongoing):** To formalize, fund, and train provincial extension networks to assume responsibility for post-border surveillance and the rapid, nationwide deployment of scientifically proven biocontrol and IPM technologies, ensuring capacity is institutionalized at the farm level.

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Agricultural Biosecurity and Plant Quarantine in Sri Lanka

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Introduction

Sri Lanka's agriculture sector has historically played a central role in national development, shaping cultural identity, economic stability, and rural livelihoods. With over 30 percent of the workforce directly dependent on agriculture, the sector remains vital for food security and income generation (Department of Census and Statistics, 2023). The country's unique geography characterized by coastal plains, central highlands, and distinct agro-ecological zones supports diverse crop production systems including rice, vegetables, fruits, spices, and plantation crops such as tea, coconut, and rubber. However, with increasing globalization, Sri Lanka's agricultural systems have become deeply interconnected with international supply chains, resulting in heightened biosecurity risks as plant materials, food products, and contaminated cargo may carry exotic pests and pathogens (FAO, 2021).

Biosecurity, as defined by the Food and Agriculture Organization, encompasses the strategic and integrated approach to analyzing and managing risks associated with food safety, animal and plant health, and environmental risks (FAO, 2020). For island nations such as Sri Lanka, strong biosecurity systems are essential for preventing the introduction and establishment of harmful organisms. While the country's geographic isolation offers natural protection, the increasing movement of goods and passengers creates new pathways for pest entry. The 2019 outbreak of Fall Armyworm *Spodoptera frugiperda* exemplifies the vulnerability of Sri Lanka's agricultural sector to global pest invasions, highlighting the need for sustained investment in plant quarantine and surveillance systems (IPPC, 2022).

Biosecurity Challenges and Impacts

Sri Lanka faces an array of biosecurity challenges driven by invasive alien species, transboundary pests, climate variability, and gaps in enforcement capacity. Invasive alien species (IAS) such as *Parthenium hysterophorus*, *Eichhornia crassipes* (water hyacinth), and the *Achatina fulica* (Giant African Snail) have established in multiple agro-ecological regions and continue to spread despite management interventions. These species affect human health, reduce crop productivity, obstruct irrigation waterways, and create long-term ecological imbalance (Wijesundara et al., 2018).

Exotic pests and diseases represent another major challenge. The introduction of Papaya Mealybug *Paracoccus marginatus* in 2008 resulted in extensive crop losses, prompting emergency biological control programs. The Banana Bunchy Top Virus, first detected in the 1980s, continues to reduce banana yields and farmer incomes. More recently, the Fall Armyworm invasion of 2019 devastated maize production across 15 districts, forcing the government to implement nationwide surveillance and containment operations (FAO, 2019).

Biosecurity challenges also have significant economic implications. Fruit fly species such as Bactrocera dorsalis and Bactrocera zonata remain major constraints to the export of mangoes and other fruit crops, resulting in consignment rejections and loss of trade opportunities. Countries such as India, Pakistan, and the United Arab Emirates enforce strict phytosanitary standards, making compliance essential for market access (APPPC, 2022).

Institutional and Legislative Framework:

Sri Lanka's biosecurity governance is grounded in a complex institutional network led by the Department of Agriculture (DOA), with the National Plant Quarantine Service (NPQS) serving as the central authority responsible for regulating plant imports, exports, inspections, and phytosanitary certification. The evolution of the country's plant protection legislation reflects over a century of institutional development aimed at mitigating the risk of exotic pest introductions.

The earliest formal regulation the Plant Protection Ordinance of 1924 was enacted during the colonial era in response to growing concerns about pest movement through maritime trade. This ordinance was later updated in 1956 as agricultural systems expanded. Recognizing the need for a more modern and internationally aligned framework, Sri Lanka enacted the Plant Protection Act No. 35 of 1999. This Act remains the country's principal legislative instrument for biosecurity enforcement, granting NPQS the authority to issue import permits, conduct Pest Risk Analysis (PRA), undertake border inspections, enforce quarantine treatments, and destroy or re-export non-compliant consignments (NPQS, 2023).

Sri Lanka is also a signatory to the International Plant Protection Convention (IPPC), obligating the country to adopt International Standards for Phytosanitary Measures (ISPMs) in managing pest risks and maintaining transparent phytosanitary systems. NPQS collaborates closely with a range of national entities including Sri Lanka Customs, the Sri Lanka Ports Authority, the Civil Aviation Authority, and the Forest Department. Interagency coordination has improved considerably through joint training programs, integrated inspection systems, and digital sharing of cargo data. However, institutional overlaps, limited staffing, and inconsistent enforcement at provincial levels present ongoing challenges to effective biosecurity governance.

National Biosecurity Measures and Programs

Sri Lanka employs a multilayered biosecurity framework built upon four strategic pillars: prevention, early detection, rapid response, and recovery. Prevention remains the most cost-effective and critical measure, focusing on minimizing the entry pathways of quarantine pests. The Pest Risk Analysis (PRA) process plays a central role in evaluating risks associated with import commodities, pathways, and countries of origin. Based on PRA outcomes, NPQS issues import permits with specific phytosanitary conditions such as mandatory treatments, country freedom declarations, or post-entry quarantine requirements.

Early detection mechanisms include routine surveillance using pheromone traps, visual inspections, molecular diagnostics, and GIS-linked monitoring tools. National surveillance programs for fruit flies (*Bactrocera* spp.), Khapra beetle (*Trogoderma granarium*), and viral pathogens provide critical data to support risk-based decision-making. NPQS laboratories conduct ELISA, PCR, and morphological tests on intercepted samples.

Rapid response systems are activated when invasive pests are detected. These responses often involve containment, delimitation surveys, destruction of infested material, enforcement of quarantine zones, and integrated pest management (IPM). The 2019 Fall Armyworm outbreak triggered national-level emergency response and coordination between DOA, universities, and FAO. Post-entry quarantine (PEQ) programs provide additional layers of security for imported planting materials, ensuring pests with latent life stages are detected before distribution.

Border and Post-Border Surveillance:

Sri Lanka’s border surveillance system is concentrated at major points of entry including Bandaranaike International Airport, Mattala Rajapaksa International Airport, and the Colombo and Jaffna seaports and etc. NPQS officers conduct inspections of baggage, cargo containers, courier parcels, and mail. High-risk consignments particularly grain, seeds, fruits, and wooden packaging are subject to detailed examination and laboratory testing. Post-border surveillance extends monitoring beyond ports into agricultural regions, nurseries, greenhouses, and commercial farms. Surveillance teams conduct systematic sampling to detect latent infections. Nursery certification programs ensure plant propagation material remains free from pests such as viruses, nematodes, and bacterial pathogens.

Table 1. Summary of Biosecurity Agencies and Functions

Agency	Primary Biosecurity Role
National Plant Quarantine Service (NPQS)	Import/export inspections, PRA, phytosanitary certification
Plant Quarantine stations and units	Monitoring high-risk cargo and passengers
Department of Agriculture Research Institutes	Diagnostics, pest research, and IPM development

Research, Technology and Innovation

Research, technology, and innovation serve as the backbone of Sri Lanka's agricultural biosecurity advancement. Over the past two decades, Sri Lanka has steadily expanded its diagnostic, surveillance, and research capacities through institutional investments, international collaboration, and technological adoption.

Molecular diagnostics represent one of the most transformative developments in plant biosecurity. Techniques such as Polymerase Chain Reaction (PCR), quantitative PCR, and DNA barcoding have significantly enhanced the precision and speed of pest detection. Before the widespread use of PCR-based testing, the identification of viral or bacterial pathogens relied heavily on symptom expression, which often led to delays or misdiagnoses. Today, laboratories at the National Plant Quarantine Service (NPQS), the Plant Protection Research Unit of the Department of Agriculture, and several universities routinely use molecular tools to diagnose viral, fungal, and insect pests (Fernando & Perera, 2023).

Digital transformation has also accelerated biosecurity efficiency. The Plant Quarantine Import Management System (PQIMS) enables real-time digital processing of import permits, risk assessments, and inspection records which will start it operation in near future. Likewise, Sri Lanka's integration into the IPPC e-Phyto system has modernized phytosanitary certification, reducing documentation errors, enhancing traceability, and increasing international compliance (IPPC, 2022). These digital platforms reduce administrative bottlenecks and support evidence-based management.

Technological innovations in remote sensing and GIS have further strengthened surveillance efforts. Spatial mapping of fruit fly hotspots, detection of invasive weeds through satellite imagery, and climate-based pest forecasting models are increasingly being used to predict pest outbreaks (Jayasinghe et al., 2024). Additionally, research into biological control agents including parasitoids for mealybugs and entomopathogenic fungi for soil pests offers sustainable alternatives to chemical pesticides.

Future Strategies for Strengthening Biosecurity

Future strategies for Sri Lanka's agricultural biosecurity must address both existing vulnerabilities and emerging global risks. A comprehensive, forward-looking approach is essential to protect national food security, maintain export competitiveness, and safeguard biodiversity.

A top priority is strengthening diagnostic laboratories. Upgrading NPQS and DOA facilities to ISO/IEC 17025 accreditation standards would enhance international credibility, improve testing reliability, and support export certification. Investment in next-generation sequencing technologies could also enable rapid detection of novel or unknown pathogens.

Sri Lanka must also focus on expanding surveillance networks. Integrating AI-supported trap monitoring systems, remote sensors, and climate-based predictive models can significantly improve early warning capabilities. Countries such as Australia and New Zealand have already adopted automated pest surveillance systems, demonstrating the feasibility and impact of these approaches.

Policy reform is another critical area. Establishing a National Biosecurity Authority could centralize responsibilities currently spread across multiple agencies, improving coordination and decision-making during emergencies. Additionally, strengthening legislation governing online plant sales, postal imports, and cross-border e-commerce is essential, as these pathways increasingly contribute to pest movement.

Finally, regional collaboration through SAARC, APPPC, and FAO should be expanded. Shared pest alerts, joint surveillance programs, and harmonized phytosanitary standards can help South Asian nations respond quickly to transboundary pest threats. As pest pressures intensify globally due to climate change, such collaboration becomes indispensable.

Constraints and Way Forward

Despite notable improvements, Sri Lanka's biosecurity system continues to face significant constraints. Chronic underfunding remains a major challenge, limiting laboratory upgrades, staffing expansion, and procurement of modern diagnostic tools. Many key facilities still rely on outdated equipment, affecting testing efficiency and response time. Human resource limitations further weaken operational capacity. NPQS and DOA require more trained entomologists, molecular biologists, quarantine inspectors, and data analysts. Without sufficient staff, surveillance coverage remains inadequate, especially in remote or high-risk areas.

In addition, low stakeholder awareness contributes to unintentional pest movement. Farmers, traders, and travelers often lack knowledge about the risks associated with transporting plant materials. Public education campaigns, school-level awareness programs, and targeted training for traders could significantly improve compliance.

To move forward, Sri Lanka must increase national investment in biosecurity, strengthen inter-agency coordination through a unified authority, and adopt advanced surveillance and diagnostic technologies. Enhancing regional partnerships and creating a national emergency response framework will further build resilience against future incursions.

Conclusion

Sri Lanka's agricultural biosecurity and plant quarantine system has evolved significantly over the past several decades. Comprehensive legislation, expanded surveillance networks, and increased international collaboration have strengthened the country's capacity to prevent and manage pest incursions. However, rapidly evolving global trade dynamics, climate change, and rising pest pressures demand continued innovation, investment, and policy development. A resilient biosecurity system requires science-driven decision-making, modern diagnostic facilities, advanced technologies, and strong regional cooperation. By prioritizing long-term institutional strengthening, Sri Lanka can safeguard its agricultural sector, protect its biodiversity, and ensure food and economic security for generations to come.

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Chapter 3

Plant Biosecurity in South Asia - Status and Challenges

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Introduction

Introduction of useful planting material from other countries has played a significant role in diversifying agriculture and boosting the production. However, introduction of seed and other planting material from other countries poses the risk of inadvertent introduction of transboundary exotic pests as evident from several examples of pest epidemics. Biosecurity is a strategic and integrated approach that encompasses a policy and regulatory framework to analyse and manage risks associated with food safety, plant and animal health and the environment. It covers the introduction of plant and animal pests and diseases, and zoonosis; the introduction and management of invasive alien species and genotypes; and the introduction and release of genetically modified organisms (GMOs) and their products (http://www.fao.org).

