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Biosecurity Policies Influencing International Exchange of PGR

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Biosecurity policies play an important role in facilitating transboundary exchange of plant genetic resources (PGR) by preventing introduction of pests into new geographical areas. International exchange of PGR has contributed significantly towards crop improvement and increased crop production. However, a number of pests have also moved across the countries along with planting material. Most countries regulate the import of germplasm because of the pest risk posed by such imports. With the coming of the two international Agreements - Convention on Biological Diversity (CBD) in 1992 and World Trade Organization (WTO) in 1995, international exchange of PGR has been altered. Under WTO, the aim is to promote trade by undertaking quarantine and influencing trade policies while CBD aims at protection and conservation of biodiversity. A number of national regulations related to biosecurity and related issues have an impact on safe international movement of PGR. Even the PGR being exchanged under the International Treaty on Plant Genetic Resources of Food and Agriculture are governed by the respective national biosecurity regulations of the nations. The various national regulations provide a fragmented legislative system which needs to be harmonized and integrated to holistically deal with biosecurity while complying with international norms. The establishment of National Agricultural Biosecurity Authority and the Biosafety Regulatory Authority of India and the enactment of the Seed Bill needs to be taken up to have a holistic approach in dealing with biosecurity. Also, there is a need to support research, training, capacity-building, networking and information sharing activities at both national and regional levels.

Key Words: Biosecurity, Holistic, Plant pests, Policies, Regulation

Introduction

Biosecurity literally means safety of living things. Technically, it is a strategic and integrated approach that encompasses the policy and regulatory frameworks to analyze and manage risks in the sectors of food safety, animal life and health, and plant life and health, including associated environmental risk (http://www.fao.org). Hence, it broadly covers food safety, zoonoses, the introduction of animal and plant diseases/pests, the introduction and release of LMOs or GMOs and the introduction and management of invasive alien species.

Globalization and climate change have impacted human and plant life and our environment in unprecedented ways. With the advent of WTO and the liberalization of trade in agriculture since 1995, new avenues for growth and diversification of agriculture have emerged while bringing in many new challenges. There is an increased risk of introduction of exotic pests, including weeds, in the country with the potential to cause serious economic loss. Climate change has the potential to alter the habitat of known pests and even cause introduction of new pests. The emergence and spread of transboundary diseases such as the Ug_{99} stem rust of wheat and rice blast pose new threats. Also, there is an increasing threat of bioterrorism. Because of these factors, biosecurity has emerged as one of the most urgent issues facing countries requiring them to foster policies and develop technological capabilities to prevent, detect, and respond to such threats.

This paper primarily deals with the regulations impacting phytosanitary aspects of biosecurity with a focus on dangers from exotic pests, status of national policies, identifies important issues that need to be addressed and the need for developing a holistic biosecurity policy to address them.

Plant Biosecurity Policies in India

Plant quarantine is the government endeavor enforced through legislative measures to regulate the introduction of planting materials, plant products, soil, living organisms, etc. in order to prevent inadvertent introduction of pests (including fungi, bacteria, viruses, nematodes, insects and weeds) harmful to the agriculture of a country/ state/ region, and if introduced, prevent their establishment and further spread. The devastating effects resulting from diseases and pests introduced along with international movement of planting material, agricultural produce and products are well documented (Gupta *et*

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al., 2005; Khetarpal and Gupta, 2008; Khetarpal *et al*., 2009; Dubey and Gupta, 2016) which clearly demonstrate that introduction and establishment of quarantine pests including weeds into new areas can severely damage the crop production and economy of a region/ country.

After the Second World War, FAO convened an International Plant Protection Convention (IPPC) in 1951, to which India became a party in 1956 along with Australia, Sri Lanka, UK, Netherlands, Indonesia, Portugal and Vietnam. At present, there are 183 contracting parties of the IPPC (as on May 28, 2017). The IPPC aims to develop international cooperation among various countries to prevent the introduction and spread of regulated pests along with international movement of plants and planting material (http://www.ippc.org) and requires that each country establish a national plant protection organization to discharge the functions specified by it.

