Plant Quarantine Issues for Germplasm Exchange and Scope for Networking in South Asia

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Exchange of plant genetic resources (PGR) has contributed significantly towards crop improvement and increased crop production in the South Asian countries. For safe exchange of germplasm the quarantine related issues which are either legislative or technical need to be addressed. The legislative issues are country specific while those of quarantine processing and methodology are applicable to all. Taking the case of India, the Plant Quarantine (Regulation of Import into India) Order, 2003 is more for facilitating bulk imports than for exchange of germplasm with pest risk analysis (PRA) made mandatory prior to issue of import permit. But in case of germplasm, a large number of species of cultivated crops (and their wild relatives/ land races) with useful traits are imported and doing PRA for them becomes difficult as their pest profile is not available. The technical issues include deployment of non-destructive methods for detection of pests in small samples, delay in release of samples due to post entry quarantine requirements, availability of diagnostic reagents such as antisera for viruses/bacteria and the need for reference collection of insect pests. Besides, research also needs to be intensified and databases developed. There is a need for a regional plant quarantine network in South Asia on the lines of the European and Mediterranean Plant Protection Organization to facilitate smooth flow of planting material/ plant products within and outside the region. It would also facilitate PRA and help in preventing use of non-tariff barriers in international trade. In view of scarcity of resources in the region capacity building under multidisciplinary collaborative research projects need to be taken up with the help of international organizations for safe exchange and quarantine of germplasm.

Key words: Germplasm, Quarantine, South Asia

Plant quarantine plays an important role in preventing introduction of pests along with the exchange of germplasm material in a new geographical area. Almost all countries regulate the importation of germplasm because of the pest risk posed by such imports. It is motivated by the philosophy that it is better to endure some inconvenience and expense in an effort to exclude the exotic pests, rather than submit to losses involved following their entry and establishment (Khetarpal and Ram Nath, 1998). However, the risks are not fully realized by many and this has led to circumvention of quarantine procedures and policies developed as safeguards. Circumvention of safeguards implies a negative image of plant quarantine believed to be too conservative and/ or plant introduction specialists or plant breeders being too liberal towards risks associated with the entry of germplasm (Kahn, 1989). This chapter discusses the issues related to plant quarantine in relation to international exchange/ introduction of plant genetic resources (PGR) and also the scope of collaboration and networking in the South Asian region.

PGR Exchange and Quarantine in the Region

The South Asia region, also referred to as the Hindustani Region of Cultivated Plant Biodiversity, is rich in genetic diversity. In case of agricultural crops this plant diversity is exhibited in the form of variable landraces and primitive types belonging to cereals, millets, legumes, vegetables, fruits, oilseeds, fibres, forages and sugar yielding plants, spices, condiments, medicinal and aromatic plants and many others. In addition, India is also a rich source of wild PGR.

The countries in the region have a lot of commonalities with respect to agro-ecological conditions, cropping systems and crop spectra. Most of them have contiguous land borders without any natural barriers. For instance, except for the island nations i.e. Sri Lanka and Maldives of the region, India has conjoined borders with Pakistan, Nepal, Bangladesh and Bhutan. The region is highly rich in plant biodiversity being the center of origin for a number of important crops like rice, mango, brinjal etc. The land races and wild relatives of many crops are distributed across national boundaries. Besides, all are developing countries with several common problems and have agriculture-based economy.

Over the years, exchange of PGR has contributed significantly towards crop improvement and crop production in the region. However, a number of pests have also moved across the countries along with planting material (Khetarpal *et al.*, 2001b, Gupta *et al.*, 2005).

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For example, *Hemileia vastatrix* causing coffee rust, bunchy top of banana and coffee berry borer, *Hypothenemus hampei* have moved from Sri Lanka to India in 1876, 1943 and 1990, respectively.