The South Asia region comprises Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. Agriculture forms the backbone of the rural livelihoods and national economy in most of the South Asia countries. The major crops of the region such as rice, wheat, maize, coconut, banana, papaya, sugarcane, rubber and others are attacked by a number of destructive pests threatening local or regional food security. The global threat to plant biosecurity in the present day is further aggravated with over one billion international travelers world-wide per year moving through airports and 18 million containers making over 200 million trips through sea-ports as part of the trade across the world every year (Sharma and Wightman 2015).

The present article deals with status of plant biosecurity in South Asia, the role of National and International organizations in dealing with such pests and the challenges encountered in ensuring plant biosecurity in the wake of emerging pests. The plant quarantine assumes special importance in safe trade and exchange of plant genetic resources (PGR). Plant quarantine is all activities designed to prevent the introduction or spread of quarantine pests or to ensure their official control. *The present-day definition of a pest is any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products* thus including all pathogens, insects, mites and even weeds.

A quarantine pest is, the pest of potential economic importance to the area endangered, either not yet present there, or present but not widely distributed, and being officially controlled (ISPM_05_2023_En_Glossary_PostCPM-17_2023-07-12_Fixed.pdf (ippc.int). In this article, pest include fungi, bacteria, viruses, viroids, phytoplasma, nematodes, insect pests, mites and weeds as per the International Standards for Phytosanitary Measures of International Plant Protection Convention.

The historical Irish famine of 1845, caused by late blight of potato (*Phytophthora infestans*) introduced from Central America; powdery mildew (*Uncinula nacator*), root eating aphid (*Phylloxera vitifolia*) and downy mildew (*Plasmopara viticola*) of grapes into France in quick succession in mid-19th Century from America; coffee rust into Sri Lanka in 1875 and its subsequent introduction into India in 1876 are prominent examples that clearly demonstrate that introduction and establishment of quarantine pests into new areas can severely damage the crop production and economy of a region/country (Khetarpal *et al.,* 2006). Like-wise, in India also, a number of exotic pests got introduced along with imported planting material causing serious crop losses from time to time. These introductions highlighted the fact that increased international travel and trade had exposed the country to the danger of infiltration of exotic pests harmful to our agriculture.

Emerging Pests in South Asia

Emerging pests mean diseases or insect pests that are newly discovered, have increased in occurrence or have spread to new locations. It may be noted that a pest can be emerging in a new locations or country for the first time but might have caused outbreaks in other regions. Similarly, a pest can always continue to be emerging in many locations or countries but may not assume severe proportion to cause an outbreak.

Hispine beetle (*Brontispalongissima*) that has spread fast with outbreaks in South East Asia poses a significant risk of spread as emerging pest in countries such as India, Sri Lanka and Bangladesh (Rethinam and Singh 2007; Takano et al., 2012). Coconut mite (*Aceria guerreronis)* has potential to spread to other coconut countries in South Asia (CABI, 2016; Vincenzo, 2016). Cassava mealybug (*Phenacoccus manihoti*) which has decreased cassava production in West Java to 30-40%, now poses acute risk to cassava production in the southern end of Karnataka in India (Parsa et al., 2012). Papaya mealybug (*Paracoccus marginatus*) which is native to Central America, was reported in 2002 in the Pacific Islands and in 2008 in India, and Sri Lanka posing greatest threat to rest of South Asia countries (Meyerdirk et al., 2004; Muniappan et al., 2008, 2011; CABI, 2016). Wheat blast (*Magnaporthe oryzae) that is reported in Bangladesh from wheat imports from Brazil is the most recent episode of biosecurity threat to India and the Indian sub-continent (Saharan et al., 2016;* Callaway, 2016;

Malaker *et al*., 2016). Tomato leaf miner (*Tuta absoluta*) damage on tomato was first noticed in Pune and Bangalore during 2014 in India and within a span of two years the pest spread to nearly 1.5 million hectares in other states. It has shown potential to damage fruits to the extent of 100% (ICAR, 2014). Tropical race 4 of Panama wilt of banana (*Fusarium oxysporum* f. sp. *cubense*) has now spread to many banana growing countries (Buddenhagen 2009; Ploetz 2015; Ordonez et al., 2016). The Western flower thrips (*Frankliniell aoccidentalis*) emerging in Indonesia and India is responsible to transmit as many as five species of tospoviruses of which *Tomato spotted wilt virus* alone is known to cause loss above US $1billion (Tyagi and Kumar, 2015).

The banana bunchy top virus (BBTV) affecting banana worldwide and causing a loss up to 100% was first recognized in Fiji (1889) and from there it was introduced to Sri Lanka, and later spread to southern India and Bangladesh. BBTV is reported in Pakistan, where the virus has almost destroyed the country's banana industry (Jones, 1994). San Jose scale (*Quadraspidiotus perniciosus*) is indigenous to Eastern Asia and from there has spread to many parts of the world. Most of the countries like Afghanistan, India (widespread), Nepal and Pakistan have the pest present thereby destroying the orchards of many fruit crops (EPPO 2014). Potato cyst nematode (*Globodera rostochiensis*) has traversed from Andes Mountains in South America to South Asia through Europe with infected potato tubers. In India, it is confined to states of Tamil Nadu, Himachal Pradesh, J & K and Uttarakhand. Up to 80% of the crop can be lost when nematode populations are high. Coffee berry borer is one of the economically most important pests of coffee (Vega, 2008) causing an estimated loss of $500 million worldwide. First found in Uganda in 1908, it was reported in Asia during 1990 from a coffee growing region in South India and has gradually spread to almost all the coffee growing areas affecting yield and quality of coffee, and reducing the income of coffee growers (Jaramillo et al., 2006).

The emerging pests are in fact the alarm bells for the region necessitating possible phytosanitary measures to contain their spread and to minimize the potential losses caused by them (Khetarpal et al., 2024).

Status of Plant Biosecurity in South Asia

Country	Legislation	Regulated Pest List
Afghanistan	Plant Protection and Quarantine Law	Not available
Bangladesh	Plant Quarantine Act 2011	Available for rice and *Citrus medica* *Latest Publications - International Plant Protection Convention* *Latest Publications - International Plant Protection Convention*
Bhutan	The Plant Quarantine Act of Bhutan 1993	Available Plant-Quarantine-Rules-and-Regulations-of-

Country	Legislation	Regulated Pest List
	Plant Quarantine Rules and Regulations of Bhutan 2018	Bhutan-2018.pdf
India	Plant Quarantine (Regulation of Import into India) Order 2003 and its 146 amendments as on 18.1.2026	Available >1200 pests (country-wise, crop-wise for 725 crop species) https://pqms.cgg.gov.in/pqms-angular/homeGuidelines/Import
Maldives	Plant Protection Act 2011	Not available
Nepal	Plant Protection Act 2007	Available Reporting Obligations: Nepal - International Plant Protection Convention
Pakistan	Pakistan Plant Quarantine Rules 2019	Available PQ-Rules-2019_3_2.pdf
Sri Lanka	Plant Protection Act 1999	Available Reporting Obligations: Sri Lanka - International Plant Protection Convention

Status of Plant Biosecurity in India

The quarantine law was enacted for the first time in India in 1914 as Destructive Insects and Pests (DIP) Act. A gazette notification entitled Rules for Regulating the Import of Plants etc. into India was published in 1936 to enforce the plant quarantine regulations. Over the years, the DIP Act was revised and amended several times, more so recently, to meet the emerging scenario of liberalized trade under the world trade organization (WTO).

In 1984, a notification was issued under DIP Act namely Plants, Fruits and Seeds (Regulation of Import into India) Order then popularly known as the PFS Order which was revised in 1989 after the announcement of the New Policy on Seed Development by the Government of India in 1988, proposing major modifications for smooth quarantine functioning. The new policy covered the import of seeds/planting materials of wheat, paddy, coarse cereals, oil seeds, pulses, vegetables, flowers, ornamentals and fruit crops. Therefore, under the revised PFS Order, 1989, care was being taken that there was absolutely no compromise on plant quarantine requirements while liberalizing import.

The establishment of WTO Agreements in 1995 although offering greater economic opportunities, has resulted in fresh challenges of increased pest risk due to liberalized international trade in agricultural commodities. With varied agricultural produce and surplus food production, India is now in a position to expand its agricultural trade, but requires National Standards to be developed for all critical phytosanitary activities. There has been a pressing need for compliance with international phytosanitary regulations. Hence, to fill-up the gaps in existing PFS Order viz., regulating import of germplasm/Genetically modified organisms (GMOs)/ transgenic plant material; live insects/ fungi including bio-control agents etc. and to fulfil India's legal obligations under the international Agreement, the Plant Quarantine (Regulation of Import into India) Order 2003 (https://pqms.cgg.gov.in/pqms-angular/homeGuidelines/Import) came into force from January 1, 2004, henceforth referred to as PQ Order 2003. Under this Order the need for incorporation of Additional/Special declarations for freedom of import commodities from quarantine and alien pests, on the basis of standardized PRA, particularly for seed/ planting materials is also taken care of. Under the PQ Order, apart from PRA being a precondition for all imports, the scope of plant quarantine activities has been widened to incorporate additional definitions. The other salient features of the Order are:

- Prohibition on import of commodities with weed/alien species contamination as per Schedule VIII; & restriction on import of packaging material of plant origin unless treated.
- Provisions included for regulating the import of soil, peat & sphagnum moss; germplasm/ GMOs/transgenic material for research; live insects/ microbial cultures & biocontrol agents and import of timber and wooden logs.
- Agricultural imports have been classified as (a) prohibited plant species (Schedule IV); (b) restricted species where import permitted only by authorized institutions (Schedule V); (c) restricted species permitted only with additional declarations of freedoms from quarantine/ regulated pests and subject to specified treatment certifications (Schedule VI) and; (d) plant material imported for consumption/industrial processing permitted with normal Phytosanitary Certificate (Schedule VII).
- Additional declarations being specified in the Order for import of 725 agricultural commodities with specific lists of more than > 1200 quarantine pests and 57 weed species.
- Notified points of entry increased to 212.
- Certification fee and inspection charges have been rationalized.

A total of 146 amendments of the Plant Quarantine (PQ) Order 2003 has been notified as on 3.3.2026 to the WTO revising definitions, clarifications regarding specific queries raised by quarantine authorities of various countries, with revised lists of crops under the Schedules IV, V VI and VII. The list under Schedule IV, V, VI and VII now include 15, 17, 708 and 519 crops/commodities, respectively.

The Directorate of Plant Protection, Quarantine and Storage (DPPQS) under the Ministry of Agriculture and Farmers Welfare is responsible for enforcing quarantine regulations and for quarantine inspection and disinfestation of agricultural commodities. The quarantine processing of bulk consignments of grain/pulses etc. for consumption and seed/ planting material for sowing are undertaken by the 73 Plant Quarantine Stations including 7 Regional Plant

Quarantine Stations located in different parts of the country and many pests were intercepted in imported consignments (https://pqms.cgg.gov.in/).

Import of bulk material for sowing/planting purposes are authorized only through six Plant Quarantine Stations located at New Delhi, Amritsar, Bengaluru, Chennai, Kolkata and Mumbai. There are 48 Inspection Authorities (IAs) including 43 IAs for certification of Post-entry Quarantine Facilities and inspection of growing plants in different parts of the country for commercial material, three IAs for inspection of tissue culture raised plants and 2 IAs for germplasm. Besides, DPPQS has developed 24 standards on various phytosanitary issues such as on PRA, pest-free areas for fruit flies and stone weevils, certification of facilities for treatment of wood packaging material, methyl bromide fumigation etc. Also, two Standard Operating Procedures have been notified on Export inspection & phytosanitary certification of plants/plant products and other regulated articles and *post-entry quarantine inspection* (https://pqms.cgg.gov.in/).

ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR) undertakes the quarantine processing of all plant germplasm including transgenics under exchange for which it has well-equipped laboratories, post-entry quarantine green house complex and a containment facility for processing transgenics (Bhalla et al., 2018; Chalam et al., 2018, Chalam et al., 2022; Chalam and Maurya, 2018). ICAR-NBPGR also has a well-equipped quarantine station at Hyderabad, which mainly deals with the export samples of International Crop Research Institute for Semi-arid Tropics (Khetarpal et al., 2006; Bhalla et al., 2018).

