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CHAPTER

Quarantine

12.1 WHAT IS QUARANTINE?

The word 'Quarantine' has been derived from the Italian word *Quanta* which means Forty. The forty day was the period of time for which a person or animal suspected to carry communicable diseases were kept in isolation so as to prevent the spread of the disease causing organisms. In 19th century or till the first half of 20th century even, cholera caused by *Vibrio comma* in Asia and yellow fever caused by Tsetse fly in Africa were considered to be the most dreaded diseases by the Americans and Europeans. Hence, any person traveling from Asia or Africa to Europe or America was kept in isolation at the airport for a period of 40 days so that any latent infection being carried by him or her might get expressed during that period. With the development of vaccines etc. the practice has been discontinued in case of several diseases. However, the term quarantine now applies more to the movement of plants/ planting materials rather than to human beings and animals.

In fact plant quarantine can briefly be defined and understood by 9-*Ps* i.e.

1. **PREVENTS** introduction of dangerous pests and plant diseases in to a country.
2. **PROTECTS** crops and plantations from the destructive ravages of pests and diseases.
3. **PRESERVES** agriculture and forest economy of a country.
4. **PERMITS** movement of plants and planting material in international trade and tariff according to scientifically based safeguards.
5. **PRESCRIBES** safe and suitable measures for the import and export of plant material from one country to another.

6. **PROVIDES** necessary inspection and treatment of plants and plant materials liable to harbor dangerous pests and diseases.
7. **PENALISES** unauthorized import of plant and plant materials
8. **PROMOTES** safe and balanced trade and tariff in plants and plant materials.
9. **PLAYS** an important role in plant protection.

The devastating effects resulting from diseases and pests introduced along with international movement of planting material, agricultural produce and products are well documented. (Ram Nath *et al.*, 1988). The Irish famine of 1845, which forced the people to migrate *en masse* from Europe, was the result of almost total failure of potato crop due to attack of late blight pathogen (*Phytophthora infestans*) introduced from Central America. Powdery mildew (*Ucinula necator*), root eating aphid (*Viteus vitifoliae*) and downy mildew (*Plasmopara viticola*) of grape were introduced in succession into France in mid nineteenth century from North America. These pests caused extensive damage to the grapevines and virtually annihilated the wine industry of the country. Coffee rust (*Hemileia vastatrix*) appeared in Sri Lanka in 1875, was so severe that 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. Germany put embargo in 1875 on the import of potatoes from USA to keep out the dreaded Colorado potato beetle (*Leptinotarsa decemlineata*). In 1898, most European countries put embargo on American import directed mainly to keep out the San Jose scale (*Quadraspidiotus perniciosus*). Among the first few countries to promulgate comprehensive plant quarantine regulations were France, Germany, USA, UK and Australia.

In India, heavy losses in grain yield of *Cicer arietinum* crop in states of Haryana, Madhya Pradesh, Punjab and adjoining areas occurred during 1981-82 due to the introduction of virulent biotype of *Aschochyta* blight from the Middle East. Bunchy top of banana entered India from Sri Lanka and causes loss to banana of over Rs 4 Crores annually (Khetarpal and Ram Nath, 1998). The dreaded Golden nematode (*Heterodera rostochiensis*) introduced from UK along with exotic seed material in 1960s has been causing severe infestation of potato tubers in the Nilgiris. Bunchy top of banana was reported for the first time in 1943 in Kottayam area of Travancore (Verghese, 1945). The disease has been introduced from Sri Lanka. Similarly, potato wart caused by *Synchytrium endobioticum* was first reported from the Darjeeling area of West Bengal by

Ganguli and Paul, (1973). Jones (1961) reported for the first time the golden nematode of potato caused by *Heterodera rostochiensis* from Ooty (Tamil Nadu). Both these diseases were introduced in India from Europe. Anxious weed *Lantana camara* was introduced in 1809 from Central America, which spread to wastelands and pastures causing displacement of native species. All these examples clearly demonstrate that imported seed/ planting material, especially bulk imports, without proper quarantine may result in introduction and establishment of quarantine pests into new areas which may severely damage the crop production and economy of a nation.

In the present context, plant quarantine is a government endeavour 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 (Kahn, 1989). The plant quarantine measures act as filters against the entry of exotic species and check or delay the introduction of unwanted organisms. Therefore, practicing plant quarantine i.e. protection of plants by observing quarantine measures will go a long way in protecting our agriculture from the ravages of exotic pests and diseases and also from further spread of those present in a particular region.

So, quarantine is a regulatory measure enforced legally by the governments to protect its people and environment from invasion of foreign pests and diseases. The policy of using government authority to prevent entry of dangerous exotic pests is based on the ground that it is preferable to undergo and tolerate some inconvenience in an effort to exclude pests and diseases than to submit to the expenses of controlling them for an indefinite period.

Various pests like late blight of potato caused by *Phytophthora infestans* in 1883, coffee rust caused by *Hemileia vastatrix* in 1879, flag smut of wheat caused by *Urocystis tritici* in 1906, downy mildew of grapes caused by *Plasmopara viticola* in 1906, San Jose Scale (*Quadraspidiotus perniciosus*) in 1910, fluted scale (*Icerya purchase*) in 1912 and codling moth (*Cydia pomonella*) in 1919 were introduced in India in the 19th century or the beginning of 20th century. However some of the introductions recorded in the later half of 20th century are as under:

1. Golden nematode in potato caused by *Heterodera rostochiensis* in 1961
2. Downy mildew of onion caused by *Pernospora destructor* in 1977
3. Downy mildew of sunflower caused by *Plasmopara halstedii* in 1985

The first plant quarantine law was promulgated in Rouen, France in 1860 to suppress and prevent the spread of common barberry, which is the alternate host for wheat rust. Other countries to establish the quarantine laws after France were Germany, USA, UK and Australia. In 1881, a California Pest Act was passed to prevent the spread of grape Phylloxera. However, subsequently, a number of countries became aware of the necessity and importance of plant quarantine for the safety and health of their agriculture. The first effort towards an International Agreement on Plant Protection was made in 1914 under the auspices of the International Institute of Agriculture, Rome. This was followed by an International Convention of Plant Protection with over 50 member countries of the Institute in 1919 under which Agreements regarding the issue and acceptance of phytosanitary certificates were finalized. The project got a set back due to Second World War and was later appreciated by Food and Agriculture Organisation (FAO) and in 1951, an International Plant Protection Convention (IPPC) was convened by the FAO (<http://www.ippc.com>). India became a party to this agreement in the year 1956 along with Australia, Sri Lanka, UK, Netherlands, Indonesia, Portugal and Vietnam. At present there are 156 signatory members of the IPPC.