- In 1875, Coffee rust (*Hemileia vastatrix)* in Sri Lanka was so severe that the production went down from 400 million pounds in 1870 to just 5 million pounds in 1889. The disease entered India in 1876 from Sri Lanka and within a decade, the coffee industry of South India was badly affected.
- Bunchy top of banana entered India from Sri Lanka and now causes loss to banana of over Rs 4 crores annually. Bunchy top was reported for the first time in 1943 in Kottayam area of Travancore (Verghese, 1945).
- Coffee berry (*Hypothenemus hampei*) borer was first reported in India in 1990 from the Nilgiris in south India and has spread to adjoining coffee growing areas seriously affecting the coffee industry which is primarily export-oriented (Ramaiah and Krishnamurthy Bhat, 1992).

Now, with the liberalization of trade under World Trade Organization (WTO), the quarantine set-up including legislation and infrastructure of all the countries in the region needs to be reviewed. As far as legislation is concerned in the South Asian countries, the Destructive Insects and Pests (DIP) Act was legislated by the British government ruling the undivided India in 1914 which covered three nations of the present day world-India, Pakistan and Bangladesh. After partition, India retained the DIP Act, 1914 under its original name revising it as per requirements over the years through various amendments. Recently, in 2003 it has revised the Plants, Fruits and Seeds (Regulation of Import into India) Order 1984 (further revised in 1989) and brought out as the Plant Quarantine (Regulation of Import into India) Order, which came into force from April 1, 2004. Pakistan adopted the DIP Act, 1914 in the year 1949, which was later replaced by the Plant Quarantine Act in 1976. Bangladesh after attaining independence in 1966 legislated the Destructive Insects and Pests rules on Plant Quarantine. Myanmar had earlier adopted the Insect Pests Act in 1914, but later found it inapplicable because of its outdated clauses and under Food and Agriculture Organisation (FAO) programme drafted a plant quarantine legislation, which was finally enacted as a Plant Pest Quarantine Law in 1993 (Table1). Nepal enacted the Plant Protection Act in the year 1972 and the Plant Protection Rules were enforced throughout the Kingdom of Nepal in 1974. The legal authority for the movement of agricultural commodities is covered by the regulations under the Plant Protection Ordinance No. 10 of 1924 in case of Sri Lanka and the Plant Protection Act was certified in 1999.

Table 1. Chronological Development of Regulations on Plant Quarantine in South Asia

Country	Regulations on Plant Quarantine	Year
Bangladesh	Destructive Insects and Pests Act	1914
	Destructive Insects and Pests rules	1966
Bhutan	Plant Quarantine Act	1993
	Bhutan Package Commodities Rules and Regulations	1995
India	Destructive Insects and Pests Act	1914
	Plants Fruits and Seeds (Regulation of Import into India) Order	1984, 1989
	Plant Quarantine (Regulation of Import into India) Order	2003
Maldives	Not available	-
Myanmar	Insects and Pests Act	1944
	Notification No- 61, 405, 406, 288	1946
	Plant Pest Quarantine Law	1993
Nepal	Plant Protection Act 2029	1972
	Plant Protection Rules	1974
Pakistan	Destructive Insects and Pests Act	1914
	The Pakistani Plant Quarantine Act	1976
Sri Lanka	Plant Protection Ordinance No-10	1924
	Plant Protection Act	1999

In India, the National Bureau of Plant Genetic Resources (NBPGR) is the nodal agency for exchange of all germplasm and trial material meant for research including transgenics. For import of germplasm, import permit from the country of import and phytosanitary certificate from country of origin are essential. NBPGR, has been authorized to issue import permit and undertake quarantine processing of germplasm material under the DIP Act and its amendments and subsequently under the PFS order 1984, 1989 and the same is being continued under the Plant Quarantine Order 2003. NBPGR is well equipped with most modern quarantine laboratories including transmission electron micro-scope and a containment facility. It is thus well equipped also for quarantine processing of transgenic germplasm in a risk-free manner (Khetarpal and Pandey, 2002; Khetarpal *et al.*, 2000).