Of the material being imported, bulk imports for sowing/planting carry maximum risk as thorough examination and treatment becomes difficult and planting area required is also too large. Quarantine processing is often restricted to smaller samples derived from them and based on results of these samples the whole consignment is rejected/detained or released after giving appropriate treatment. The bulk consignments meant for consumption pose lesser hazards. However, certain small samples meant for research purposes especially germplasm or wild relatives or landraces of a crop are more likely to carry diverse biotypes/ races/strains of the pest and are of immense quarantine importance. These samples usually comprise of. Besides, in case of true seed, generally, risks are more due to deep-seated infections than with surface-borne contamination. However, import of vegetative propagules present a much higher order of risk than true seeds.

Over the years, during quarantine processing, a large number of pests have been intercepted in imported bulk consignments (https://pqms.cgg.gov.in/) and in germplasm and other research material (Khetarpal et al., 2006; Bhalla et al., 2018; Chalam et al., 2022; Chalam et al., 2023). These pests intercepted include many that are not known to occur in India, have different races/biotypes/strains not known to occur in India; present in India but not on the host on which a pest was intercepted and are reported to be present widely in India causing economically important crop yield losses. Details of methods used for detection and interception of pests and salvaging methods used for disinfestation/disinfection of imported germplasm are given below:

Methods for Detection and Interception of Pests in Quarantine

All imported samples including germplasm accessions, trial/ nurseries breeding material of various crops comprising both true seeds and vegetative propagules were examined for the diagnostics of accompanying exotic pests by using various techniques (Chalam et al., 2022). The Division of Plant Quarantine at ICAR-NBPGR has developed procedures for stepwise and systematic processing for detection and interception of various kinds of pests (Fig. 1).

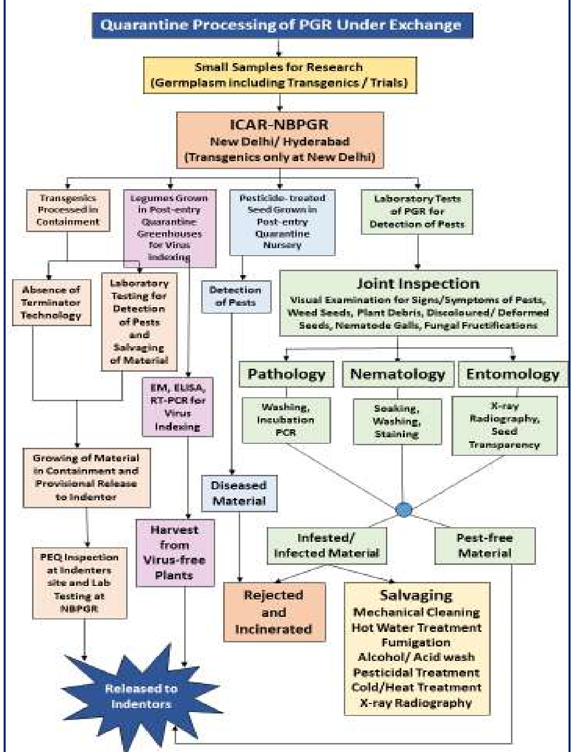

Fig. 1 Schematic presentation of Quarantine Processing

During quarantine processing, imported material is also examined for the presence of weed seeds, soil, plant debris, insect life stages, nematodes and pathogens (fungi, bacteria, viruses, viroids, phytoplasma etc.).

Visual Inspection: All seeds, *in vitro* cultures, vegetative propagative materials etc. were examined visually and through stereo-binoculars to detect the presence of bunt and smut balls, seed galls, ergot sclerotia, spores, rust pustules, on the seed. In case of seeds, shrielled, small sized and seeds showing mottling, necrosis, split seed coat symptoms and other discoloration are indicative of viral infections and were discarded and incinerated. The external feeders and secondary insect pests, infesting the seeds, can be detected visually easily either by unaided eye or using magnifying glass or stereoscopic binoculars. Infection due to fungi is shown through malformed seeds and fructifications of fungi along with the seed/on the seed surface. Bacterial infection is suspected in seed showing yellow discolouration around the hilum.

Infected materials are either incinerated or salvaged using various salvaging techniques depending on the category of pest(s) intercepted prior to release. As a result of quarantine processing, it has been observed that seed-borne pests may cause losses in quality and germination of seed, distribution of new strains or physiological races of pest(s) along with the seeds and planting material to new geographical areas and development of epiphytotics. Therefore, critical quarantine examinations with specialized tests are conducted to ensure the interception and identification of fungal, bacterial, viral pathogens, insects and mites, nematodes and weeds of quarantine importance associated with seeds and other planting materials. The specialized/advanced examinations used for revealing diverse groups of pests are described below.

Detection of insects and mites

- **X-ray radiography** is a non-destructive method used to detect bruchids/ phytophagous chalcidoids other insect groups in seeds that do not elicit any exterior symptoms on the surface of the seed. Crops like pulses, oilseeds, tree species and some grasses are compulsorily subjected to X-ray radiography as far as germplasm import is concerned (Bhalla et al., 2018). On viewing the X ray on the screen with real-time X ray system (Kubtek Xpert 80 X ray system), seeds showing insects are selectively picked and healthy seeds are handed over to the indentor.
- **Transparency method** is done for detecting insect infestation in very small seeds like sesame. The seeds are boiled in lactophenol solution (lactic acid, phenol, distilled water and glycerin in 2:2:2:1 ratio, respectively) for 1-2 hours depending on the toughness of seeds. This rendered them transparent to expose insect inside.

Detection of Fungi and Bacteria

- **Blotter test:** The seeds suspected to be infected with pathogens are placed on three layers of damp filter paper in Petri plates (110 mm) and incubated at 22 ± 1^{0}C in alternate cycles of 12 h fluorescent light and darkness for seven days and then examined under higher magnification.
- **NaOH seed soaking test:** Rice seeds are soaked overnight in 0.2 per cent NaOH showed shiny black discoloration in seeds infected with kernel smut (*Tilletia barclayana*). Upon breaking infected seed in water on a glass slide, a stream of teliospores is released which were observed under compound microscope.
- **Washing test**: Seeds suspected to be contaminated with surface-borne rusts spores are shaken in water with a pinch of sand on a mechanical stirrer for 30 seconds and resultant suspension are examined with the compound microscope for uredo and teloi spores of rust pathogen.

- **Molecular based detection of seed-borne pathogens:** The ITS based detection is used routinely in seed-borne fungal pathogens and 16Sr RNA based detection in bacterial pathogens. Also, PCR-based and LAMP-based protocols have also developed for specific detection of various fungi and bacteria (Kumar *et al*., 2017; Kumar et al., 2023; Tripathi et al., 2023).

Detection of Viruses

- **Post-entry quarantine growing:** Apparently healthy-looking seeds of legume germplasm of different crops are grown during respective *Kharif* and *Rabi* seasons in insect-proof PEQ greenhouses at ICAR-NBPGR, New Delhi. Seedlings are observed regularly after emergence till flowering. The accessions showing virus-like symptoms are further subjected to Electron microscopy (EM), Enzyme-linked immunosorbent assay (ELISA) and Reverse-transcription Polymerase chain reaction (RT-PCR), if required (Chalam, *et al*., 2017). All plant residues and plant samples used for testing are incinerated as per quarantine procedure. Only harvested seed from healthy plants is released to the indenters.
- **Post-entry quarantine inspection (PEQ) at indenter's site:** The germplasm other than legumes are released on an undertaking by the indenter that material is grown in isolation under the observation of a plant pathologist. The accessions showing virus-like symptoms are collected during PEQ inspection further subjected to EM, ELISA and RT-PCR, if required (Chalam and Khetarpal, 2008).
- **Electron microscopy (EM):** Two mg tissue from leaf samples showing prominent viral symptoms during growing-on test are taken and processed following the standard protocol. The grids are examined under Transmission Electron Microscope.
- **Enzyme-linked immunosorbent assay (ELISA):** The leaf samples showing virus-like symptoms of different crops, distinctive healthy-looking samples and *in vitro* cultures are tested by adopting the classical ELISA protocol using polyclonal antiserum against 52 viruses. A sample is considered as infected if its optical density (OD) value is more than twice that of negative control (Chalam *et al*., 2017).
- **Reverse-transcription Polymerase Chain Reaction (RT-PCR)**: RNA is taken out from samples using RNeasy ® Plant Mini Kit (Qiagen), as per the protocol provided by the manufacturer. Synthesis of cDNA is performed with Thermo Fischer cDNA Kit. PCR reaction is carried out using different primers and the PCR products are separated by electrophoresis and image is visualized and captured by Gel documentation system. RT-PCR is used wherever the ELISA results is ambiguous/inconclusive (Abhishek *et al*., 2024; Deepika *et al*., 2024; Chalam *et al*., 2017; Kalaiponmani *et al*., 2024).

Detection of Nematodes

- **Nematode extraction from suspected germplasm:** Seeds known or suspected of seed-borne nematodes are drenched in water for 24-48 h to soften the seeds. Hard seeds are cut open / teased/ crushed to enable the nematodes to come out in water. Similarly, plant debris and soil clods are also soaked in water, sieved through nematological sieves of 100, 200, 325 and 400 mesh and nematodes are extracted by modified Baermann's funnel techniques. Vegetative propagules like bulbs, suckers, corms, rhizomes, tubers, rooted cuttings etc. are also observed for detection of nematode. These planting materials are rinsed with clean water, cut into small pieces of 2-3 cm long and incubated for 24 h to allow migratory stages to come into water suspension. Nematodes are recovered, fixed, inspected and identified under a compound microscope. In addition, few roots are stained for detection of sedentary nematodes using acid fuchsin and lactophenol solution.

Detection of Weeds

- **Naked/ aided eye examination**: Samples are inspected for weed seeds by sieving through sieves of different hole sizes. The working sample is spread as a single uniform layer on a clean sheet of paper or in a white tray and observed using illuminated magnifier and the weed seeds are separated. Weed seeds are categorised into different types based on their colour, shape, size, texture and the presence of any appendage. Separated weed seeds are kept in screw cap vials and its details labelled on the vial for future reference. Stereoscopic binoculars are used for observing seeds that are extremely small.

After various tests/ examinations the intercepted pests are identified and 75 pests not yet reported from India were intercepted in germplasm imported from various countries during the last 25 years (Chalam et al., 2023). Although the consignments are accompanied by a Phytosanitary Certificate stating its health status, several pests were intercepted in them, many of which are not yet reported from India.

Several pests of quarantine significance have been intercepted from imported seeds and planting material. The pests intercepted can be categorized as: (i) those which are not known to occur in India; (ii) are known to occur in India but not on the host it was intercepted; (iii) have different races/ biotypes/ strains not known to occur in India; (iv) are reported to be present in India but with a wide host range. Such interceptions signify the success of quarantine, otherwise, these pests would have entered the country and played havoc with the plant biodiversity and agriculture.

Salvaging of Infested/ Infected/ Contaminated Material

The various approaches used for salvaging of germplasm are as below:

- **Mechanical Cleaning:** Cleaning is the important mechanical method used in plant quarantine. A consignment may be contaminated with dust, debris, soil particles, dead insect, egg masses, pupa, adult insect, fungal bodies like ergot, bunt, sclerotia, smut balls and different kinds of weeds. All these contaminants need to be removed from the consignment. Cleaning can be done by hand picking, sieving, gravitational separators etc.
- **Heat treatment:** Hot water treatment is very effective tool to eradicate many plant pathogenic fungi, bacteria, and nematodes in seed material. In principle, the material is pre-soaked and kept in water at definite temperature. The basic principle employed in this approach is that treatment temperature should be high enough to kill the associated pest but not affect the host seed. But, in maximum cases the margin of safety is very narrow, hence, the temperature needs to be very precisely calculated. A total 1,212 paddy samples infected by fungi, bacteria, and nematodes were salvaged by treatment with hot water (52°C for 30 minutes.).
- **Chemical treatments:** Chemicals/pesticides could be applied as spray, dip, dust, or as a slurry. It should be ensured that dose of chemical should be such as to eradicate the pest but not kill the host seed/propagule. Also, the personnel handling the treatment should not get adversely affected by the chemical used. The treatment could be given upon arrival after ascertaining the status of health of the material. The chemical chosen and its dose used should depend upon the pest/pathogen involved. Seed samples infected by various fungi were salvaged by fungicide seed dressing using Carbendazim and Dithane M-45 (1:1).
- **Fumigation** of the seed under atmospheric pressure or lowered pressure is acceptable as a phytosanitary treatment for storage insects. Fumigants like, phosphine, EDCT (ethylene dichloride + carbon tetrachloride mixture) and methyl bromide are commonly used fumigants in India. Methyl bromide has critical use exemption in quarantine and pre-shipment while non-feed stock uses of carbon tetrachloride is restricted. Samples are salvaged using aluminum phosphide (Phosphine at 2 g per cubic metre for 72 hrs)/ EDCT mixture at 320 mg/litre for 48 hrs against seed-borne insects.
- **Alcohol wash:** Alcohol wash is given for eliminating seed-borne spores of several fungi. The contaminated seed are stirred with ethyl alcohol and a dash of river sand on the mechanical stirrer for 30 seconds. Due to abrasive action of the sand, the spores adhering to the seed surface get separated in the alcohol.
- **Acid wash:** Concentrated Sulphuric acid is used as an acid wash for killing spores of sugar beet rust (*Uromyces betae)* sticking to sugar beet seeds. The

seeds were stirred in the acid with a glass rod for one minute and thereafter immediately washed with running tap water till all traces of acid are removed and dried.