With the coming of the two international Agreements of Convention on Biological Diversity (CBD) in 1992 and World Trade Organization (WTO) in 1995, international exchange of agricultural commodities has taken a different turn. Under WTO, the aim is to promote trade by undertaking quarantine and influencing trade policies while CBD aims at protection and conservation of environment and biodiversity. Also, the International Treaty on Plant Genetic Resources for Food and Agriculture was adopted in 2001 for establishing a global system to provide farmers, plant breeders and scientists' access to plant genetic materials. The Treaty facilitates access to the genetic materials of 64 crops in the Multilateral System for research, breeding and training for food and agriculture. India is a signatory and has ratified all three international instruments impacting transboundary movement of plants/ planting material and needs to comply with the requirements under each. Even the PGR being exchanged under the Treaty are governed by the respective national biosecurity regulations of the nations.

A number of national regulations related to biosecurity or issues related to it have an impact on safe trade and exchange of PGR. The chronology of notification of Indian Acts and Policies related to plant biosecurity and the provisions in brief covered therein are given in Table 1.

Infrastructure

In India, agriculture is in the State list of the Constitution and crop production, including plant protection from indigenous pests, is the responsibility of State Governments. The Central Government (Ministry of Agriculture and Farmers Welfare) supplements States' efforts in pest surveillance and management by disseminating innovative pest management technologies. Plant quarantine and locust control in the scheduled desert area, being inter-state and international subjects, are managed by the Government of India.

The Department of Agriculture Cooperation and Farmers Welfare (DAC&FW) through its Directorate of Plant Protection, Quarantine and Storage (DPPQS) implements schemes of plant protection and quarantine through Central Integrated Pest Management Centers (CIPMCs), Plant Quarantine Stations (PQS) at different airports, seaports and land frontiers, Locust Warning Organization circle offices and Central Insecticides Laboratory (CIL) and Regional Pesticides Testing Laboratories (RPTLs), Central Insecticide Board and Registration Committee (CIB&RC) and the National Institute of Plant Health Management (NIPHM).

Plant quarantine regulations are implemented under the Destructive Insects and Pests Act, 1914 and the Plant Quarantine (Regulation of Import into India) Order, 2003. Other regulations relevant to biosecurity are the Environment (Protection) Act, 1968, the Biological Diversity Act, 2002, and the Insecticides Act, 1968. Plant quarantine regulations aim to prevent introduction of exotic pests, diseases and weeds into India, during the import of agricultural commodities, in accordance with the WTO-SPS Agreement. Phytosanitary Certificates (PSCs) are issued for exports as per the International Plant Protection Convention (IPPC) 1951 of the FAO and post-entry quarantine (PEQ) inspections undertaken for imports.

In all, two categories of materials are being imported under the PQ Order, 2003: (a) bulk consignments for consumption and sowing/ planting, and (b) samples of germplasm in small quantities for research purposes. The PQS under the DPPQS undertake quarantine processing and clearance of consignments of the first category (http://www.plantquarantineindia.nic.in). The five major Plant Quarantine are fully equipped and were modernized under an FAO-UNDP funded project.

Table 1. Indian Regulations related to Plant Biosecurity from the turn of the 20th Century