Issues Related to Quarantine in Exchange of Germplasm

There are number of issues related to quarantine in exchange of plant germplasm. The legislative issues

are country specific whereas those of quarantine processing and methodology are applicable to all. The following legislative issues pertain to India alone:

The national quarantine legislation needs to be in harmony with the international norms laid down by International Plant Protection Convention (IPPC) and the countries in the region are trying to gear up their activities to comply with it. India has attempted to do so by bringing out the new Plant Quarantine (Regulation of Import into India) Order 2003, henceforth referred to as the PQ Order. Under this the imports have been classified as

a) Prohibited plant species (Schedule IV)
b) Restricted plant species where import is permitted only by authorized institutions (Schedule V)
c) Restricted plant species permitted only with additional declarations of freedom 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).

Under the PQ Order, a pest risk analysis (PRA) has been made mandatory for all material being imported into the country other than those mentioned in Schedules V, VI and VII. However, the legislation has been drafted more for facilitating bulk imports than for exchange of germplasm (Khetarpal and Gupta, 2006). Issues specific to germplasm exchange are as follows:

The various schedules V, VI and VII of the Order give lists of crops for which a generic PRA is given and detailed PRA is not required. In case of germplasm, a large number of species of cultivated crops (and their wild relatives/land races) with useful traits are imported but do not find mention in any of the schedules. Hence, a detailed PRA becomes obligatory for them which, in fact, is elaborate and modalities of its preparation are being developed by NBPGR in consultation with the Deaprtment of Agriculture and Cooperation, Ministry of Agriculture. There is an effort to decentralize the power to waive off the requirement of having a detailed PRA in specific case of germplasm of species not mentioned in any of the aforesaid schedules. This is more relevant in the present context when access to germplasm is becoming more and more difficult under the Convention on Biological Diversity, 1992.

Another difficulty, which is faced during import of certain material, is the additional declarations being sought under the Schedule VI (Species permitted only with additional declarations of freedom from quarantine/ regulated pests and subjected to specified treatment certifications). Many countries from where a pest is not reported find it difficult to certify in the phytosanitary certificate the freedom from those pests. To solve this problem, provision needs to be there in the PQ order to waive off the requirements for the declaration of pests not reported from that country. This would greatly help the indentors in procuring germplasm of their interest from varied sources.

The technical issues that include issues pertaining to quarantine processing i.e. methodology for detection and salvaging of pests are enumerated as follows:

- The amount/ size of the germplasm sample is very crucial from quarantine processing point of view, as sampling procedures meant for bulk material cannot be adopted here. Also, the technique applied should enable detection of miniscule amounts of pest in the samples and be non-destructive at the same time. The sample size may not be enough for direct testing of seed through the various techniques being applied to detect different types of pests. Hence, in case of small but precious samples of germplasm extreme precaution is needed to ensure that the result obtained in the tested part is not a false positive or a false negative (Khetarpal, 2004). A minimum size of the sample to be imported has to be made mandatory.
- The seed samples of leguminous crops known to carry seed-transmitted viruses (Kumar *et al.*, 1994) are grown in post-entry quarantine glasshouses and the seedlings showing symptoms are tested for viruses by biological and serological tests, and only the harvest from the virus-free plants is released to the indentors (Khetarpal *et al.*, 2001a; Chalam *et al.*, 2004). Also, chemically treated material of international trials, which cannot be subjected to laboratory testing, are also subjected to post-entry quarantine growing in isolation (Dev *et al.*, 2003). Thus, post-entry quarantine testing and release from indexed disease free plants may take one crop season, delaying the use of material.
- For detection, often the diagnostic reagents such as antisera for viruses/ bacteria are not easily available for exotic pests for which a repository of antisera needs to be established, as one has to deal with exotic pests in quarantine. In quarantine