- **X-ray radiography:** X-ray radiography technique is used to detect and salvage hidden infestation in the seeds due to seed beetle (bruchids), weevils, seed wasps (chalcidoids) and others insects. Seeds of 340 plant genera known to carry hidden infestation caused by insects are subjected to X-ray radiography. The seeds are spread out in one layer and exposed to X-rays. Upon viewing the X-ray, infested seed can be easily separated from healthy ones manually from the sample (Gupta et al., 2018).

- **Cold treatment:** Low temperature is employed to kill the insects in seed materials. Most of the insect kills between -10 to 15 ^{0}C within hours and this technique is used for disinfestation of seed samples infested with various stages of insects.

- **Formalin root dip treatment:** Several species of plant parasitic nematodes are killed in root zone of various vegetative. Plant propagules samples were salvaged by root dip in formalin at 0.25% for 10 minutes.

- **Healthy harvest through post entry quarantine growing:** Healthy harvest is made from seed samples infected by various viruses and supplied to the indentors.

Prophylactic treatments

Suspected seed samples, are subjected to prophylactic fumigation with aluminium phosphide (Phosphine at 2 g per cubic metre for 72 hrs)/EDCT mixture at 320 mg/litre for 48 hrs against seed borne insects while vegetative propagules samples are given pesticidal dip/spray treatment against insect-pests and pathogens. Additionally, prophylactic treatment with hot water (52°C for 30 minutes.) is given to all samples of paddy against seed borne pathogens. To avert the introduction of new strains of tobamo viruses, all the imported seed samples of chilli and tomato are treated with 10% tri-sodium orthophosphate.

Regional Efforts to Ensure Plant Biosecurity

Regional cooperation and coordination are critical in reducing the outbreaks of pests and their movement in the region. FAO through its Regional Offices undertake plant protection activities related to Integrated Pest Management (IPM), pesticide management etc. and also facilitate the implementation of ISPMs of the International Plant Protection Convention (IPPC) which is an international agreement on plant health with 182 current signatories aims to protect cultivated and wild plants by preventing the introduction and spread of pests (https://www.ippc.int/en/).The IPPC thus has a strong presence in each of the FAO regions, delivering its services through Regional Plant Protection Organizations (RPPOs). Of the nine RPPOs of FAO one is in Asia region viz., Asia-Pacific Plant Protection Commission (APPPC). The APPPC located at the FAO Regional Office Bangkok, was established in 1956 and has 25 countries from Asia and Pacific as members (http://www.fao.org/asiapacific/apppc/en/). The EU-funded FAO program on IPM for cotton in Asia had six member countries of Bangladesh, China, India, Pakistan, the Philippines and Vietnam where cotton is a chief cash crop and also faces huge losses due to many pests including those of transboundary importance.

There is a need to tackle the issue of biosecurity at a regional level with collaboration among countries who shares contiguous boundaries for comprehensive regional biosecurity. The South Asian Association of Regional Cooperation (SAARC) should facilitate collaboration among South Asian Countries (SACs) for creating a bio secure region. The following are areas for regional collaboration and networking for plant biosecurity**:**

Challenges in ensuring plant biosecurity in South Asia

The challenges in managing pest outbreaks and transboundary pests in South Asia arise from the very fact that the member countries fall under different categories of capacity, resources and hence the operational quality in dealing with the problem. India has the best of regulatory provisions, resources, program, institutional infrastructure for plant quarantine facilities to meet the challenges of biosecurity to a great extent. Thus, the compliance to implementation of different international standards as laid down by IPPC are just not at the same level within the region. This poses a huge challenge in harmonizing the quarantine norms to deal with the transboundary movement of pests at regional level.

Ensuring pest-free movement of seed and planting material in South Asia: The international trade in seed and planting material in bulk and exchange of plant genetic resources are known to carry pests to long distances along with their movement (Khetarpal 2004; Chalam et al., 2022; Chalam et al., 2023). The quarantine processing of germplasm material in most of the countries is often not as stringent as commercial material despite the fact that germplasm can be also potential source of spread of quarantine pests into the region. India has intercepted 75 quarantine pests in germplasm imported from various countries across the world (Bhalla et al., 2018; Chalam and Khetarpal 2008; Chalam and Maurya, 2018; Chalam et al., 2008; Chalam et al., 2014; Chalam et al., 2017; Chalam et al., 2022; Chalam et al., 2023; Khetarpal et al., 2001; Khetarpal et al., 2006). If not intercepted many of these quarantine pests would have entered and become the emerging pests.

Ensuring the absence of important pests not yet introduced in South Asia: Mexican cotton boll weevil (*Anthonomus grandis*) is listed as an A1 quarantine pest by EPPO and has high quarantine significance for South Asia. Since it exists in subtropical region, it indicates that the cotton-growing area in the region are at potential risk of invasion and there is a need to be vigilant. On maize which is an important food security crop in the region, ergot disease (which is endemic in central Mexico) caused by *Claviceps gigantea* is yet not reported (https://doi.org/10.1079/cabicompendium.13789).

Preventing Transboundary Movement of important pests among South Asian Countries: There should be efforts to prevent the transboundary movement of pests among South Asian countries (SACs). As per the literature, cowpea mottle virus is present in Pakistan and absent in other SACs. Cocoa necrosis virus is present in Sri Lanka but absent in other SACs. Wheat blast is present in Bangladesh and absent on other SACs. NPPOs of SACs need to update the list of prohibited plant species from a given country based on evolving scenario of emerging pests.

Ensuring concerted efforts towards biosecurity by Regional Organizations: The SAARC and the global and regional donor agencies need to prioritize on plant biosecurity engagements and synergize their action plans for economic, food and environmental security and work closely with FAO, APPPC and NPPOs.

Conclusions and Perspectives

The role and responsibilities of the NPPOs thus become crucial. Attention of all policy makers, quarantine officials and researchers alike is needed to meet the challenges of biosecurity for ensuring food, economic and environmental security in South Asia.

The key issues and strategies proposed are given below:

- By closely monitoring which pests are most frequently reported from which countries, and what commodities tend to be infected/infested, it may be possible to predict high-risk pests, commodities, or regions of origin for South Asia.
- The South Asian Countries (SACs) need to strengthen surveillance programmes and regular survey and surveillance programmes need to be undertaken to get a realistic picture of status of pests in SACs and for authentic mapping of endemic pests present in the SACs and this in turn will help in preparation of A1, A2 pest list for South Asia in line with EU. The SAARC should take initiative to prepare A1, A2 pest list for South Asia.
- The SACs need to prepare/ update crop-wise and country-wise regulated pest list in line with India.
- The SACs need to strengthen early warning/rapid response systems.
- National Referral Laboratories and Accredited Diagnostic Laboratories for diagnostics of different pests in South Asia will strengthen biosecurity systems in the region.

- Implementation of e-Phyto in SACs will facilitate trade in the South Asia and with other countries.
- Third country/Intermediate quarantine labs in South Asia may be identified by the SAARC for pest-free exchange of plant genetic resources among SACs.
- Roster of Experts on Plant Biosecurity/ Quarantine in South Asia and South Asia Regional Expert Group on different Pests will strengthen plant biosecurity in the region.
- Development of National Plant Biosecurity Diagnostic Network in line with Australia and USA in all SACs is need of the hour. The network may include Remote Microscopy system, National reference collections, user-friendly portable devices for on-the-spot identification of pests, rapid, non-invasive detection of characteristic volatiles or electromagnetic radiation from infected plants and ultimately, a national biosecurity chip for diagnosis of all current threats to agriculture.
- Development of South Asia Plant Pests Diagnostic Networks (SAPPDN) will strengthen plant biosecurity in the region.
- An internet-based portal mechanism for exchange of official information to facilitate communication among SACs needs to be developed by SAARC.
- The SACs should ensure proper compliance to International and Regional Standards with special reference to that of pest risk analysis, pest surveillance and pest reporting. Some of the countries need to invest more on capacity building for developing infrastructure and expertise in various domains of SPS.

It is clear that under the present international scenario, the quarantine specialists have a major role to play not only in promoting and facilitating the export and import in the interest of their respective nations but also in protecting the environment from the onslaughts of invasive alien species. The importance of quarantine has increased manifold in the WTO regime and adopting not only the appropriate technique but also the right strategy for pest detection and diagnosis would go a long way in ensuring pest-free trade and exchange of germplasm and is considered the best strategy for managing transboundary movement of pests. Also, genomics would help in continuous surveillance, rapid diagnosis and real-time tracking of global movement of pathogens. Machine learning and AI algorithms can be leveraged to analyse large-scale genomic data sets and predict disease outbreaks based on environmental and epidemiological factors.

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Chapter-4

Proceedings of the Regional consultation meeting on "Agricultural Biosecurity for Plant Health in South Asia".

Background

This regional meeting on "Agricultural Biosecurity for Plant Health in South Asia" was approved by the 13th GB, meeting of the SAARC Agriculture Centre, which was held in October 2019. Healthy plants constitute the foundation for all life on earth, making up the oxygen we breathe and over 80% of the food we eat. Plant health is the key to the sustainable intensification of agriculture to feed the growing global population by 2050. Protecting the health of plants is vital for human health, food security, trade, the economy, and environment. Plants are under constant attack from pests and diseases. Crop losses caused by *pathogens, insects and* weeds *are estimated to reduce* global agricultural productivity between 20-40 percent. In terms of economic value, plant diseases alone cost the global economy around USD 220 billion annually and invasive insects around USD 70 billion. Noxious weeds also cause substantial yield and economic losses.

In addition to billions of dollars of losses in crops and trade revenue by these pests and diseases every year, they also cause huge loss of dollars for expensive eradication efforts. They are most often spread by people, especially through international travel and trade. Despite declining resources for plant health protection services, international, regional, and national plant health organizations continue in their efforts to protect plant health around the world. One of their primary goals is to prevent the spread of plant pests into new areas where they could cause significant environmental and economic damage. These organizations accomplish this critical goal in many ways, from regulating the global trade of agricultural products to developing innovative, scientific methods for addressing pest threats and promoting responsible practices that reduce pest spread.

Biosecurity is a set of precautions or approach that encompasses the policy and regulatory frameworks to prevent the introduction and spread of harmful organism (insect pests, pathogen, or invasive alien species). It analyses relevant risks to plant life/health and to the environment. In general, "biosecurity is the safeguarding of resources from biological threats". Focus of biosecurity program is to restrict the entry of any threat responsible for hazardous effect on environment by collaboration with member countries. Plant quarantine, national and international stock holders play a key role in plant biosecurity program.

Pest Risk Analysis, Survey and Surveillance are the different steps to detect the pest incidence and provide a direction for the further process of investigation and control. Biosecurity advocates a strategic and integrated approach to meet the consumer expectations in relation to the food safety safeguarding the resources and protecting environment and biodiversity. Agricultural Bio-security Authority of member countries regulates the import and export of plants and related products preventing the introduction of quarantine pests from other countries and implementing post-entry quarantine measures.