12.1.1 Organizational set-up of plant quarantine in India

In order to protect Indian agricultural, horticultural and forest wealth against the likely onslaught of exotic pests, Government of India took some early steps when it legislated the Destructive Insects and Pests (DIP) Act as far back as in 1914. Rules and regulations have been framed and promulgated from time to time under the provision of this Act. These regulations can be grouped as foreign quarantine regulations which regulate import of plants and planting materials from other countries and domestic quarantine regulations which regulate movement of plant materials within the country. Plant materials are imported into India under the Plants, Fruits and Seeds (Regulation of Import into India) Order, 1989 popularly known as PFS Order 1989, and the Plant Quarantine (Regulation of Import into India), 2003 popularly known as PQ Order, 2003 issued under DIP Act. In the beginning the Act was implemented by Custom Department who were non-technical people, but later the Government of India established the Directorate of Plant Protection, Quarantine and Storage (DPPQS) in 1949. The Directorate was headed by Plant Protection Advisor (PPA) to Government of India. The responsibility of PPA is to implement the quarantine laws which come in force from time to time. The Directorate of Plant Protection, Quarantine and Storage (DPPQS) of Ministry of Agriculture is the apex body for implementation of

plant quarantine regulation. It has a national network of 63 plant quarantine stations at different airports (12), seaports (37) and land frontiers (14). Table 12.1:

Table 12.1 Points of entry for import of plants / plant materials and other articles as per Schedule I clauses 2 (xxi), 3 (13) and 3 (14).

	<i>Airports</i>	<i>Land Frontiers</i>	<i>Seaports</i>
1.	Amritsar (Punjab)	Agartala (Tripura)	Alleppy (Kerala)
2.	Bangalore (Karnataka)	Amritsar (Panjab)	Beypore (Kerala)
3.	Chennai (Tamil Nadu)	Attari Rly. Sta. (Panjab)	Bhawnagar (Gujarat)
4.	Guwahati (Assam)	Attari Waga Border Check Post (Panjab)	Calicut (Kerala)
5.	Hyderabad (Andhra Pradesh)	Banbasa (Uttaranchal)	Chennai (Tamil Nadu)
6.	Kolkata (West Bengal)	Bongaon (West Bengal)	Cochin (Kerala)
7.	Mumbai (Maharashtra)	Gede Road (West Bengal)	Cuddalore (Tamil Nadu)
8.	New Delhi (Delhi)	Jogbani (Bihar)	Gopalpur (Orissa)
9.	Patna (Bihar)	Moresb (Manipur)	Goa
10.	Tiruchirapalli (Tamil Nadu)	Panitanki (West Bengal)	Kolkata (West Bengal)
11.	Trivandrum (Kerala)	Raxaul (Bihar)	*Haldia (West Bengal)
12.	Varanasi (Uttar Pradesh)	Ripadiha (Uttar Pradesh)	Jamnagar (Gujarat)
13.	Sonauli (Uttar Pradesh)	Kakinada (Andhra Pradesh)	Kakinada (Andhra Pradesh)
14.		Zokhwathar (Mizoram)	Kandla (Gujarat)
15.			Karaikal (Pondicherry)
16.			Kollam (Kerala)
17.			Karwar (Karnataka)
18.			Krishnapatanam (Andhra Pradesh)
19.			Machlipatnam (Andhra Pradesh)
20.			Mandvi (Gujarat)
21.			Mangalore (Kerala)
22.			Mumbai (Maharashtra)

	<i>Airports</i>	<i>Land Frontiers</i>	<i>Seaports</i>
23.			Mundra (Gujarat)
24.			Nagapatnam (Tamil Nadu)
25.			Nova Shiva (Maharashtra)
26.			Navlakhi (Gujarat)
27.			Okha (Gujarat)
28.			*Paradeep (Orissa)
29.			Pipavav (Gujarat)
30.			Pondicherry
31.			Porbandar (Gujarat)
32.			Rameshwaram (Tamil Nadu)
33.			Thiruvananthpuram (Kerala)
34.			Tuticorin (Tamil Nadu)
35.			Veraval (Gujarat)
36.			Visakhapatnam (Andhra Pradesh)
37.			Vizhinjam (Kerala)

*For import of food grains by Food Corporation of India only

In all, three categories of materials are being imported under the PFS Order, 1989, which are as follows:

- (a) bulk consignments of grains/pulses for consumption
- (b) bulk consignments of seeds/planting materials for sowing/ planting and
- (c) samples of germplasm in small quantities for research purposes.

The Plant Quarantine Stations under the DPPQS undertake quarantine processing and clearance of consignments of the first two categories, while, NBPQR undertakes the quarantine processing of all plant germplasm and

Out of the three different categories of material being imported, bulk imports for sowing/ planting material carry maximum risk as thorough examination and treatment becomes difficult and planting area required is also far 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 fumigation treatment or fungicidal/ insecticidal treatments. The bulk consignments meant for consumption pose lesser hazards. However, certain small samples meant for research purposes are of immense quarantine importance. These samples usually comprise of germplasm material or wild relatives or landraces of a crop, and are thus more likely to carry diverse biotypes/ races/ strains of the pest/ pathogen. Besides, in case of true seed, generally, risks are more with deep-seated infections than with surface-borne contamination. However, import of vegetative propagules present a much higher order of risk than true seeds.