the detection of exotic pests is the prime concern and for specialized detection and identification of viruses of exotic origin, it becomes mandatory to have the corresponding antisera for carrying out serological assays. Similarly, for detection by Polymerase Chain Reaction (PCR) it is necessary to know the sequence of the exotic virus or a part of its genome in order to synthesize the corresponding primers for their detection. This requires an antisera bank of exotic viruses, a database on sequences of virus specific primers, and also a repository of seeds of indicator hosts for easy access to quarantine officials as they often have to work under time pressure. Expertise is also required in the field of taxonomy and biosystematics as there is a continuous need to identify new pathogens or strains unknown to a region.

- The identity of the species, when intercepted in quarantine, needs to be established speedily to determine the quarantine risk posed by the pest and the suitable disinfestation procedures to be applied. Identification of quarantine insect-pests is difficult because few institutions have an insect reference collection. Also, reference collection for exotic insect pests and identification keys are not readily available. Moreover, even if information on the species is available, it is scattered in various journals and quick retrieval is a problem. Therefore, attempts need to be made to consolidate the taxonomic information with the preparation of digitized keys for quick and reliable identification of various genera and species.
- Research prioritization in quarantine would involve
  - development of sensitive and non-destructive detection and salvaging techniques to detect low levels of infections as the quarantine samples need to be subjected to various techniques for detection of a variety of pests namely; fungi, bacteria, viruses, nematodes, insects, mites, etc. This becomes very challenging as in case of small samples of germplasm often there are not enough seeds available to subject the seed lot to various tests. Hence, more attention needs to be given to non-destructive techniques wherever possible. Also, such methods to salvage the germplasm for making pest-free material available to the indenters especially as access to germplasm has presently become more difficult in the post-CBD era.
  - development of suitable alternatives to methyl bromide (MB), a widely used quarantine fumigant being phased out due to its adverse environmental impacts (Kapur *et al.*, 2004). MB, an ideal quarantine fumigant, has been facilitating safe movement of commodities/ germplasm in the past has been designated as ozone-depleting substance and a potential health hazard to various organisms in the Montreal Protocol (1987) under WHO/ UNEP and is to be eventually phased out. Ozone depletion is a global concern as it guards the earth against harmful UV-B radiations. India ratified Montreal Protocol and is legally committed to phase out the use of MB except for pre-shipment and quarantine purposes by 2015. Hence, there is an urgent need to intensify research to develop/ standardize alternatives to MB to meet the international phytosanitary requirements.
  - development of molecular techniques for detection of races/ biotypes/ strains also needs to be intensified as they are also considered as pests under the IPPC definition of pest, which should be sensitive enough to detect even low levels/ concentrations of pests. However, their use should be made to detect specified pests of potential quarantine importance.
  - studies on factors affecting likelihood of survival of pest under different conditions of transport, sensitive methods for detection of pest at entry, mode 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 etc. need to be urgently undertaken to authentically prepare a PRA during exchange.
- Availability of databases on quarantine pests and endemic pests would simplify the job of the quarantine personnel. Such lists of potential quarantine and endemic pests of different crop species would act as a ready reckoner.

Scope of Developing a Regional Quarantine Network

As the South Asian region has a nearly similar crop spectra and pest problems, it has a number of common

challenges in relation to quarantine considerations and pest risk. Therefore, there is an urgent need as well as scope for collaboration and networking in the region on the lines of Association of South East Asian Nations (ASEAN) or European Union to act at the regional level for enforcement of quarantine regulations keeping in mind the unknown potential hazard of germplasm exchange and new technologies like genetically modified crops (Khetarpal and Gupta, 2004).