The annual value of trade in agricultural products has grown almost three-fold over the past decade largely in emerging economies and developing countries reaching USD 1.7 trillion. FAO estimates that agricultural production must rise by about 60 percent by 2050 to feed a larger and generally richer population. The importance of trade as growth facilitator has been recognized in SAARC countries as well. It is evident from the growing trade openness of SAARC economies over the years. South Asian Countries are fortunate to be free from many serious plant pests that exist overseas due to more than a century of effective quarantine measures and our geographic isolation from the rest of the world. But our agricultural industries, landscapes and biodiversity are under threat from pests and diseases. Factors such as international and interstate movement, tourism and the increasing volume of goods moved into and around the SAARC countries are all contributing to these increasing risks. Therefore, it is overall consensus to consider that the increasing emergence of plant pests and diseases is not only associated with the appearance of new pests but also to the recently emerged pest dissemination mainly from trade and human transport. They are most often spread by people, especially, through international travel and trade. Despite declining resources for plant health protection services, international, regional and national plant health organizations continue in their efforts to protect plant health around the world. One of their primary goals is to prevent the spread of plant pests into new areas where they could cause significant environmental and economic damage. These organizations accomplish this critical goal in many ways from regulating the global trade of agricultural products to developing innovative, scientific methods for addressing pest threats and promoting responsible practices that reduce pest spread in means of biosecurity.

Considering the importance of plant health, the UN General Assembly declared 2020 as the International Year of Plant Health (IYPH) aiming to raise awareness of plant health with government, industry and the wider community on how protecting plant health can help end hunger, reduce poverty, protect the environment, and boost economic development and to highlight the vital role of national and regional plant health organizations in protecting plants from deadly pests and diseases. It is imperative to increase awareness among the public and policy makers of the importance of healthy plants and the necessity to protect them to achieve the Sustainable Development Goals (SDGs). In the context of the IYPH, plant health is defined as "the discipline that uses a range of measures to control and prevent pests, weeds and disease-causing organisms from spreading into new areas, especially through human interaction such as international trade". Pests are defined as any species, strain or biotype of plant, animal, or pathogen that damage plants or plant products including insects, viruses, bacteria, nematodes, and invasive plants.

Thus, governments, policy makers and legislators need to prioritize plant health and protection, particularly policies and legislation related to the preventing pest outbreaks, promoting environment friendly pest management practices, monitoring, and reporting and facilitating safe trade. They should empower national and regional plant protection organizations by providing them with adequate human and financial resources. Donors need to be regularly informed about opportunities for investing in new and existing plant health initiatives and technologies. In this context, the SAARC Agriculture Centre (SAC) conducted a meeting considering the importance of building awareness on plant health in South Asia.

Objectives:

1. To review the biosecurity laws, regulations, policies, and strategies and assess national standards for phytosanitary measures for plant quarantine.

2. To explore the institutional arrangements for biosecurity and their roles and responsibilities for plant health management.

3. To document technical and policy recommendations to enhance the plant quarantine operations.

Methodology:

The meeting was conducted in virtual mode, in which the National Focal Experts of SAARC Member States, participated and presented their country papers on the above subject, and also shared their experiences and views. Similarly invited scientists of different research and development organizations also participated in this meeting. In addition to it, eminent scientists of the different universities, research and development organizations gave their presentations on the different aspects of Agricultural biosecurity and Plant health. The meeting was interactive, participatory and there were group discussions on the above-mentioned subject.

Expected outputs:

1. To document summary of national biosecurity legislations in respect to plant quarantine.
2. To develop action plan to face future biosecurity threats.
3. To develop capacity of human resource to formulate strategic plan against biosecurity threats for South Asia.
4. To development policy brief for strengthening the plant quarantine in South Asia.

Participants: Two participants from each SAARC Member State, especially, from the Department of National Plant Protection Organization/Plant Quarantine Department/Department of Agriculture Extension / Seed Certification of the relevant institutes which are mainly responsible for National Plant Protection participated in this meeting.

Mode: Virtual mode

Schedule: 19-21 August 2025

Proceedings

Regional consultation meeting on "Agricultural Biosecurity for Plant Health in South Asia" was conducted on 19-21 August 2025, in virtual mode. In this meeting nominated focal points and scientists of six SAARC Member States including Bangladesh, Bhutan, Maldives, Nepal, Pakistan and Sri Lanka participated.

Ambassador Abdul Motaleb Sarker, Additional Foreign Secretary & D.G SAARC and BIMSTEC was the Chief guest in the inaugural session, Dr. Nazamun Nahar karim, Executive Chairman Bangladesh Agricultural Research Council (BARC) was the Special Guest while Mr. Tanveer Ahmad Torophder, Director (ARD & SDF) SAARC Secretariat Nepal was the Guest Honor of this event.

Dr. Md. Harunur Rashid, Director SAARC Agriculture Centre welcomed all the participants and reiterated SAC, s dedication to regional cooperation, noting that a unified strategy is vital for plant health and sustainable growth. He also emphasized that agricultural biosecurity is essential for protecting crops from transboundary pests and diseases that threaten food security in the region.

Dr. Sikander Khan Tanveer, Senior Program Specialist (Crops), SAARC Agriculture Centre briefed the participants about the objectives of conducting this regional consultation meeting.

Dr V. Celia Challam, Head and Principal Scientist, Division of Plant Quarantine, ICAR-NBPGR, New Delhi, India, was the Key Note Speaker of this meeting. In her detailed presentation on "Plant Biosecurity in South Asia: Status and Challenges", she warned about the rising threats from invasive pests and diseases, such as Locusts, Fall Armyworm and Wheat Blast, which are exacerbated by climate change and porous borders. Her presentation covered in detail about plant biosecurity in South Asia and the ways that how to prevent spread of pests and diseases in South Asia. Her presentation also covered plant biosecurity quarantine legislations in South Asia. She also mentioned in detail about the agricultural biosecurity management in India.

According to her, plant transboundary movement and plant material are related to the movement of plants and their related material through different sources like

Sea cargo, Air cargo, Road cargo and Train cargo. She also gave the example of spread of pests globally, from any area of the world to other areas of the world, like the spread of *Parthenium Histophorous*, Potato Late Blight, Coffee Berry Borer, BBTV and Peanut strip virus etc. She also mentioned about the plant biosecurity/quarantine legislations, which all the SAARC Member States have approved for the control of pests and diseases. She also mentioned in detail about the National Plant Quarantine system of India. According to her, there is a certain Post entry quarantine period, which varies for different crops. For example, for apple and pear it is 1-2 years. Similarly for the coconut it is, 5 years. In India the Post-entry quarantine facility – Closed facility has been developed for different crops like for imported apple germplasm. Similarly, Post – entry Quarantine Facility – (Open-facility) and their isolation ranges from 500-1000 mt. She also mentioned about the Analysis of Risk of Introducing pests along with the germplasm.

She also mentioned about the potential quarantine pests for India. According to her, ICAR-National Bureau of Plant Genetic Resources, New Delhi and Hyderabad are the Nodal agencies, for germ plasm including transgenics, the issue of Import permit. These agencies issue Phytosanitary Certificate. During last 5 years under germplasm exchange total 7,53,286 samples were processed collectively by the both agencies i.e., ICAR-NBPGR, RS, Hyderabad, and total 294 Phytosanitary Certificates were issued and these both agencies earned Rs. 775,231 lakhs, as a Quarantine processing fee. She also mentioned about the number of pests (Fungi, Bacteria & Mites, Nematodes, Viruses and Weeds) intercepted in germplasm imported from different countries during last 5 years. She also mentioned about the quarantine processing of exotic germplasm and similarly about the joint inspection of planting material. According to her different techniques like Seed Transparency test, and Real-time X-Ray and Molecular detection of insects, pests are used. For detection and identification of Nematodes, visual examination and the soaking of seeds, Soil clods etc. are also used for isolation of nematodes. Similarly for the detection and identification of weeds in exotic germplasm imported into India, visual examination, magnifying lens and grow – out test (i.e. vegetative and floral characters) is used. For detection of viruses Electron Microscopy and ELISA test technology are being used. Similarly, Multiplex RT-PCR has been used for detection of five soybean viruses in quarantine. She also mentioned, about the imported Transgenics for the period, during the last 12 years i.e., from 2014-15 and also talked about the pests, which have been intercepted in Transgenic germplasm. Similarly, she also mentioned about the viruses, which have been intercepted in transgenic soybean germplasm. Different phytosanitary treatments which are being used include mechanical cleaning and seed treatment, Pesticidal dip/spray, Acid wash, Spirit wash, X-ray radiography, Fumigation, Hot water and PEQN. She also presented the impact of regulations and diagnostics, probable annual losses due to various exotic pathogens, if introduced into India. She also mentioned about the presence of maize chlorotic mottle virus and barley strip mosaic virus in Asia Pacific region. Similarly, she also mentioned in detail about the Phytoplasma regulated pests in South Asia and also about the distribution of important emerging pests in Asia-Pacific region. According to her, we can help each other through capacity development in South Asia. These capacity development key areas include Pest Risk Analysis (Regulated pest list and local pest data base), Survey and Surveillance, Threshold levels (Diagnostics and Pest-entry Quarantine), Disinfestation/Disinfection, Pest - free areas and Export Certification System). According to her, there should be survey and surveillance, to identify new pests and diseases e.g., Tuta absoluta and Wheat Blast and there is a need of pest alert system. Similarly, there is need of monitoring of pests to know about their spread to other areas. She also gave suggestion about the establishment of South Asia Plant Pests Diagnostic Network (SAPPDN) in line with USA and Australia.

She discussed about the Phytosanitary treatments and told that, there should be alternatives to Methyl Bromide. For this purpose, Vapor heat treatment method and similarly other methods can be used. Likewise for export facilitation, there should be pest-free areas. There should be Export Certification System and similarly there should be A1, A 2 pest list for South Asia in line with EPPO. There should be continued trainings on Biosecurity and Biosafety policies, diagnostics, and on phytosanitary treatments and issues. According to her challenges for plant biosecurity in Asian countries include air-borne pests, movement of PQ officials, lack of awareness among Custom officials, infrastructure but no operational cost. She suggested that for plant biosecurity, there is a need of closely monitoring of pests i.e., which pests are the most frequently reported from which country and which commodities tend to be infected/infested. It might be possible to predict high pests, commodities or regions of origin. Collecting and disseminating relevant pests' information across South Asia and SE Asia region. There is need of development of A1, A 2 list of pests in the region (South Asia/SE Asia) in line with EU. There is need of strengthening of surveillance programs to identify new pests, development of early warning/rapid response systems, establishment of National Referral Labs in South Asia, establishment of accredited Diagnostic Laboratories (as per ISPM45), implementation of e-Phyto, development of third country/intermediate quarantine labs in South Asia, and similarly, there is need of creation of awareness among custom officials, researchers and public, and likewise establishment of roster of experts (plant biosecurity/quarantine) in South Asia, establishment of South Asia regional expert group on pests, and there is need of joint efforts of South Asian/South East Asian countries, through SAARC & RPPO regarding development of National Plant Pests Diagnostic Networks (NPDN) and development of South Asia Plant Pests Diagnostic Networks (SAPPDN).

Mr. Tanveer Ahmad Torophder, Director ARD & SDF SAARC Secretariat Nepal, the Guest of Honor, emphasized the need of harmonizing measures to ensure safe trade, while Dr Nazamun Nahar Karim Executive Chairman BARC, the Special Guest urged stronger research – policy ties to protect crops and to increase the productivity of crops. Ambassador Abdul Motaleb Sarker, the Chief Guest of the meeting, underscored the need for regional action to protect agriculture from pests and diseases that threaten the food security and trade of this region. He congratulated SAARC Agriculture Centre for arranging this regional meeting.

In the technical sessions presentations were given by the focal points of the SAARC Member States.

Bangladesh country paper was presented by A.K.M Mofidul Islam, Deputy Director (Export), Plant Quarantine Wing Bangladesh. According to him Bangladesh is predominantly an agrarian country, and agriculture sector contributes about 11.55% in the country's GDP, and employs around 44.42% of total labor force. He gave a detailed presentation about the present status of plant quarantine in Bangladesh. According to him, the country has passed phytosanitary regulations including Plant Quarantine Act 2011 and Plant Quarantine Rules 2018. He informed the participants in detail about Plant Quarantine Wing and its functions. According to him Plant Quarantine Wing DAE has developed an automation system for issuance of phytosanitary certificate for plants and their products through online automation software to provide IP, PC, RO, IP Time Extension & Anchorage Permit. Exporter or Importer can apply from his office on line, and there is no need to visit office physically. Country has developed a Reference Plant Quarantine Laboratory at Head office, a Plant Quarantine Lab in Central Pack House, and 15 Plant Quarantine Laboratories in 15 Plant Quarantine Stations.