A large number of fungal pathogens have been intercepted in imported germplasm material during quarantine processing (Khetarpal, *et al.*, 2006). The interceptions of quarantine significance (Agarwal *et al.*, 1989 ; Dev *et al.*, 198.), 1999; Lambat *et al.*, 1983; Ram Nath *et al.*, 1973; Singh *et al.*, 2006) included

1. Pathogens not reported from India
2. Pathogens having physiological races
3. Pathogens having limited distribution in India
4. Pathogens having a wide host range
5. Pathogens reported to cause significant economic losses and
6. A new pathogen, *Drechslera pluriseptata* on elusine seed from Zambia (Khetarpal *et al.*, 1984).

12.1.2 New Policy on Seed Development (1988)

The New Policy on Seed Development (NPSD) came into force on 1st October, 1988 with an objective to provide the Indian farmers with the best genetic material available anywhere in the world to increase agricultural productivity, farm

no introduction of new insects or diseases in the country. Keeping in view the indigenous capabilities, the policy takes a differentiated approach to the import of various categories of seeds and planting materials. The quarantine policy for different categories of seeds is also different. Thus, the policy aimed at liberalization of imports along with streamlining of plant quarantine procedures and encouragement to domestic seed industry through incentives.

12.1.3 National Seeds Policy (2002)

The Seeds Act, 1966 and Seeds Control Order promulgated there under, and the New Policy on Seeds Development, 1988 forms the basis of promotion and regulation of the Seed Industry. Far-reaching changes, however, have taken place in the national economic and agricultural scenario and in the international environment since the enactment of the existing seed legislation and the announcement of the 1988 Policy. Globalization and economic liberalization have opened up several new opportunities as well as challenges. While providing the appropriate climate for the seed industry to utilize available and prospective opportunities, safeguarding the interests of Indian farmers, protecting and conserving agro-biodiversity and traditional knowledge, are the main objectives of the policy. The National Seeds Policy has come into force which encompasses quality assurance mechanisms coupled with facilitation of a vibrant and responsible seed industry. Major thrust areas for quarantine of imported seeds and planting material in the policy includes the following points.

- It would be ensured that there are no deleterious effects on the environment, health and bio-safety.
- Compulsory fulfillment of requirements under prevailing plant quarantine procedures would be required to prevent entry into the country of exotic pests, diseases and weeds detrimental to the Indian agriculture.
- All imports of seeds would require a permit granted by the Plant Protection Advisor to the Government of India and a small specified quantity of imported seeds would be sent to the Gene Bank maintained by NBPGR, New Delhi.
- All import of seeds and planting material, etc. will be allowed freely subject to EXIM Policy guidelines and the requirements of PFS Order, 1989 as amended from time to time.
- Tubers and bulbs of flowers would additionally be subjected to post- entry quarantine. However, the existing policy which permits free import of seeds of vegetables, flowers and ornamental plants, cuttings, saplings of

flowers, tubers and bulbs of flowers by certain specified categories of importers would continue.

- After the arrival of consignments at the port of entry, quarantine checks would be undertaken; which may include visual inspection, laboratory inspection, fumigation and grow-out tests.

In India, private companies are more active in seed trade while government's role is more in proactive policy development. A harmonious interaction between the two can put Indian seed industry on par with the best in the world by preventing the introduction of exotic pests through effective quarantine measures.

The PFS Order, 1989 stipulates:

1. No consignment shall be imported into India without a valid 'Import Permit' issued by the competent authority
2. No consignment shall be imported unless accompanied by an official 'Phytosanitary Certificate' issued by the authorized official of the source country of consignment.
3. The import of plants/fruits/seeds for consumption is allowed only through authorized entry points.
4. The import of plants/plant materials for propagation or sowing or planting is permitted only through the ports of Amritsar, Chennai, Delhi, Kolkata and Mumbai.
5. Hay, straw or any material of plant origin, except sawdust and wood shavings, shall not be used as packing material.
6. Import of soil, earth, clay, peat and similar materials shall not be permitted except for research investigations.
7. Plants and seeds which require post-entry quarantine(PEQ)/post-entry inspection(PEI) shall be grown in PEQ facilities approved by Plant Protection Advisor(PPA) to Govt. of India / Designated Inspection Authority (DIA) or any other officer authorized in this regard to conform to the conditions laid down by PPA. The period for which and conditions under which the material shall be grown in such facility shall be stipulated in the import permit.
8. Seeds of coarse cereals, pulses and oilseeds shall be cleared/rejected after quarantine checks within a period not exceeding 55days.
9. the consignment of seeds of vegetables/flowers/ornamental plants and bulbs and tubers of flowers shall be cleared/rejected within a period not exceeding 50days.

10. The import of seeds/planting materials of fruits shall be permitted selectively by DAC on the recommendations of concerned State Director of Horticulture/Agriculture subject to plant quarantine regulations.

12.1.4 Domestic quarantine

Under the provisions of DIP Act, the Central Government may, by notification in the official gazette, prohibit or regulate the export or transport from one State to another State of India of any article or class of articles likely to cause infection to any crop. The State Government may also make rule for the detention, inspection or destruction of any article or class of article in respect of which a notification has been issued by Central Government. At present we have domestic quarantine regulations to prevent spread of eight pests, considered to have restricted distribution. The eight pests are:

1. Apple scab (*Venturia inaequalis*)
2. Banana mosaic virus
3. Bunchy top of banana
4. Codling moth (*Cydia pomonella*)
5. Fluted scale (*Icerya purchasi*)
6. Potato wart (*Synchytrium endobioticum*)
7. Potato cyst (*Globodera rostochiensis* and *G. pallida*)
8. San jose scale (*Quadrastichodotus perniciosus*)

12.1.5 Significant interceptions in imported material

Over the years a large number of pests and pathogens have been intercepted in imported material and germplasm during quarantine processing. Significant interceptions, many of which are yet not reported from India are enumerated below.

Insects and mites: This include *Acanthoscelides obtectus* on *Cajanus cajan* introduced from Brazil and Columbia, in *Phaseolus vulgaris* introduced from Italy and Nigeria; *Anthonomus grandis* on *Gossypium* spp. introduced from USA; *Ephestia elutella* on with Macadamia (nuts) and *Vigna* spp. from USA; *Pachymerus lacerdae* on nuts of *Orbynya phalerata* introduced from Brazil; *Quadrastichodella eucalypti* on with *Eucalyptus* spp. from Australia.