Year	Legislation	Key features related to plant protection
1914	Destructive Insects and Pests (DIP) Act	• Enacted as the first quarantine law in India after the British ordered compulsory fumigation of imported cotton bales to prevent Mexican cotton boll weevil (*Anthonomus grandis*) ordered in 1906 • Prohibits or regulate the import into India or any part thereof or any specific place therein or any article or class of articles specified therein • Prohibits or regulate the export from a State or the transport from one State to another State in India of any plants and plant materials, diseases or insects, likely to cause infection or infestation • Authorizes the State Govt. to make rules for detention, inspection, disinfection/ disinfestation or destruction of any pest or class of pests or of any article or class of articles for which center has issued notifications • Revised and amended several times over the years with provisions for domestic quarantine of nine pests
1966	Seeds Act	• Act was passed by the parliament in 1966 and the Seed Rules were framed under it in 1968 • Legislative measures promulgated to ensure high quality of seed in the market place • Act provides for a system of notification of kinds or varieties of seeds • Seed (Control) Order, 1983 seeks to control and regulate seed production and distribution • Seed declared as an essential commodity under the Essential Commodities Act, 1955 • Periodically revised with the changing national and international scenario • A relevant aspect to be kept in mind is that the authorities created under the Act are entitled to act only in the case of seeds sold for agricultural purposes and not for human consumption
1968	Insecticides Act	• The Act and the rules framed thereunder seek to ensure the availability of quality, safe and efficacious pesticides to the farming community and to manage risks to human health and the environment. • Regulates import, manufacture, sale, distribution and use of insecticides with a view to prevent risk and promote safety measures • Registration committee registers insecticides after verifying claims regarding efficacy and safety
1984 1989	Plants Fruits and Seeds (Regulation for Import into India) Order Revised PFS Order	• No consignment would be imported into India without a valid import permit issued by the competent authority for a. bulk consignments – the Plant Protection Advisor to the Govt. of India b. importing germplasm of agri-horticultural crops including transgenic material for research- the Director ICAR-NBPGR c. forest plants – the Forest Research Institute, Dehradun d. remaining plants of economic and general interest- the Botanical Survey of India, Kolkata • No consignment can be imported unless accompanied by an official Phytosanitary Certificate issued by an official agency of the exporting country • Seeds/ planting materials requiring isolation growing under detention, to be grown in an approved post-entry quarantine facility • Import of soil, earth, sand, compost, plant debris accompanying seeds/ planting materials is not permitted. Hay, straw or any other material of plant origin would not be used as packing material • Special conditions for import of plants, seeds for sowing, planting and consumption have also been mentioned under Schedule II (Clause 4) of the Order • This was repealed after PQ Order 2003 came into force.
1986	Environment Protection Act	• Aims to protect and improve quality of environment • Provides for management and handling of hazardous wastes, use, import/ export and hazardous micro-organisms, genetically engineered organisms or cells • Both LMOs and invasive alien species (IAS) are covered under the EPA; but, it does not state in clear terms the modality for restriction.
1988	New Policy on Seed Development	• Came into force with an objective to provide the Indian farmers with the best genetic material available anywhere in the world to increase agricultural productivity, farm income and export earnings • Encourages an export-oriented horticultural industry the government wanted to provide best seed or other planting material like bulbs, cuttings, saplings and bud woods freely to the farming community for export promotion • Aimed at liberalization of imports along with streamlining of plant quarantine procedures and encouragement to domestic seed industry through incentives
2001	Protection of Plant Varieties and Farmers Rights Act	• Has set up a Plant Varieties and Farmers' Rights Protection Authority • Allows the registration of new plant varieties within a specific list of genera and species, as well as farmers' varieties • Accords specific privileges to researchers/ breeders while respecting quarantine regulations

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Year	Legislation	Key features related to plant protection

2002	Biological Diversity Act	• Addresses the access to genetic resources, associated knowledge and equitable sharing of benefits arising there from to the country
		• To safeguard the interest of the people of India few exceptions are:
		  • Use by vaids and hakims
		  • Free access to the Indian citizens to use within the country for research
		  • Collaborative research involving biodiversity subject to policy guidelines and approval
		• The Act does not restrict movement of pests within the country nor has any provision to deal with invasive alien species (IAS). In fact, no mention is made of these species throughout the legislation.

2002	National Seeds Policy	• The Seeds Act, 1966, Seeds Control Order and NPSD, 1988 promote and regulate the seed industry • Encompasses quality assurance mechanisms along with facilitation of seed industry • Thrust areas include quarantine of imported seeds and planting material and compliance to biosafety • A specified quantity of imported seeds to be sent to National Genebank, ICAR-NBPGR