He also mentioned about the constraints for biosecurity which includes inadequate infrastructure, scarce manpower shortage and skill gaps, weak cold supply chain management system, insufficient treatment plants & packing houses, absence of rapid testing kit, limited international standards of surveillance system, lack of Public - Private Partnership (PPP) and insufficient accredited laboratory for rapid testing of plant and plant products.

According to him, for better agricultural biosecurity in the country, there is need of upgradation of infrastructure of plant quarantine stations, regular trainings of the Quarantine department staff and stakeholders, upgradation of surveillance system, investment in research and innovations in agricultural biosecurity, investment in more rapid kits and in the development of modern accredited laboratories, engagement of the private sector to modernize cold chain management system and establishment of more treatment plants and packing houses.

Bhutan country focal point /scientist, Mrs Yeshi Lahamao (National Plant Protection Centre NPPC, DOA, MoAL, Thimpu) and Sonam Drji N, (Bhutan

Food & Drug Authority BFDA, MoH), Bhutan participated in this meeting. Mr Sonam Dorji, in his detailed country presentation, talked about the agriculture sector of the country and similarly about the agricultural biosecurity framework, policy and legislation, institutional arrangements. He also mentioned about the different constraints (challenges) related to the plant biosecurity in the country and also gave suggestions for its future better management.

According to him, Bhutan Food and Drug Authority (BFDA) and MoH as NPPO of Bhutan - mandated Plant Biosecurity Authority. BFDA is also designated SPS enquiry point of Bhutan. National Plant Protection Centre (NPPC), as the nodal agency under the DOA, MoAl, serves as a referred agency for all PP activities including R&D, diagnostic, pest surveillance, and PP inputs. He also mentioned about the diseases and insects/pests of Bhutan which are closed monitored and controlled including Citrus greening (HLB), Bacterial disease, Giant African Land Snail (IAS), and Fall Armyworm.

He also mentioned about the current biosecurity measures, which are divided into 3 groups i.e., Pre-border measures (which consist of prior approval, import permit, PRA etc. from BFDA & NPPC), measures taken at border (which includes inspection, sample, testing and treatment (ICP, BFDA) and Post – border measures including surveillance, sample, diagnosis and management advisory (which is done by NPPC, BFDA). For the internal/Domestic quarantine, MoAL, DoA, notify plant pest outbreak, MoH, BFDA implement domestic quarantine and similarly Local government and community engagement is also involved in this process.

A number of policies, acts and regulations have been passed by the Government of Bhutan for the plant biosecurity management in the country. Similarly, he also mentioned about different affiliated regulations and guidelines and applied relevant SOP, which are related with the plant biosecurity in the country. He also mentioned about the institutional arrangement in the country in detail which includes different agencies and different linked institutes.

The different transformative initiatives taken by the government includes, imitative to join IPPC ePhyto Solution through STDF, Ecological Niche Modeling to asses pests' projection and risk mapping (Adaptation Fund Project), and Heat Treatment facilities at PAQS establishment.

He also mentioned about different constraints/challenges which are being faced in the country and these include limited infrastructure and facilities (Plant quarantine stations – greenhouse, proper inspection desk etc.), limited pest risk analysis (PRA) analyst and competency on molecular pest diagnostics, remote sensing technologies and AI-based pest forecasting, lack of advance testing and diagnosis technology for pest/pathogen, lack of data access on pest outbreaks and invasive species and weak collaboration and effective coordination for relevant stakeholders.

According to him for better agricultural biosecurity, there is need of strengthening of national plant quarantine system, risk analysis and research with modern tools and equipment's, data management, digitalized and leveraging technology (ePhyto solution) and outsource phytosanitary treatment services to private industries. He also suggested that SAC should support/promote technology transfer and innovation and similarly SAC should support on regional pest surveillance and early warning systems and to facilitate data sharing on pest's outbreaks and invasive species.

The Maldives country paper was presented by the Ms. Fathimath Huwaidha, Plant Protection officer. According to her, the contribution of agriculture sector in the GDP of the country is about 1.1%. Main biosecurity challenges in the country include, geography of the country, as the Maldives has 1192 Islands, which are grouped into 26 atolls, dispersed across the ocean, over 870 km from north to south and 130 km east to west. Invasive species, climate change, pests' outbreak (i.e., coconut beetle infestation in 1980s-90s, Hispid beetle and whitefly out breaks across the country, and limited infrastructure in the form of lack of diagnostic laboratory facilities and lack of NPPO despite increasing imports and biosecurity risks.

Country has developed legal framework for biosecurity and 180+ pesticides have been authorized and registered in national agrochemical registry and similarly 170 biopesticides have been approved in the country. Data and surveillance gap include absence of base line data, regarding limited information on endemic species, invasive and emerging fauna and flora reactive approach, limited information regarding climate change impact on agricultural pests and diseases and no laboratories and capacity of the staff. However international organizations, like FAO and IPCC and as well as neighboring countries help in case of biosecurity related matters and similarly neighboring countries like India and Sri Lanka offer advanced testing capabilities and help in pathogen and disease management.

According to him, legislative strengthening, division of responsibilities between national and local governments in agriculture and plant protection, regional collaboration and integrated reporting can be helpful in better agricultural biosecurity in the country.

Country paper of Nepal was presented by Mr. Madhave Bhatta (Senior Plant Protection Officer PQPMC Nepal). He highlighted the biosecurity issues of the country and also mentioned different outbreaks and similarly control specific pests and diseases including invasive species and migratory pests since 2011. Like *Helicoverpa armigera* issue of wheat crop and similarly BPH (*Nilaparva lugens*) and rice armyworm (*Mythima separta*) issues of rice crop etc. He also mentioned the different issues which are related with the over or improper use of pesticides, ripening agents and similarly use of hormones in vegetables etc.

Different other issues related to biosecurity include inadequate infrastructure, weak traceability and certification systems. He also mentioned in detail about the different initiatives taken by the government related to plant biosecurity. According to him government of Nepal has taken a number of biosecurity measures to make the biosecurity better, like the establishment of labs, development of fumigation chamber and pest quarantine facilities and similarly phytosanitary import regulation and phytosanitary certification service and Plant Quarantine and Protection Act etc.

He also mentioned about the current major programs of NPPO to support plant biosecurity in the country. According to him Nepal has established a coordination system, with the different stakeholders for plant health management both at the national and as well as at the international level.

According to him, for better agricultural biosecurity, there is need of strong collaboration between the all-level governments (Federal, Provincial and Local), and there is need of periodic legal reviews, risk ranking of commodities/ countries, nationwide rapid detection, survey of pests and conformity diagnosis, continuous training of the staff, development of national pest and host database, awareness, compliance and community engagement and regional and international collaboration.

As a country focal point, Mr. Muzamil Hussain, officer of Department of Plant Protection (DPP), Ministry of National Food Security and Research (MNFS&R), government of Pakistan, presented the country paper of Pakistan. According to him, agriculture sector contributes around 19-20% in GDP and employees around 38% of the labor force. Invasive and Quarantine pests of the country, include Fruit flies, Khapra beetle, Desert locust, Cotton leaf curl disease complex and Citrus green/HLB. Main measures taken for control of insects include, different Pre-border risk management practices, different Border operations, and different Post Border management practices. Regarding diseases control, different measures taken include focus on trans-mission, detection and diagnosis, information to the concerned stakeholders and use of new tools and strategies. Similarly, country has developed a legal and policy framework for phytosanitary and biosecurity measures. Country, has also developed a number of institutional arrangements and each institute/organization has its own role and responsibility.

Country, has established a laboratory network to assure quality standards and rapid resting of samples. In future in addition with maintaining the network, their network will be expanded and upgraded diagnostic capabilities and similarly surveillance will be extended along with enhanced surveillance. Studies will be conducted, keeping in view long term climatic data, to evaluate changing pest risk distribution and phenology and to study the patterns of pest's introductions and establishments, assess links to trade, travel and weather anomalies.

He also mentioned the different constraints which include scientific, technical and regulatory problems. He also gave a number of suggestions for further better management of plant biosecurity in the country including expansion of accredited labs, proficiency testing, expression surveillance, tracing of farmers and regional cooperation.

Sri Lanka paper was presented by Dr. (Ms.) R.N. Dissanayake Assistant Director of Agriculture (Research), National Plant Quarantine Service, Katunayake Sri Lanka and Dr. (Ms.) P.M.D. Munasinghe Assistant Director of Agriculture (Development), Plant Quarantine Station, BIA, Katunayake Sri Lanka, focal point/scientists. According to them, agriculture is the foundation stone of the Sri Lankan's economy, culture and livelihoods. She informed about invasive alien species (Parthenium weed, Giant African Snail), exotic plant pests/diseases (Banana bunchy top virus, Papaya mealybug), Fruit flies, weed infestation (water hyacinth), Pest resistance (e.g., Brown plant hopper in paddy), Food product contamination (Khapra beetle), Illegal movement of plant /animal products (Spiraling white fly) and climate change linked pest outbreaks (Fall Armyworm). She mentioned in detail about the intervention of the department of Agriculture in the protection of biosecurity and similarly about the measures taken by the government for disease transmission and detection. She also mentioned biosecurity laws of the country and the agricultural biosecurity progress in the country. She also mentioned in detail the different steps, which the government has taken for the improvement of biosecurity measures in the country, including institutional arrangements, coordination with different national stakeholders and similarly different international coordination activities.

She also mentioned the constraints like limited resources, inadequate quarantine facilities and diagnostic labs, high import volume, informal trade routes which are hard to monitor, outdated laws, weak enforcement, low awareness and training of stakeholders, technological limitations, regional and transboundary issues and limited rapid response and coordination capacity and gave a number of suggestions for better biosecurity including increase in investment in biosecurity sector upgradation of infrastructure, strengthening of regulations, enhancement of awareness and training of different stakeholders, adoption of advanced technologies for e-Phyto and real-time monitoring tools, improvement of regional cooperation and building of emergency response capacity.

Invited guests speakers including Professor Dr. Ramizuddin Miah, Dean Gazipur Agriculture University Bangladesh; Dr. Ivan Rwomushana, Global Lead – Pest Preparedness, CABI Kenya, Professor; Dr. Rakha Hari Sarker, Professor Department of Botany Dhaka University Bangladesh; Mr. Abdur Rehman, Deputy Director Project Implementation and Research CABI, Pakistan; Dr. Madhhubala, Assistant Director NIPHM, Hyderabad India; Professor Dr. Mohammad Shaef Ullah, Department of Entomology BAU, Mymensingh Bangladesh; Dr. Girish A.G,, Deputy Director (PP), NIPHM Hyderabad India;

Dr. Manju Thakur, Crop Health Advisor, CABI South Asia, India, Mr. Ihsan Ullah, Consultant Horticulture SWIAACONTACT and Dr. Saleh Ahamed, Country Head CABI, Bangladesh gave presentations on the different aspects related to Agricultural Biosecurity and Plant Health including Plant Biosecurity and One health; Invasive alien species: best prevention and management practices; Biosecurity for introduction of LMOs & GMOs; Emergency response for plant Biosecurity; Capacity building for plant biosecurity, Surveillance & Monitoring of pests for better agricultural biosecurity; Policy & regulatory framework for plant biosecurity; Enhancing biosecurity through science based pest preparedness and risk analysis in South Asia; WTO & IPPC in phytosanitary regulations and Public Private Partnership (PPP) in phytosanitary measures.

Dr. Madhhubala, Assistant Director NIPHM, Hyderabad India, in her lecture mentioned, the factors which are influencing the plant biosecurity and talked about the international and local stakeholders, who are involved in the plant biosecurity. On the international level the main organizations responsible are WTO-SPA, FAO, CAC, DIE, OPPC-CPM and CBD and at the countries national level, the government agencies, industry, scientific research institutes, farmers, especially interested groups, Non-Governmental Organizations (NGOs) and general public. According to her, there is need of systematic assessment of biosecurity capacity which includes analysis of existing biosecurity capacity, development of medium-term vision of biosecurity, try to assess the gap analysis and an assessment of the options and actions needed to close the gaps. According to her, capacity building of the people involved in biosecurity of plant health will assist countries to develop harmonized and integrated biosecurity framework.