Nematodes: This include interceptions of *Ditylenchus dipsaci* in *Allium cepa* (bulbs) from UK, *Heterodera schachtii* in *Beta vulgaris* (soil clods) from Germany,

Denmark and Italy (Sethi *et al*, 1972) and *Rhadinaphelenchus cocophilus* in *Cocos nucifera* (husked nuts) from Guyana and *Aphelenchoides fragariae* in strawberry (rooted plants) from Australia. *Heterodera schachtii*, the sugarbeet nematode and *Heterodera rostochiensis*, the golden nematode were intercepted at Madras port in a bulk consignment of potato from Scotland, Northern Ireland and West Germany during 1965-68, the consignment of which was destroyed by dumping into the sea (Renjhen, 1973). Twelve thousand cuttings of hops (*Humulus lupulus*) were unauthorisedly imported into India in 1974 from Australia were intercepted at New Delhi Airport as they were carrying the nematode *Heterodera humuli*.

Fungi: This include *Peronospora manshurica* (downy mildew of soybean) from more than 16 countries, *Uromyces betae* from UK; *Fusarium nivale* in wheat (from Italy, Mexico, Sweden, U.K.), on barley (from Italy and Hungary) and on *Aegilops* (from East Germany), safflower rust, *Puccinia carthami* from USA; *Ascochyta pisi* from Europe and USA; *Botryodiplodia theobromae* from several Asian countries; *Drechslera maydis* from minor millets imported from Africa and Americas and *Ustilago maydis* from USA (Khetarpal *et al.*, 2001).

Phoma betae and *Heterodera schachtii* were intercepted in a 6 metric tonne consignment of sugar beet from Denmark in 1971 at Bombay port (Sethi *et al.*, 1972). In 1973, 1, 20,000 seeds of oil palm (*Elaeis guineensis*) were imported from Nigeria. When the seeds were sown in post entry quarantine, they were found to have severe infection of *Fusarium oxysporum* f. sp. *elaedis* causing the vascular wilt. Another pathogen of oil palm *Schizophyllum commune* was intercepted in a consignment of oil palm from Papua New Guinea at Madras port in 1978. A consignment of oil palm from Malaysia showed the incidence of Marasmius bunch rot caused by *Marasmius palmivorus* when seeds were sown in post-entry quarantine nursery at Andamans and Nicobar islands in 1985. One lakh gladioli bulbs from Netherlands were found to have the incidence of *Fusarium* rot caused by *Fusarium oxysporum* f sp *gladioli* in 1980. *Tilletia contraversa* and *Claviceps purpurea* causing dwarf bunt and ergot, respectively, in wheat were intercepted in a consignment from USA in 1988-89. Reddy and Muthaiyan (1982) reported the interception of *Fusarium moniliforme* f. sp. *subglutinans* in seed of *Pinus carabaea* var. *hondurensis* from Fiji. The pathogen causes pitch canker of Pines.

Bacteria: Important bacterial interceptions include *Xanthomonas campestris* pv. *campestris* from brassicas imported from Australia and Canada; *Burkholderia solonacearum* 'biovar3' in association with groundnut imported from Australia

and *Pseudomonas syringae* pv. *syringae* from *Hibiscus cannabinus* imported from Bangladesh.

Viruses: The important viruses intercepted include soybean mosaic potyvirus in soybean, pea seed-borne mosaic potyvirus in pea and frenchbean, peanut stripe potyvirus in groundnut, cowpea mottle carmovirus in cowpea, barley stripe mosaic hordeivirus in wheat, bean common mosaic potyvirus and broadbean stain comovirus in faba bean (Khetarpal et. al., 2001). Peanut mottle virus (PMV) was intercepted by CPPTI, Hyderabad during post-entry quarantine inspection of ground nut germplasm imported by ICRISAT.

Weeds: In the early years of 19th century *Lantana camara* was introduced from Central America. Similarly, *Phalaris minor* and *Parthenium hysterophorus* were introduced into India from Mexico and South America in the middle of 20th century.

12.1.6 Present International Scenario

The recent biologic and economic development in International trade activities and the thrust of the World Trade Organization (WTO) Agreements and the Convention on Biological Diversity (CBD) suggest that countries need to update their quarantine or plant health services to improve health status of their exports.

12.1.7 World Trade Organization

The establishment of the WTO in 1995 has provided unlimited opportunities for international trade of agricultural products. History has witnessed the devastating effects resulting from diseases and pests introduced along with the international movement of planting materials, agricultural produce and products. It is only recently however, that legal standards have been promulgated in the form of Sanitary and Phytosanitary (SPS) Measures for regulating the international trade. The WTO Agreement on the Application of SPS measures concerns the application of food safety and animal and plant health regulations. It recognizes government's rights to take SPS measures but stipulates that they must be based on science, should be applied only to the extent necessary to protect human, animal or plant life or health and should not arbitrarily or unjustifiably discriminate between members where identical or similar conditions prevail (<http://www.wto.org>, Khetarpal and Gupta, 2002).

The SPS Agreement aims to overcome health-related impediments of plants and animals to market access by encouraging the "establishment, recognition

and application of common SPS measures by different Members". The primary incentive for the use of common international norms is that these provide the necessary health protection based on scientific evidence and improve trade flow at the same time.

SPS measures are defined as any measure applied:

1. To protect animal or plant life or health within the territory of the Member State from risks arising from the entry, establishment or spread of pests, diseases, disease-carrying organisms or disease causing organisms.
2. To protect human or animal life or health within the territory of the Member State from risks arising from additives, contaminants, toxins or disease causing organisms in food, beverages or foodstuffs.
3. To protect human life or health within the territory of the Member State from risks arising from diseases carried by animals, plants or products thereof, or from the entry, establishment or spread of pests. or
4. To prevent or limit other damage within the territory of the Member State from the entry, establishment or spread of pests.