2003	Plant Quarantine (Regulation for Import into India) Order and its amendments	• Notified in compliance to the Sanitary and Phytosanitary Agreement of WTO
		• Pest risk analysis made a precondition for all imports
		• Gives schedules for import of various plants and planting materials based on degree of risk involved with additional declarations and special conditions
		  • prohibited plant species are plants/planting materials and countries from which import is prohibited (Schedule IV)
		  • restricted species are plants and plant materials the import of which into India is restricted and permissible only with the recommendation of an authorized institution (Schedule V)
		  • species requiring additional declarations and special conditions: where no recommendation is required from issuing authorities (Schedule VI)
		  • plant material imported for consumption or industrial processing permissible on the basis of a phytosanitary certificate, an inspection conducted by inspection authority and treatment as may be required (Schedule VII)
		  • List of prohibited weed species given in Schedule VIII
		  • List of nine regulated pests under domestic quarantine, now notified under Schedule XIII as regulated non-quarantine pests (http://agricoop.nic.in/sites/default/files/WTO1032016.pdf)
		• Director, ICAR-National Bureau of Plant Genetic Resources empowered to deal with import of PGR for research purposes.
		• The order also regulates the import of GMOs of plant origin for the purpose of agricultural research or experimentation. Such imports would require an import clearance by Review Committee on Genetic Manipulation (RCGM) before the import permit is issued by the Director, ICAR-NBPGR. However, the order does not cover imports of GMOs for commercial purposes, which are governed by separate clearances.

2015-20	Foreign Trade Policy	• Provides policy measures for enhanced market access across the world and diversification of export markets. • To increase India's percentage share in global trade special initiatives identified for market diversification, technological upgradation, support to stakeholders in Agriculture among other sectors • Vishesh Krishi and Gram Udyog Yojana (VKGUY) (Special Agriculture and Village Industry Scheme) has the objective to promote exports of agricultural products, minor forest products, Gram Udyog products and forest-based products.
2010	Seed Bill (draft)	• More emphasis given to seed quality including health aspects • Any traded seed should be identified in terms of the variety to which it belongs, meet the minimum prescribed standards for germination, genetic and physical purity, maximum standard in seed health and an acceptable level of agronomic performance • Certification of seed standards is mandatory and done by accredited Seed Testing Laboratories • Deals with the import of seeds and it provides for the compulsory registration of all imported seeds (although the government may allow the import of an unregistered seed for research purposes). Further, all imports of seeds "shall be subject to the provisions of the Plant Quarantine (Regulation of Import into India) Order, 2003, made under the Destructive Insects and Pests Act, 1914
2013	Biotechnology Regulatory Authority of India Bill (draft)	• The Bill sets up an independent authority, the Biotechnology Regulatory Authority of India (BRAI), to regulate organisms and products of modern biotechnology. • BRAI to regulate the research, transport, import, containment, environmental release, manufacture, and use of biotechnology products. • Regulatory approval by BRAI would be granted through a multi-level process of assessment undertaken by scientific experts. • BRAI would certify that the product developed is safe for its intended use, however, all other laws governing the product would continue to apply.

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Year	Legislation	Key features related to plant protection
2013/ 2016	Agricultural Biosecurity Bill (draft)	• Provides for establishment of an Authority/ Board for prevention, control, eradication and management of pests and diseases of plants, animals and unwanted organisms for ensuring agricultural biosecurity. • Most international obligations of India for facilitating imports and exports of plants, plant products, animals, animal products, aquatic organisms and regulation of agriculturally important microorganisms • Provisions for effective domestic quarantine incorporated • Regulates introduction of new or beneficial organisms in the country • Regulates impact of transgenic material with respect to sanitary and phytosanitary matters • Empowers the quarantine officers for search and seizure of material

ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR) undertakes the quarantine processing of all plant germplasm and transgenic planting material under exchange for which it has well- equipped laboratories, green house complex and a Containment Facility has also been established for processing transgenics (Khetarpal *et al.*, 2006). ICAR-NBPGR also provides the necessary back-up research. 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 (Chakravarty *et al*., 2005).

Gaps in the National Plant Biosecurity System

I Legislation: *Enactment of Agricultural Biosecurity Bill 2013/ 2017*

The Destructive Insects & Pests Act (DIP Act), 1914 and the PQ Order 2003 cover import of plants/ plant products based on risk assessments and management there is a need to strengthen them with respect to the following:

- The DIP Act is an old legislation and subsidiary to the Sea and Customs Act which does not give direct powers to the Plant Quarantine Officers to deport or destroy or confiscate the consignment or lodge complaints under the Indian Penal Code; powers for seizures/ detention or forfeiture/ confiscation of infected/ infested material need to be incorporated; punishment or penalty on the importers or custom house clearing agents or other defaulters for violation of the Acts needs to be introduced and the provisions for regulating or prohibiting plants need to be strengthened. Also, the Act contains several definitions which need revision and updation.
- Although the DIP Act has the provisions for domestic plant quarantine, there are no supporting clauses for its enforcement resulting in ineffective enforcement.