Dr. Md. Ahsan Ulla, Consultant Horticulture SWISSCONTACT, gave presentation on “Role of Bangladesh NPPO in Enhancing the trade with WTO Compliances” and talked about the 3 international standards setting bodies including World Trade Organization (WTO), Agreement on the application of Sanitary and Phytosanitary Measures (SPS Agreement). He also mentioned about the agreement on the application of sanitary and phytosanitary measures (SPS Agreement), which is the agreement on how governments can apply measures for food safety, animal health and plant health without any unnecessary obstacles to trade.

He also informed the participants about the International Plant Plant Pritection Convention (IPPC). The purpose of which is to facilitate international cooperation in controlling plant pests and to prevent their international spread. According to IPPC (Article 1.4), IPPC covers wide range of pests and wild flora invertebrates, diseases and weeds, which can be directly or indirectly harmful. He also mentioned the challenges which are being faced in Bangladesh. According to him as per WTO-SPS Agreement and IPPC Convention and IPPC Procedure the NPPO (National Plant Protection Organization) should have Administrative Legislative and Financial Authority, but in Bangladesh, the NPPO is yet to be established though there is an Act for establishment of National Plant Protection Quarantine Authority (NPQA) in Plant Quarantine Act, 2011. He also mentioned about the International Standards for Phytosanitary Measures (ISPMs) and there are currently 45 standards and these standards can be divided into Reference standards, Pest risk analysis standards, Concept standards and Specific standards.

During discussion, emphasis was given by the participants on strengthening of regional Biosecurity networks, investing in early warning and surveillance systems, harmonizing quarantine standards, and raising farmer awareness regarding integrated pest management. Experts also emphasized on the role of digital tools, development of resistant varieties and for regional funding in addressing emerging threats. Similarly promoting of real-time data sharing, and advancing regional research collaborations to build resilient and safe agricultural systems.

Mr. Abdur Rehaman, Deputy Director CABI, Pakistan, gave presentation on "Emergency Response for Plant Biosecurity". According to him, plant biosecurity includes measures and policies to prevent the introduction of and spread of harmful plant pests, diseases and invasive species because plant health is vital for sustainable agriculture, food security, economic stability and biodiversity conservation. Important pests in South Asia include fruit fly, brown plant hopper of rice, locust, stem borer, red palm weevil affecting crops integral to SAARC nations (Malhotra 2019). Main purpose of emergency response is the rapid containment and eradication of pests or disease, protect agricultural productivity, and natural ecosystems, minimize economic and environmental impacts and maintain market access and public confidence.

Types of plant biosecurity emergencies include Emergency Plant Pest (EEP) outbreaks, Invasive species threatening local flora, Sudden outbreak of diseases and illegal introduction of harmful plant material. Operational response planning includes establishment of Local Control Centers (LCCs), Incident Action Plans with clear objectives for containment and eradication, Surveillance and Tracing of pest spread, Quarantine, movement control and disposal protocols and Disinfection of equipment and materials. Governance and legal frameworks include role of governments, industry, and stakeholders in response, legal authorities for quarantine and control measures, funding mechanisms and cost-sharing agreements and compliance with national and international biosecurity laws.

Response coordination and command structure include, use of Incident Command System (ICS) structure, Defined roles: Incident Controller, State Coordinator, Scientific Advisory panel, communication flow between local, state and national response teams and multi-agency cooperation and resource sharing. Preparedness and Detection include, Training and awareness programs for early detection, Reporting mechanisms for suspect pests and diseases, Diagnostic laboratory support and Simulation exercises and drills to test readiness.

Response actions include, immediate containment through quarantine zones, surveillance and delimiting surveys, pest/disease eradication through chemical, mechanical or biological methods, disposal of infected material in environmentally safe ways and communication with stakeholders and public.

Challenges in emergency response include timely detection of outbreaks, Response and Capacity limitations, managing cross jurisdictional coordination, Ensuring compliance among farmers and industry and communication challenges during crises. It can be concluded that Biosecurity emergencies require timely, coordinated action, planning at national and local levels is essential. Clear roles of legal authority and communication enhance effectiveness and training and involvement of stakeholders' and improved preparedness.

Dr. Ivan Rwomushana, Global Lead - Pest Preparedness/Senior Scientist Invasive Species gave lecture on Invasive alien species: best prevention and management practices. According to him, 60% of global extinctions caused solely or partly by invasive alien species. Economic impact of invasive species on Africa's agriculture sector is to be at least 30 billion annually. Biological invasions are as costly as natural hazards. According to him, Africa alone has lost US$ 14.5 bn, Asia US$ 180.8 bn since 1980 (+704% increase).

Management methods which farmer use against invasive insects/pests include cultural methods (26%), physical/mechanical methods (7%), chemical methods (65%) and biological methods (2%). He presented the results of a study, which was regarding management of challenges with using nature-based options for control of invasives. According to the results of the study, more than 60% of the farmers were lack of awareness about the nature-based options for invasives, more than 40% of the farmers, said that there was limited availability of biopesticides, more than 10% of the farmers said that biopesticides have high cost, according to 0% of the farmers, biopesticide was fit for one kind of pest and 10% of the farmers said that biopesticides are slow acting.

He also showed the results of a study which was conducted to find out the perception of pesticides vs nature-based options. The results showed that maximum farmers think that pesticides are more effective, prevent disease, are quick in work, are easily available, work on a range of pests, increase productivity as compared to Biopesticides but according to them Biopesticides promote plant growth, are safe to handle and safe to environment, as compared to pesticides. He also shared the results of a study of biological control of invasive species in Africa like the Biological control of papaya mealybug in East Africa (KE, UG, SS), Opuntia biocontrol in Kenya, Parthenium biocontrol, and Prosopis biocontrol.

He also mentioned CABIs strategy for Fall armyworm control in Africa, and also mentioned about the Fall armyworm in Ghana and Zambia. Similarly, he also mentioned about the control Tomato leaf miner biocontrol, and mango mealybug biocontrol. CABI biocontrol of CBB in USA and Black thrips control especially in chili fields in Bangladesh, and similarly Spiraling whitefly control of citrus and chilies.

Dr. Md. Ramizuddin Miah, Professor, Department of Entomology and Dean Faculty of Graduate Studies Gazipur Agricultural University Bangladesh, gave presentation on Agricultural Biosecurity and One health. According to him, plant biosecurity and One Health are inter connected, with efforts to protect plant health contributing to overall well-being and sustainable development. A One Health approach recognizes the interdependence of human, animal, and environmental health including plant health, and emphasizes the need for integrated strategies to address associated risks. Healthy plants result into nutritious food, which results into healthy people and healthy animals.

According to One health action, healthy crops improve livestock feed quality. Reduced use of pesticides improves water quality and strong ecosystems reduces disease risk. All stakeholders including governments, scientists, farmers and international organizations needs to play their role through local and as well as through global coordination. For the future, there is need of development of climate - resilient varieties of different crops, AI-based pest detection, stronger international cooperation and community participation in monitoring and control of pests and diseases. Plant health is the foundation of sustainable life and biosecurity is a shared responsibility.

Professor Dr. Rakha Hari Sarker, Department of Botany, Dhaka university, gave presentation on “Biosecurity for introduction of LMOs and GMOs”. He discussed the challenges which are being faced by the SAARC Member States and similarly the global status of plant Biotechnology, Biosecurity and Biosafety and Regulatory issues related to LMOs and GMOs. According to him, the world is facing a classical “Trilemma” including population increase, decreasing arable land, and need of increasing agricultural productivity. According to an estimate in 2050 the planet has to feed 3 billion more people. One billion are already suffering from hidden hunger (lack of micronutrients). Area of arable land is decreasing @ about 1.2% per year, so the agricultural productivity is required to be increased every year. To overcome the challenges, we need to develop improved crop varieties. The desired improvement of crops can be achieved through Selective breeding, Mutation breeding, Transgenic breeding and Genome breeding.

Biotechnology is considered globally as the potential options to increase agricultural productivity and nutritional enhancement. In biotechnology, a living Modified organism (LMO) is defined as any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology, while Genetically Modified Organisms (GMOs), are plants, animals or microbes that have had their DNA changed using genetic engineering techniques. GMOs possess “Potential risk to human health and environment”.

Biosafety regulations are important ensure the environmentally safe application of biotechnology which results to develop a Genetically Modified Organisms (GMOs).

As well as regulatory issues of LMOs and GMOs are concerned, the Cartagena Protocol Biosafety ensures safe transfer, handling, and use of LMOs and GMOs, addressing potential risks associated with modern biotechnology. Top 5 leading biotech producer countries by acreage include United States, Brazil, Argentina, Canada and India. The major commodity crops that are planted to GE varieties (Maize, Soybean, Canola, Cotton) are traded globally in enormous volumes and major importers of biotech commodities are used for animal feed and for oil production. It can be concluded that modern biotechnology can be utilized to address these challenges including food and nutritional security. Member countries has required regulatory guidelines for regulating LMOs/GMOs. There is need of expediting the research activities in plant genetic engineering following proper guidelines and safety protocols and there is need for a collaboration in the area of Biotechnology, Biosafety and Biosecurity.

Dr. Manju Thakur, Crop Health Advisor CABI, gave lecture on "Enhancing biosecurity through science-based pest preparedness and risk analysis in South Asia". She discussed in detail about enhancing biosecurity through science-based pest preparedness and risk analysis in South Asia. She mentioned the reasons that why so many pest invasions are now a days. The main reasons include, accidental introduction of pests through trade, because global trade is increasing rapidly, porous borders, weak border biosecurity, inadequate capacity to limit or stop invasions, and lack of adequate information about potential invasions. Invasions affects biodiversity, agricultural productivity and economies. She also discussed in detail about the generalized pest invasion curve, and showed the different steps to stop the invasion of pests including prevention, eradication, containment and asset-based protection, and told that prevention of pests is the best management. She also mentioned in detail about the PlantwisePlus invasive species management mechanism, and similarly talked about CABI's initiatives taken to support risk assessment-based biosecurity in the region. The aims of which are to strengthen the capacity of the NPPOs and other national stakeholders in conducting risk - based scanning of the potential threats of invasive species in conducting systematic pest risk assessment (PRAs).

She also mentioned CABI led activities to strengthen pest preparedness and discussed in detail about the uses of Horizon Scanning Tool. This tool gives lists of pests absent from a country of risk (Potentially quarantine pests). It prioritizes the pests on the basis of risks. The main purposes of prioritization are to focus risk management on highest risks for better utilization of limited resources.

Scoring risk includes rapid risk assessment for each pest. It needs to assess 100s of pests absent from a country. Some main risk elements as in full Pest Risk Analysis (ISPM 11 PRA for Quarantine Pests). 4 risk components include likelihood of entry, likelihood of establishment, potential socioeconomic impact and potential environmental impact. Its score ranges from 1 (low) to 5 (high) for each risk component. This scoring system is based on system, used in other countries.

She also mentioned in detail about the Pest Risk Register Establishment and maintenance, which is a pest risk register, a decision support tool prepared in a scientific way to keep record and updated risk pests of crops. She discussed the challenges which are being faced in South Asia and these challenges, includes no Pest data bases established available in the countries. Countries have very long regulated pest lists, some missing possible threats to the countries are not assessed and included in regulated pests' lists, and pests in the lists are sometimes already reported in the country but not removed from the regulated pest lists.

Regarding institutionalization of certain activities (HS and RA); no SOP,s and protocols, PRA activities are only need based and also only for export purpose and similarly no regular surveillance programs (due to lack of budget, resources and trained manpower) and all these issues make the risk based assessments difficult.

She also mentioned about the Taskforce on ASEAN Pest Database (TF-APD), the aim of which is to promote sustainable trade via responsible and sustainable agricultural practices to enhance the safety of agricultural products through effective implementation of the TF-APD.

Dr. Shaefullah, Professor Department of Entomology (BAU) Mymensingh gave lecture on Surveillance & Monitoring of pests for better Agricultural Biosecurity. According to him, facts that contribute to pest movement & establishment include international trade, human movement/travel and climate change.

According to him biological invasions are as costly as natural hazards. Global economic losses from biological ($ 1,208 billion) were in the same order of magnitude as economic losses from storms ($ 1,913.6 billion) and earthquakes ($ 1,139.4 billion). Invasions costs increased further than natural hazards costs overtime with a 702% increase in reported losses between the periods of 1980-1999 and 2000-2019.