Prior to the establishment of WTO, governments on a voluntary basis could adopt international standards, guidelines, recommendations and other advisory texts. Although these norms remain voluntary, a new status has in effect been conferred upon them by the SPS Agreement. A WTO Member adopting such norms is presumed to be in full compliance with the SPS Agreement.

12.1.8 Existing international organizations for developing standards

In order to achieve the targets international standards need to be developed for which WTO has assigned the responsibility as follows:

- (a) *For food safety:* The Codex Alimentarius Commission (CAC) based in Rome is a subsidiary organ of the Food and Agricultural Organization (FAO) of United Nations and the World Health Organization (WHO). The SPS Agreement designates Codex as the authority for all matters related to international food safety evaluation and harmonization. Codex also develops methodologies relating to food additives, veterinary drugs, pesticide residues, and contaminants, methods of analysis and sampling, and codes and guidelines of hygienic practice.
- (b) *For animal health and zoonosis:* Zoonosis is animal diseases transmittable to humans. The standards, guidelines and recommendations are developed under the auspices of the International Office of Epizootics

for the Phytosanitary Measures (ISPMs) affecting trade. The guidelines and recommendations are developed under the auspices of the Secretariat, IPPC.

The above three organizations commonly called as the 'three sisters' are observers and important contributors to SPS committee meetings. They are also called in as experts to give advice to WTO dispute settlement panels. For matters not covered by the above organizations, appropriate standards, guidelines and recommendations are promulgated by other relevant international organizations open for membership to all members of WTO, as identified by the SPS Committee. The WTO agreements suggest that countries not only update their quarantine or plant health services to improve health status of their exports; they should also incorporate pest risk analysis (PRA) for making regulatory decisions during imports and exports. To this end FAO has been working in consultation with various Regional Plant Protection Organizations such as that of Europe and North America. It has published ISPM Part 1 on Guidelines for pest risk analysis, dated February, 1996 under the provisions of SPS Measures. The standards, guidelines and recommendations for SPS have been developed under the auspices of the secretariat of the IPPC. The essence of the ISPM and SPS documents is regulatory action for International trade. Imports should be based on an acceptable level of risk through PRA and take transparent action having the least negative effect on the flow of international trade but still commensurate with the level of risk.

Quarantine services of most countries determine the entry status of imported agricultural commodities based on perceived risk. The entry status is the combination of a country's law, regulations, guidelines, policy and decisions of inspectors at ports or points of entry. A biologically based position about entry status is that if the risk (i.e. chances of pest entry) is perceived to be high, the entry status of imported articles should be conservative, or conversely if the risk is perceived to be low, the entry status should be liberal. The entry status is also influenced by the use of effective and practical safeguards. If the risk of introduction is low but the entry status is conservative, then it is not based on scientific facts but alleged to be a trade barrier. If the risk is high and the entry is liberal, again the status is not scientifically sound.

A PRA conducted according to international standards can provide the basis for our national planners to allocate resources to areas facing the highest risk and thereby, enabling them to better protect our agriculture and environment from the entry and establishment of exotic pests. PRA offers an improved method for assessing and managing risk by providing a format to consider and perhaps weigh the relative importance of the various factors leading to a more biologically sound approach to pest risk and mitigation. PRA, which consists of risk assessment and risk management, is a procedure by which quarantine services can technically justify new regulations, phytosanitary guidelines or safeguards, operational procedures, entry status of imported articles and resource allocations (Gupta et al. 2002a).

The IPPC requirement for a PRA consists of three stages (viz., Initiation, Risk Assessment and Risk Management) whose compilation should be fully documented in the event a review or dispute arises. The PRA should clearly document information sources and the rationale used in reaching a management decision regarding mitigation measures that have been taken or are to be taken. PRA consists of risk assessment (scientific estimation of likelihood and magnitude of risk of establishment of a given pest) and impact assessment (estimation of the consequences of the establishment of pest). Therefore, to ensure that imported commodity present a minimal pest or disease risk to our agriculture and forestry, PRA must be conducted.

12.2 CONVENTION ON BIOLOGICAL DIVERSITY

The Convention on Biological Diversity (CBD), affirms that conservation of biodiversity is a common concern of humankind and reaffirms that nations have sovereign rights over their own biological resources. The treaty states as major objectives the conservation of biological diversity and sustainable use of its components; fair and equitable sharing of the benefits arising out from the use of genetic resources; and appropriate transfer of relevant technologies (<http://www.cbd.org>).

The quarantine related commitments made by parties to the Convention are:

- to establish means to regulate, manage or control risks associated with use and release of living modified organisms from biotechnology with likely adverse environmental effects (Article 8g).
- to prevent introduction of species from outside a country which could threaten native ecosystems or species (Article 8h).

Although CBD covers all types of organisms (including plants), the scope of IPPC appears broader. The IPPC covers all organisms injurious to plants and plant products, whereas the coverage under the CBD is subject to their sustainable use. The ISPM 11 (supplement) on Analysis of Environmental risks is being developed by IPPC to address the environmental safety issues. This would give an independent framework of rules for WTO members who are not signatories to CBD (Gupta *et al.*, 2002b).

12.3 SALVAGING OF INFECTED/CONTAMINATED SEED MATERIAL

Infected or contaminated seed is the primary source of inoculum for a number of destructive diseases of agricultural crops. Seed health testing is an essential management tool for the control of seedborne and seed-transmitted pathogens and detection of the fungal pathogen is the primary means to control the development and spread of disease. Salvaging is a process of disinfection/decontamination of infected seeds. The principles of salvaging the infected germplasm are same as those adopted for traditional plant disease control:

1. **Exclusion** (prevent the introduction of inoculum)
2. **Eradication** (eliminate, destroy, or inactivate the inoculum)
3. **Protection** (prevent infection by means of prophylactic treatments) and
4. **Therapy** (cure infected planting materials) except that the tolerance limit for any pathogen in quarantine is zero and efforts are thus made to eliminate the pathogen completely. In the post Convention on Biological Diversity era, the PGR are no more considered as the heritage of mankind and thus, the access to germplasm material is becoming more difficult. Therefore, more and more efforts are made to ensure that the incoming material when found infected be salvaged by developing suitable treatments in order to make them available for the research programmes. The seedborne fungi can be present: i) on the seed in the form of mycelium, spores or fruiting bodies *e.g.* smut or bunt spores ii) inside the seed in the form of mycelium like loose smut or iii) along with the seed in the form of smutted or bunted grains, ergot sclerotia etc. Various physical and chemical methods adapted for disinfection or decontamination (Singh and Khetarpal, 2005) are described below:

12.3.1 Mechanical cleaning

(i) Discolouration and deformation of seeds: Seeds showing apparent disease symptoms like discolored, deformed or shriveled seeds detected during

examination of dry seeds by naked eye or under stereo-binocular microscope are indicative of presence of certain pathogens. These seeds are separated out by hand picking to minimize the risk of sowing diseased seeds.

(ii) Fruiting bodies mixed with seeds: Certain fungal fruiting structures associated with the seeds like Karnal bunt, hill bunts of wheat, sclerotial structures are separated out. The remaining seed sample is given ethyl alcohol wash to remove any surface-borne contamination. Cotton seed sample infected with sclerotia of *Sclerotinia sclerotiorum* is mixed with warm water and stirred well. Sclerotia start floating and then separated (Milenko, 1964). Soil clods, plant debris and weed seeds which are suspected to harbour infection are removed by hand picking under the stereo-binocular microscope.

12.3.2 Alcohol wash

For eradication of surface-borne spores of rusts, bunts and smuts adhered to the seed coat, the contaminated seeds are washed in ethyl alcohol in a test tube. The content of tube is shaken well on a mechanical stirrer for 30 seconds. For eradication of rust spores in safflower (*Puccinia carthami*) and sunflower (*P. helianthi*), a modified technique of seed washing was developed (Agarwal et al., 1990) by adding a pinch of river sand to ethyl alcohol. Spores adhering to seed surface get agitated and separate out in the alcohol. Washed seeds are thoroughly dried.

12.3.3 Acid wash

For eliminating the rust spores in sugarbeet seeds, *U. betae*, a quarantine pest, not known to occur in India, an acid wash technique was developed by Ram Nath et al. (1986). The contaminated beet seeds are stirred in concentrated sulphuric acid for one minute followed by washing under running water to remove traces of acid. Treated seeds are sun dried.

12.3.4 Hot water treatment (HWT)

HWT is one of the most commonly used techniques for controlling various seedborne pathogens. Seed sample is transferred to muslin cloth bag and subjected to a temperature for optimum period (Table 11.1), which is lethal to the pathogen but not detrimental to the seed. HWT is preferred to pesticide treatments because of the health hazards and environmental pollution caused by the later.

12.4 PATHOGEN NOT KNOWN TO OCCUR IN INDIA

There are about 333 fungal pathogens on different crops, 48 bacterial pathogens and 212 viruses, mycoplasma and viroides which are not known to occur in India. Out of this 72 fungal pathogens, 20 bacterial pathogens and 51 viruses, mycoplasma and viroides are seedborne, which are listed below (Sharma et al, 1990).

Table 12.2 Seedborne fungal pathogens not known to occur in India

Sr.No.	Pathogen	Disease	Host	Distribution
1	<i>Alternaria cucumerina</i> (El.& Ev.) Elliot	Leaf spot	<i>Cucumis</i> spp., <i>Citrullus lanatus</i>	Worldwide
2	<i>Alternaria panax</i> Whetzel (syn. <i>A. araliae</i> Greene)	Leaf spot	Family Araliaceae	China, Japan, Korea, Australia, Hawaii, New Zealand, Spain, UK, USA, Venezuela
3	<i>Ascochyta fabae</i> Speg.	Leaf and pod spot	Broad bean	Egypt, Morocco, China, Israel, Japan, Korea, Turkey, Australia, New Zealand, Europe, Canada, Argentina
4	<i>Botrytis allii</i> Munn	Gray mold, Neck rot	Onion, Leek, Shallot	Canary Islands, Egypt, Kenya, South Africa, Tanzania, China, Cyprus, Israel, Japan, Australia, New Zealand, Europe, Canada, USA, Brazil, Morocco, Zambia, Taiwan, Vietnam, Saudi Arabia, Afghanistan, Iran, Iraq, Jordon, Korea, Nepal, Pakistan
5	<i>Botrytis anthophila</i> Bondartzev	Gray mold, leaf blight, stem rot	Clover	New Zealand, Tasmania, Czechoslovakia, Finland, France, Germany, UK, Ireland, Netherlands, Norway, Poland, Sweden, Switzerland, USA

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<i>Host</i>	<i>Distribution</i>
Onion, Leek	Japan, Australia, New Zealand, Bulgaria, Denmark, UK, Netherlands, Norway, USA
Broad bean	Africa, Burma, China, Iran, Israel, Japan, Turkey, Australia, New Zealand, Europe, Argentina, Chile, Uruguay
Tulip blight	Australia, New Zealand, Tasmania, Europe, Canada, USA, Argentina, Iraq, Japan, Korea, Philippines, Chile
Oak	USA
Cabbage, Cauliflower	Ethiopia, Kenya, South Africa, Sri Lanka, China, Taiwan, Israel, Japan, Malaysia, Nepal, Turkey, Australia, New Zealand, Europe, Canada, USA, Chile
Timothy grass	Japan, Korea, New Zealand, Europe, Canada, USA
Oats and members of Graminae	Australia, Netherlands, Scotland, Switzerland, Canada, USA