The enactment of the Agricultural Biosecurity Bill 2013/ 2017 would take care of the above issues.

II Infrastructure: *Establishment of new plant quarantine stations with adequate facilities, manpower to regulate imports through notified points of entry, pest monitoring and control*

Government of India has notified more than 130 International Entry Points which are being managed by only 57 functional Plant Quarantine Stations. There is an urgent need for new PQ Stations with good infrastructure and trained technical personnel. The existing PQ Stations are required to be strengthened with additional human and infrastructural resources in view of the rapid increase in the quantum of international trade.

Further, strengthening of technical human resources is required for pest monitoring and surveillance, pesticide registration and testing systems, etc. The five major Plant Quarantine Stations need to be strengthened/ established to act as referral centres for rapid and accurate diagnosis of plant pests/ pathogens.

III Capacity Building and Modernization: *Development of an Integrated Information Management System*

There is a need to improve the information management system used by the plant and animal quarantine services to meet organizational and client needs by way of free exchange of information. The Plant Quarantine Information System recently launched by the DPPQS, is a good step in this direction. The PQIS accessible from http://plantquarantineindia.nic.in provides an efficient and effective service for the stakeholders such as importers, exporters, individuals and the Government. It facilitates importers to apply online for Import Permit, Import Release Order and Exporters to apply online for Phytosanitary Certificate. Exporters and importers can view the status of their application online and access history of his application during the entire life cycle of

the application. This will help in bringing transparency in functioning.

Establishment of Biosecurity and Trade Unit

There is an urgent need to establish a Biosecurity and Trade Unit with various Cells namely;

- ***Sanitary and Phytosanitary Cell*** dealing with requirements for import of plants and planting material in the SPS-WTO regime, scientific justification to facilitate pest/ disease free trade in agricultural commodities, fulfill the obligations of the SPS Enquiry Point, examine the WTO-SPS notifications from other countries, preparing India's SPS notifications for WTO, preparing India's market access claims, bilateral agreements with countries etc. (Khetarpal and Gupta, 2002).
- ***Risk Analysis Unit for Import and Export and Market Access Cell*** to undertake science based pest risk analysis for the application of SPS measures consistent with the WTO-SPS Agreement and IPPC international standards on pest risk analysis (Gupta and Khetarpal, 2004). The unit would also organize trainings for capacity building in plant quarantine, develop national standards and harmonize with the international standards.
- ***Integrated Pest Surveillance and Rapid Response Cell*** to ensure early detection of introduced pests, to provide reliable data for Pest Risk Analysis and monitoring pest status in an area to support market access through "pest-free areas". There is a need to conduct regular surveys to watch the introduction, establishment and spread of pests & diseases. In case of any eventuality, a Rapid Response Team would be constituted to check and control the spread of the disease
- ***Centralized Biosystematics Cell*** needs to be established for identification of pests/ diseases faster to enhance the decision making by the operational staff at port of entries. The unit would comprise experts in the fields of entomology, plant pathology including nematodes and weed science with supporting staff for identification of the pests/diseases. The ICAR-DARE Bureaux for microorganisms and insects (arthropods) would be utilized as resource base for this purpose. They would use the latest tools such as molecular techniques, digitized keys and remote microscopy for speedy and accurate identification of pests.
- ***Emergency Action and Biosecurity Disaster Management Cell*** to be developed as an integrated unit with specialized experts for undertaking biosecurity risk assessment, draw out Emergency Action Plan to combat pest menace in the event of any pest epidemic by integrating the various control techniques so as to timely manage the pest incidence and avoid crop loss/yield. It could have four wings dealing with plants, farm animals, living aquatic resources and agriculturally important micro-organisms.
- ***Human Resource Development Cell*** for regular trainings on sanitary and phytosanitary issues for identification of pest diagnostics, sampling, international standards/ guidelines etc. is required. This Cell would also organize trainings, seminars, workshops etc. on sanitary and phytosanitary issues and standards along with related standard operating procedures, at domestic and international level. Besides, the Cell would also sensitize policy makers/ implementers, administrators, politicians, stakeholders (village farmers, farmers owning large organized farms), general public to the importance of food safety, good agricultural practices, plant quarantine requirements through seminars, symposia, workshops and mass media programmes is required.