He discussed in detail about the pest surveillance. According to him, surveillance is an official process which collects, and records data on pest presence or absence by survey, monitoring other procedures (IPPC, 2018). The ISPM 6 divides surveys into three categories; delimiting, detection and monitoring surveys. Delimiting surveys define the boundaries of pest infestations, monitoring surveys assess pest population, and detection surveys check for the presence of target pests.

He talked in detail about the present status of surveillance in Bangladesh. Similarly, he also mentioned about the CABI Horizon Scanning Workshops, which have been conducted during the previous years in Dhaka, during the years 2022 and 2023, in which Anthropoid pests and diseases were identified among the list of anthropoids with the potential to threaten Bangladesh's agriculture and economy.

He also explained regarding prioritizing invasive species through horizon scanning and gave an example of assessment of Anthropoids in Bangladesh. Similarly, he also mentioned about the development of surveillance protocol for coconut hispine beetle and capacity development of PQW, and similarly surveillance for the *Thrips parvispinus*. For pest preparedness and response planning, he emphasized for strengthening pest surveillance and biosecurity in South Asia. For this purpose, regional cooperation through SAARC, to improve pest monitoring and control, use of shared knowledge & technology, by adoption of modern pest surveillance tools for better prevention, sustainable across South Asia and there is need of action by uniting for a secure and thriving agricultural environment in South Asia.

There was detailed discussion on the different aspects of Agricultural Biosecurity and Plant Health in these three days regional consultation meeting. Recommendations of this meeting are given below;

Recommendations:

1. Monitoring and Surveillance:

- Adoption of international standards of surveillance system.
- Data keeping regarding pest outbreaks and invasive species.
- Update of pest risk analysis (PRA) and host-pest data bases.
- Pest risk analysis, molecular level pest diagnosis, remote sensing technologies and AI based forecasting.

2. Capacity Building:

A. Human Resource Development:

- Regular trainings of the Quarantine officials, staff, inspectors and Extension workers on pest diagnostics, surveillance, and import risks analysis.
- Sufficient skilled manpower engagement.

B. Strengthening of Facilities:

- Establishment of sufficient plant quarantine Accredited laboratories with sufficient financial resources for rapid testing of plant and plants products.
- Upgradation of infrastructure of plant quarantine stations, with greenhouses, proper inspection desks etc.
- Establishment of sufficient treatment plants and packing houses.
- Availabilities of pest and disease rapid testing kits.

- Sufficient availability of government allocated budget for biosecurity programs.
- Labs having molecular facility, reference collections, barcoding and digital image libraries etc.

3. Rules and Regulations:

- Provisions and update of Acts, Rules and Regulations.
- Harmonization of SAARC Member States frameworks and standards of plant biosecurity.
- Gaps minimization of pre and post border biosecurity.

4. Networking on Biosecurity:

- Establish data and information sharing platform.
- Regional collaborations of labs for quick and cost-effective testing of samples of plants insects/pests/diseases.
- Regional pest surveillance and early warning systems, data sharing on pest outbreaks and invasive species.
- Information sharing regarding emerging pests, invasive species and various quarantine pests.

Regional Consultation Meeting on

"Agricultural Biosecurity for Plant Health in South Asia"

Date: 19-21 August, 2025
Organized by SAARC Agriculture Centre (SAC)
Venue: Virtual

Meeting Time: August. 19 to 21, 2025 (10:30 am to 2:00 pm, Bangladesh Time)
Day 1 (19 August 2025)- Inaugural M.C: AHM Taslima, STO, SAC

Program Schedule

Time	Program	Responsibility
	Inaugural Session	
10:30-10:40	Welcome address	**Dr. Md. Harunur Rashid** Director, SAARC Agriculture Centre
10:40-10:50	Introduction of the participants	
10:50-11:00	Consultation meeting objectives and overview of the program	**Dr Sikander Khan Tanveer** Senior Program Specialist (Crops), SAC
11:00-11:20	Plant Bio-security in South Asia- Status and Challenges.	**Key Note paper presenter**: **Dr. V. Celia Challam** Head & Principal Scientist Division of Plant Quarantine ICAR- National Bureau of Plant Genetic Resources New Delhi-India.
11:20-11:25	Remarks by the Guest of Honor	**Mr. Tanvir Ahmad Torophder** Director (ARD & SDF) SAARC Secretariat, Nepal
11:25-11:30	Remarks by the Special Guest	**Dr. Nazmun Nahar Karim** Executive Chairman, BARC
11:30-11:40	Remarks by the Chief Guest	**Ambassador Abdul Motaleb Sarker** Additional Foreign Secretary (SAARC & BIMSTEC), MoFA, Dhaka, Bangladesh
11:40-11:50	**Break**	

Technical Session: 1 **Technical Session Chair:** Dr. Md. Harunur Rashid, Director, SAC **Rapporteurs:** SPS (NRM) and SPO (NRM)		
Country Paper Presentations		
11:50-12:15	Country paper presentation of Bangladesh.	
12:15-12:40	Country paper presentation of Bhutan	
12:40-1:05	Country paper presentation of India	
1:05-1:30	Country paper presentation of Maldives	
1:30-2:00	Discussion	
Closing of the Day 01		
Day-2 (August 20, 2025) **Technical Session-2** **Session Chair:** Dr. Md. Harunur Rashid, Director, SAC **Rapporteurs:** SPS (Livestock) and SPS (NRM)		
Country paper Presentation		
10:30-10:55	Country paper presentation of Nepal	
10:55-11:20	Country paper presentation of Pakistan	
11:20-11:45	Country paper presentation of Sri Lanka	
11:45-12:10	Pant Biosecurity and One Health.	**Professor Dr Ramiz Uddin Miah** Dean, Gazipur Agriculture University, Gazipur Bangladesh
12:10-12:35	Invasive alien species: best prevention and management practices.	**Dr Ivan Rwomushana** Global Lead - Pest Preparedness, CABI, Kenya
12:35-12:45	Break	
Technical Session-3 **Session Chair:** Dr. Md. Abdus Salam, Member Director-Crops, BARC **Rapporteurs:** SPS (NRM) and SPO (Pub.)		
12:45-1:10	Biosecurity for introduction of LMOs & GMOs	**Professor Dr. Rakha Hari Sarker** Department of Botany Dhaka University Bangladesh

1:10-1:35	Emergency Response for Plant Biosecurity.	**Mr. Abdul Rehman** Deputy Director, Project Implementation and Research, CABI, Pakistan
1:35-1:55	Capacity building for Pant Biosecurity.	**Dr Madhubala** Assistant Director NIPHM, India
1:55-2:00	Discussion	
Closing of the Day 02		
Day-3 (August, 21, 2025)		
Technical Session-4: **Session Chair:** Dr. Syed Nurul Alam, Former Director-BARI **Rapporteurs:** SPS (NRM) and SPO (NRM)		
10:30-10:55	Surveillance & Monitoring of Pests for Better Agricultural Biosecurity.	**Prof. Dr. Mohammad Shaef Ullah** Department of Entomology BAU, Mymensingh Bangladesh
10:55-11:20	Policy & Regulatory Frame work for Plant Biosecurity.	**Dr. Girish A.G** Deputy Director (PP). NIPHM, India
11:20-11:45	Enhancing Biosecurity through Science Based Pest Preparedness and Risk Analysis in South Asia	**Dr. Manju Thakur** Crop Health Adviser, CABI South Asia-India
11:45-12:10	WTO & IPPC in Phytosanitary Regulations	**Mr. Ihsan Ullah** Consultant Horticulture SWISSCONTACT
12:10-12:35	Public Private Partnership (PPP) in Phytosanitary Measures.	**Dr Saleh Ahmed** Country head CABI, Bangladesh
12:35-12:45	**Break**	
Technical Session -5: **Session Chair:** Dr. Md. Harunur Rashid, Director, SAC **Rapporteurs:** SPS (Livestock) and SPO (Pub)		
! 2:45 - 01:15	Discussion & Conclusion	
Break Out Room Session Discussion:	**Current Biosecurity condition.** • Research • Labs establishment	

	• National and regional Biosecurity measures **Government Policies / support** • Current policies • Challenges to implement • Future policy • Capacity Building: Human Resource and Infrastructure	
01:15-01:20	Recommendations	**Dr. Sikander Khan Tanveer** SPS(Crops), SAC
01:20-01:30	Vote of Thanks	**Dr. Md Harunur Rashid** Director, SAC

SAARC Agriculture Centre

Regional Consultation Meeting on

"Agricultural Biosecurity for Plant Health in South Asia"

List of participants

Sl.	Name	Designation with Address	Email	Contact No
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Special Guest				
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Chief Guest				
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Key Note Speaker				
20.	Dr V. Celia Challam	Head & Principal Scientist Division of Plant Quarantine ICAR- National Bureau of Plant Genetic Resources New Delhi-India.	mailcelia@gmail.com	+919968299994
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Photo Gallery

Ambassador Mr. Abdul Motaleb Sarker, Additional Foreign Secretary (SAARC and BIMSTEC), MoFA, Dhaka, Bangladesh, Chief Guest of the Meeting.

Dr. Nazmun Nahar Karim, Executive Chairman, Bangladesh Agricultural Research Council (BARC), Dhaka, Bangladesh, Special Guest of the Meeting

Mr. Tanvir Ahmad Torophder, Director (ARD & SDF) SAARC Secretariat, Kathmandu, Nepal, Guest of Honor of the Meeting.

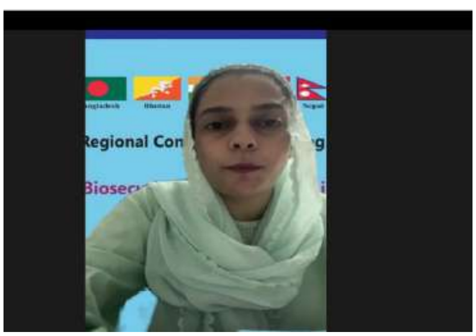
Dr. Md. Harunur Rashid, Director, SAARC Agriculture Centre (SAC), Dhaka, Bangladesh, welcoming the meeting participants.

Dr V. Celia Challam, Head and Principal Scientist, Division of Plant Quarantine, ICAR-NBPGR, New Delhi, India, keynote speaker of the meeting.

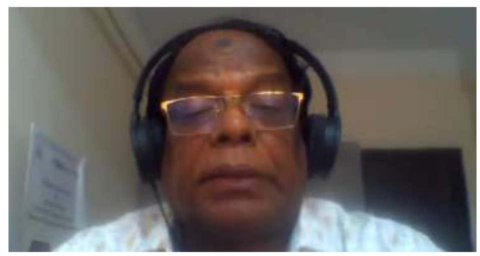
Dr. Sikander Khan Tanveer, Senior Program Specialist (Crops), SAARC Agriculture Centre, Dhaka, Bangladesh, briefing the objectives and overview of the meeting.

Meeting Photos

SAARC Member States Focal Points/Scientists presenting their country papers , pictures of some resource persons and group photos of the participants of meeting.



Meeting Photos (Contd.)



Meeting Photos (Contd.)

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Dr. Sikander Khan Tanveer is serving as Senior Program Specialist (Crops) at SAARC Agriculture Centre (SAC), Dhaka, Bangladesh, since April 2023. He holds MSc (Hons.) in Agronomy from the University of Agriculture Faisalabad, Pakistan and PhD in Crop Cultivation and Farming from Northwest A&F University, Yanling, P.R China. Before joining SAC, he served in various scientific and leadership positions at the Pakistan Agricultural Research Council (PARC), including National Coordinator (Wheat). He has extensive expertise in wheat research, crop management, varietal develoment, seed production, conservation agriculture, climate-smart agriculture, regenerative agriculture and sustainable cropping systems. He has led numerous national, regional and international projects and contributed significantly to the development and promotion of improved wheat varieties and resource-conserving technologies. He is the author of several research papers, book chapters and reports and has edited three books.

Dr. Md. Harunur Rashid is the Director of SAARC Agricultural Center (SAC), Dhaka, Bangladesh. He earned PhD degree under prestigious IRRI Fellowship from Bangladesh Agricultural University, Mymensingh. He is authors of more than hundred research articles, policy documents, book chapters, training manuals and popular articles. Previously he worked as a Scientific Officer, and Senior Scientific officer at Bangladesh Rice Research Institute. He is also working as a Member Director (NRM), Bangladesh Agricultural Research Council (BARC). Recently several novel training modules for human resources development in agriculture and allied sciences have been developed by him.

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