Some of the areas for collaboration in the region are:

1. There is a need to establish a regional plant quarantine network through harmonization of plant quarantine regulations in South Asia on the lines of the ASEAN and the European and Mediterranean Plant Protection Organization (Dhillon *et al.*, 2004). This would not only help in preventing introduction of exotic pests of quarantine significance into the Region but also facilitate the flow of planting material/ plant products within the region based on harmonized plant health related standards. The first step in this direction would be compilation of status of pests present in different countries of the region.
2. Common quarantine regulations can be envisaged according to the norms prescribed by the IPPC wherein common pests present in all the countries could be listed to enable the waiver of additional declarations in the issue of import permit during exchange within the region. This would imply a compilation of information on pests present or absent all over the region, or a part of the region (Table 2 and 3). Such a data would also facilitate development of PRA for crops/ pests and trade related plant safety standards of common interest to prevent their use as non-tariff barriers in international trade. Countries which have an expertise for doing quarantine of special crops/ pests could take up that task on behalf of other member countries.

Table 2. Few Pests not Reported in South Asian Region Based on Published Records

Pest	Distribution Status
South American fruit fly *Anastrepha fraterculus*	Mexico, Central and South America
Mexican cotton boll weevil *Anthonomus grandis*	West Indies, Mexico, Central America, Venezuela and USA
Colorado potato beetle *Leptinotarsa decemlineata*	North America and Europe
Groundnut scab *Sphaceloma arachidis*	Brazil
South American leaf blight *Dothidella ulei*	Mexico, Central America, West Indies and South America
Ergot of maize *Claviceps gigantea*	South America and Mexico
Citrus burrowing nematode *Rhodopholus citrophilus*	USA
Rice yellow mottle virus	Africa
Maize streak virus	Africa, USA and South America

3. Collaboration can be developed to conduct combined PRA for crops/ pests of plant quarantine significance common to the region. For this purpose, each country would be required to take up survey for the occurrence and distribution of pests of the common crops of the region and share the information. Preparation of a computerized database of pests and pathogens present and if localized then particular area identified to review the records of new pests detected and outbreaks also needs to be taken up. For instance, movement of plant pests recently introduced in any of the South Asian countries such as *Bemisia tabaci* (B biotype) introduced in India which is a polyphagous pest with a wide host range of > 600 plant species requires immediate attention. Monitoring the movement and spread of established plant pests of concern to the countries also needs immediate

Table 3. Few Pests with Limited Distribution in the Region Based on Published Records

Pest	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
San Jose scale	–	–	+	–	–	+	–
Banana bunchy top disease	+	–	+	–	–	–	+
Potato cyst nematode	–	–	+	–	–	+	+
Tea stem canker	–	–	+	–	–	–	+
Sunflower downy mildew	–	–	+	–	–	+	+
Coffee berry borer	–	–	+	–	–	–	+
Phloem necrosis virus in tea	–	–	–	–	–	–	+
Pine wilt nematode	–	+	–	–	+	–	–

+ reported as present, - not reported

attention. Pests like sunflower downy mildew introduced into India and which have yet not spread to other sunflower growing countries like Bangladesh in the region, needs to be carefully monitored especially since both the countries have contiguous land borders.

4. Human resource development needs attention to overcome the major constraint of lack of trained personnel in developing an effective networking system. Regular training programmes to strengthen both the research capabilities and the training of trainers in national programmes should be conducted at the regional level.
5. Quarantine and PGR management is a developing multidisciplinary field in which many researchable issues are emerging. These researchable issues could be identified and collaborative efforts made to tackle these issues, particularly in view of paucity of scientific and financial resources in the region.

Perspectives

International Plant Genetic Resources Institute (IPGRI-now Bioversity International), South Asian Network on PGR (SANPGR), Asia and Pacific Plant Protection Commission (APPPC) and Committee on Sanitary and Phytosanitary Measures of SAARC need to enhance their efforts in developing a strategy at regional level to identify areas of collaboration, streamline the technical and policy issues and network for safe exchange and quarantine. The partner countries should decide to develop a consensus on working out the modalities on development of database, exchange of information, harmonization of regulations and human resource development.

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