IV *Strengthening Research Back-up*

- Classification of the threat agents including insects, mites, micro-organisms and bio-weapons challenging the biosecurity of agriculture based on perceived risk levels.
- Increased use of radiation and other frontier techniques as effective mitigation treatment.
- Development of user-friendly serological/molecular diagnostic protocols/kits for prognostic detection of exotic pests and their variants and also for the detection of GMOs/ LMOs.
- Development of digitized biosystematic keys for identification of pests.
- Epidemiological studies including survey and surveillance of diseases/pests to prepare database on endemic pests, identify pest free areas and target IPM for reducing threats.
- Developing models for risk analysis for exotic pests, diseases and invasive weeds.

- Developing standard operating procedures through relevant Handbooks/Manuals for survey and surveillance and monitoring major diseases/pests including invasive weeds.
- Studies on epidemiology of economically important pests and diseases vis-à-vis climate change.
- Studies on factors affecting likelihood of survival of pests under different conditions of transport, modes of dispersal, distribution of hosts/ alternate hosts at destination, potential for establishment, reproductive strategy and method of pest survival, potential vectors and natural enemies of the pest in the area.
- Simulated evaluation of mitigation options to deal with epidemics/ pandemics.
- Need for special focus on management of indigenous minor diseases, pests and invasive weeds with a potential to impact food security, environment including biodiversity, and trade.
- Development of national dynamic biosecurity database of pest, diseases, invasive weeds and their management.

Need for Integrated National and Regional Agricultural Biosecurity

Internationally, the Agreement on the Application of Sanitary and Phytosanitary Measures of the WTO, governs SPS measures in relation to international trade. The Codex Alimentarius Commission (Codex), the IPPC and the Office International des Epizooties (OIE) provide international standards for food safety, plant health, and animal health, respectively. Further, the Cartagena Protocol of Convention on Biological Diversity (CBD) applies to the transboundary movement, transit, handling and use of Living Modified Organisms (LMOs). Guidelines on the management of invasive alien species have been developed under the SBSTTA (Subsidiary Body on Scientific, Technical and Technological Advice) of CBD (Rana *et al.*, 2004, Gupta *et al*., 2009). This group of international agreements, organizations and programmes are part of a loose international framework for biosecurity, and reflects the sectorial approach to regulate this area.

FAO has recognized the growing importance of biosecurity, and made it one of its sixteen Priority Areas for Inter-disciplinary Action. Biosecurity was also included in the Medium Term Plan which aims at "promoting, developing and reinforcing policy and regulatory frameworks for food, agriculture, fisheries and forestry" (http://www.fao.org.COAG/2003/9.htm).

Models to rationalize regulatory functions among sectors in the quest for improved effectiveness and efficiency have appeared in a number of countries. New Zealand has a Biosecurity Act since 1993 and a Biosecurity Minister and Council since 1999. In US, agricultural biosecurity is looked after by the Animal and Plant Health Inspection Service (APHIS) headed by an administrator under the US Department of Agriculture (USDA). In Australia, biosecurity is the charge of the Department of Agriculture, Fisheries and Forestry (DAFF) looking after plant and animal biosecurity policy development, risk management measures and international trade. The quarantine machinery of New Zealand, USA and Australia have been totally transformed and upgraded in their own ways to meet the challenges of their national biosecurity and safe trade.

Presently in India, agricultural biosecurity is managed on a sectoral basis through the development and implementation of separate policy and legislative frameworks (e.g. for animal and plant life and health). Sectoral agencies organize their work without much attention to the other sectors and no attention is paid to the interdisciplinary nature of biosecurity. In a modern national system, there is need for a more harmonized and integrated approach, with competent authorities responsible for different sectors of agricultural biosecurity working together towards common goals. Sectoral policies, laws and regulations can be harmonized to avoid contradictions, overlaps and gaps. This encompasses the joint setting of biosecurity priorities and allocation of resources, joint planning of activities, and integrated systems for monitoring and review of outcomes. An integrated agricultural biosecurity system would present a single interface to exporters/ importers and allows for sharing of resources among the sectoral agencies (Khetarpal and Gupta, 2007).