Sr.No.	Pathogen	Disease	Host	Distribution
13	<i>Colletotrichum linicola</i> Pethybr. & Laff. (syn. <i>Colletotrichum lini</i>)	Anthracnose, seedling blight	Flax	Ethiopia, China, Taiwan, Iran, Japan, Turkey, Europe, Canada, USA, Argentina, Paraguay, Peru
14	<i>Crinipellis pemiciosa</i> (Stahel) Singer (syn. <i>Marasmius pemiciosus</i> Stahel)	Witche's broom	Cacao	Grenada, Trinidad, Bolivia, Brazil, Columbia, Ecuador, Guyana, Peru, Surinam, Venezuela
15	<i>Cylindrocladium braziliensis</i> (Batista & Ciferri) Peerally n. comb.	Die back, damping off	Eucalyptus	Brazil
16	<i>Deuterophoma tracheiphila</i> Petri	Mal secco	Citrus	Algeria, Tunisia, Uganda, Israel, Lebanon, Syria, Turkey,
17	<i>Diaporthe phaseolorum</i> (Cooke & Ellis) Sacc. var. <i>caulivora</i> Athow & Caidwell	Stem canker	Soybean	Canada, USA
18	<i>Diaporthe woodii</i> Punith. (conidial state: <i>Phomopsis leptostroiformis</i> (Kuhn) Bubak)	Stem blight	Lupinus spp.	Europe, Africa, Australia, North America
19	<i>Diplodia pinea</i> (Desm.) Kickx (syn. <i>Sphaeropsis ellisii</i> Sacc.)	Bark canker and die back, twig blight, stag-head, red top, bud wilt	Pine and other conifers	Africa, Japan, Malaysia, Thailand, New Zealand, Europe, Canada, USA, Jamaica, Argentina, Brazil, Chile
20	<i>Drechslera iridis</i> (Oud.) MB Ellis	Ink disease	<i>Iris</i> spp. <i>Lachenalia glaucina</i> , <i>Tritonia</i> spp.	Europe, Canada
21	<i>Elsinoe phaseoli</i> Jenkins	Scab, pod spot	Lima bean, <i>Phaseolus</i> spp.	Kenya, Malawi, Uganda, Zambia, Zimbabwe, China, Mexico, USA, Central America, West Indies, Brazil, Surinam

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Host	Distribution
Cereals, cucurbits, <i>Beta</i> , <i>Dianthus</i> , <i>Musa</i> , <i>Trifolium</i> , <i>Solanum</i> spp.	Africa, Australia, Germany, Hungry, New Caledonia, New Guinea, Romania, Sarawak, Sweden, UK
Cucumber	Kenya, Libya, South Africa, Asia, Australia, Europe, Canada, USA, Panama
Muskmelon	USA, Canada, Europe, Taiwan, Iraq, Japan, Philippines, Australia
Coffee	Africa, El Salvador
<i>Lolium</i> spp. and other members of Graminae family	Japan, Philippines, Australia, New Zealand, Europe
Strawberry, <i>Agrimonia</i> , <i>Alchemilla</i> , <i>Comarum</i> , <i>Geum</i> , <i>Epilobium</i>	Australia, new Zealand, Tasmania, Denmark, UK, Ireland, Netherlands, Sweden, USA, Canada
Cherry	Europe

Sr.No.	Pathogen	Disease	Host	Distribution
29	<i>Gnomonia fragariae</i> Kleb.	On dead leaves	Strawberry	Israel, Australia, New Zealand, Belgium, UK, France, Germany, Hungary, Romania, Spain, Canada, USA
30	<i>Guignardia fulvida</i> Sanderson (Anamorph: <i>Aureobasidium lini</i> (Lafferty)Herm.- Nijhof (= <i>Polyspora</i> <i>lini</i> Lafferty)syn. <i>Discosphaerina</i> <i>fulvida</i> (Sanderson) Sivanesan)	Stem break, browning	Flax, cotton	Kenya, South Africa, Japan, Australia, New Zealand, Europe, Canada, USA
31	<i>Hemileia coffeicola</i> Maubl. & Rogers (syn. <i>Uredo</i> <i>coffeicola</i> Maubl. & Rogers)	Rust	Coffee	Bioko, Cameroon, Central African Republic, Nigeria, Sao Thame and Principe, Togo, Uganda, Zaire
32	<i>Itersonia</i> <i>pastinacae</i> Channon	Canker	Parsnip	Australia, New Zealand, UK, Italy, Canada, USA
33	<i>Kabatiella caulivora</i> (Kirch.)Karak.(syn. <i>Gloeosporium</i> <i>caulivorum</i> Kirch.)	Scorch, Northern anthracnose	Clover	Morocco, Japan, Australia, New Zealand, Europe, Canada, USA
34	<i>Kabatiella zae</i> Narita & Y.Hiratsuka	—	Maize	Japan, New Zealand, France, Germany, Yugoslavia, Canada, USA
35	<i>Leptosphaeria</i> <i>avenaria</i> Weber (Conidial state: <i>Septoria avenae</i> Frank)	Leaf blotch, black stem, straw breaking, black groat, kernel blight	Oats, wheat	Africa, Israel, Korea, Australia, Europe, Canada, USA, Brazil, Uruguay
36	<i>Lophodermium</i> <i>canaberrianum</i> Stahel ex Minter & Miller	Needle cast	<i>Pinus</i> <i>engelmannii</i> <i>P. ponderosa</i>	Australia, USA

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Name	Distribution
Coconut	Kenya, Tanzania
Lettuce, endive	Libya, Mauritius, Japan, Lebanon, Philippines, Turkey, Australia, New Zealand, Europe, Canada, USA
Rubber	Mexico, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, Trinidad, South America, Haiti, El Salvador
Cacao	Panama, Columbia, Ecuador, Peru, Venezuela
<i>Linum</i> spp.	Ethiopia, Kenya, Morocco, Tanzania, China, Turkey, Australia, New Zealand, Europe, Canada, Mexico, USA, Argentina, Peru, Brazil, Uruguay
Cotton, citrus, Coffee, Soybean, Tomato, <i>Phaseolus</i> spp.	Africa, Burma, USA, Central America, West Indies, Brazil