Accordingly, there is a need to establish a national mechanism under whose umbrella all the related issues are dealt with in a comprehensive manner to achieve national agricultural biosecurity, protect animal and plant life and health and environment. There is a need for synergy of expertise from various organizations under the Ministries of Agriculture and Farmers Welfare, Environment Forests and Climate Change, Commerce & Industry, Rural Development, Health and Family Welfare,

Science and Technology, Home Affairs, Defence, and National Disaster Management Authority. Integration of the system is required at the top level for taking prompt decisions and conveying firm policy guidelines for managing risk of entry, establishment or spread of pests and diseases and undertaking action plans to regulate them effectively. The integrated system would facilitate (a) timely handling of calamities, (b) appropriate utilization of resources, and (c) establishment of a systems approach to achieve desired results. Integration would imply sharing of national facilities and expertise across different disciplines and institutions like ICAR, CSIR, and SAUs etc. In the light of the various issues highlighted, there is an urgent need for a coordinated effort to have an effective biosecurity system in the country.

The challenges for implementation of the Biosecurity regime in India are immense, given the size and geographical variations within the country. Lack of trained manpower and the resources for scientific research are additional challenges that loom large. In some of the other countries that have undertaken a similar exercise, there is a suggestion to consolidate existing legislation and create a single agency to deal with Biosecurity concerns. However, this approach needs more careful consideration in the Indian context. The motivations behind the existing legal framework and the focus of work of the respective institutions differ vastly. Besides, the Biosecurity concerns do not necessarily override the pre-existing purposes behind the sectoral legislative instruments as listed in Table 1. An altogether new legal framework harmonized with these pre-existing legislations, with a mechanism tailored to carry out the task of promoting biosecurity within their respective mandates, could perhaps be a more effective approach.

Presently, at the national level efforts are being made to develop a coherent biosecurity strategy for the country by the formulation of a comprehensive Agricultural Biosecurity Bill in 2013. DAC&FW has initiated the establishment of a National Agricultural Biosecurity System with a National Agricultural Biosecurity Centre at DPPQS and a National Agricultural Biosecurity Network with the stakeholders from various ministries, ICAR, SAUs and state departments (Swaminathan, 2008). Also, the re-drafting of the Biosecurity Bill in 2017 by the DAC&FW to address the issue of national biosecurity in a holistic manner are some of the important steps in the right direction.

Besides, effective regional collaborative efforts are needed to deal with all known or perceived agricultural biosecurity threats. India has land contiguity with many neighbouring countries and close proximity to the Island nations of Sri Lanka and Maldives. As a result any new pest incursions in these neighbouring countries may eventually enter into India as pests do not recognize national boundaries. The cooperation with neighbouring countries and harmonization of phytosanitary measures in the South Asia will go a long way in protecting the biosecurity of the Region as well as the Nation. India being a lead country in the region, should take the initiative for identifying the potential pest threats to the region. Further, in the event of any new pest incursions in the neighbouring countries which may be of potential concern to India's biosecurity, the NPPO of India may need to take a proactive role by providing necessary assistance to the neighbouring countries in containment and eradication (Satyanarayan and Satyagopal, 2013). This is also required to fully utilize the available resources at the regional level both in terms of infrastructure and expertise.

The key areas for regional collaboration include harmonizing regulations, simplifying quarantine procedures, risk analyses, research and human resource development (HRD). The regulatory cooperation would be for joint deliberation on policy issues at international fora. The quarantine procedural collaboration includes identification of expertise/ accredited labs/ post-entry quarantine facilities for testing special crops/ pests in a network mode and countries with contiguous borders could develop programmes for eradication/ declaration of pest free areas to facilitate exports from the region. Also, each country to freely share information on respective surveillance programmes to enable development of common pest risk analyses for crops/ pests of quarantine significance and also deal with common biosecurity threats and emergencies (Gupta and Dubey, 2016). The areas of collaborative research and HRD also need to be identified based on gap analysis and suitable collaborative programmes developed. Development of database on pest status in countries of the region in addition to regular trainings to strengthen research capabilities need to be conducted.

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