No.	Pathogen	Disease	Host	Distribution
46	<i>Phoma exigua</i> Desm. var. <i>exigua</i> & <i>Phoma exigua</i> var. <i>foveata</i> (Foster) Boerema (syn. <i>Phoma solanicola</i> Prill & Delacr.)	Stem canker	Potato	Mexico, Australia, Europe, Canada, USA
47	<i>Phoma medicaginis</i> var. <i>pinodella</i> Malbr. & Roum. (syn. <i>Ascochyta pinodella</i> Jones)	Black stem, leaf spot	Clover, Plum spp.	Europe, USA, Canada
48	<i>Phomopsis juniperivora</i> Hahn	Twig blight	Conifers	Kenya, Mozambique, South Africa, New Zealand, Canada, USA, Uruguay, Tanzania, Europe
49	<i>Phytophthora citricola</i> Savada (syn. <i>Phytophthora Sweden</i> , <i>cactorum</i> (Leb. & Cohn.) Schroet. var. <i>applanata</i> Chester)	Blossom blight, dieback	Citrus spp., Hops, Lilac, Raspberry, <i>Rhododendron</i>	South Africa, Taiwan, Japan, Australia, New Zealand, Germany, UK, Italy, Antilles, Canada, USA, Argentina
50	<i>Phytophthora drechsleri</i> Tucker	Buckeye rot of fruits	Various crops	Egypt, Malagasy Republic, Rhodesia, Japan, Australia, Hawaii, New Zealand, Canada, USA, Argentina, Brazil
51	<i>Phytophthora phaseoli</i> Thaxter	Downy mildew	Lima bean	Zaire, Philippines, Sri Lanka, Italy, Mexico, USA, Puerto Rico
52	<i>Pleioaeta setosa</i> (Kirchn.) Hughes (syn. <i>Ceratophorum setosum</i> Kirchn.)	Brown spot	<i>Crotalaria</i> spp., <i>Cytisus</i> spp., <i>Lupinus</i> spp., <i>Orinthopus</i> spp.	South Africa, Sri Lanka, Israel, Japan, Malaysia, Australia, Europe, USA, Brazil
53	<i>Puccinia allii</i> Rud.	Leaf, stem and fruit spot	Onion	Worldwide
54	<i>Puccinia antirrhini</i> Diet. & Holw.	Rust	<i>Antirrhinum</i> spp.	Africa, Iran, Iraq, Israel, Turkey, Australia, Hawaii,

Host	Distribution
Cabbage, Cauliflower Europe	Japan, Philippines, Australia, New Zealand
Festuca, Lolium, Phleum and Poa spp.	North America, Europe, Australia, New Zealand
Pyrethrum	Belgian Congo, Kenya, Tanzania, new South Wales, UK, Germany, Italy
Barley, Rye	Worldwide
Almond, apricot, apple, pear, cherry, loquat, peach, quince, grapevine	Worldwide
Onion	Mauritius, Hong Kong, Japan, Korea, Australia, New Zealand, Europe, Canada, USA, Brazil
Clover, lucern	Egypt, China, Israel, Japan, Korea, Australia, New Zealand, Europe, Canada, Mexico, USA, Chile
Agropyron spp. Grasses, wild	Australia, New Zealand, North America, Europe, Scandinavia
bean	China, Japan, Nepal, Romania, Canada, USA, Columbia

Sl. No.	Pathogen	Disease	Host	Distribution
64	<i>Septoria helianthi</i> El. & Keil.	Leaf spot	Sunflower	Africa, China, India, Australia, Germany, Hungary, Romania, Argentina, Canada, USA
65	<i>Septoria passerinii</i> Sacc.	Speckled leaf blotch	Barley, Lolium spp.	Africa, Saudi Arabia, Turkey, Australia, Europe, Canada, USA
66	<i>Sorosporium saponariae</i> Rudolphi	Flower smut	<i>Saponaria officinalis</i> , <i>Dianthus</i> spp.	Algeria, Morocco, Pakistan, Australia, Europe, USA, Argentina, Chile
67	<i>Tilletia contraversa</i> (syn. <i>Tilletia brevifaciens</i> Fischer)	Dwarf bunt	Wheat, <i>Aegilops</i> , <i>Agropyron</i> , <i>Bromus</i> , <i>Lolium</i> <i>Poa</i> , <i>Secale</i> spp.	Libya, Afghanistan, Turkey, Argentina, Uruguay
68	<i>Tilletia holci</i> (Westend.) Schroet. (syn. <i>Polycystis holci</i> Westend.; <i>Tilletia rauwenhoffii</i> Fischer V. Waldh.)	Covered smut	<i>Holcus</i> spp., <i>Anthoxanthum odoratum</i>	Europe, USA, New Zealand, Chile, Falkland, Islands
69	<i>Tilletia sphaerococca</i> (Rabenh.) A. Fischer & V. Waldh.	Smut	<i>Agrostis</i> spp.	Europe, Azores, Morocco, Pakistan, New Zealand, USA, Falkland, Islands
70	<i>Urocystis occulta</i> Rabenh.	Stripe or flag smut	Rye, <i>Agropyron</i> spp.	South Africa, Japan, Turkey, Australia, Europe, Canada, USA, Argentina
71	<i>Uromyces betae</i> Klckx	Rust	Sugarbeet	Worldwide
72	<i>Ustilago striiformis</i> (Westend.) Niessl. (syn. <i>Tilletia striiformis</i> (Westend.) Sacc.)	Stripe rust	Grasses	USA, Europe, Asia, New Zealand

Source: Sharma et al, 1990

Table 12.3 Seedborne bacterial pathogens not known to occur in India

Sr.No.	Pathogen	Disease	Host	Distribution
1	<i>Corynebacterium fascians</i> (Tilford) Dowson (syn. <i>Phytomonas fasciens</i> Tilford; <i>Bacterium fasciens</i> (Tilford) Lacey.	Fasciation of sweet pea, leafy gall of Chrysanthemum	Sweet pea, Chrysanthemum and many other hosts	Iran, Europe, Canada, USA
2	<i>Corynebacterium flaccumfaciens</i> pv. <i>betae</i> Dye & Kemp (syn. <i>Corynebacterium betae</i> Keyworth, Howell & Dowson)	Silvering disease	Sugarbeet	UK, Republic of Ireland
3	<i>Corynebacterium flaccumfaciens</i> pv. <i>flaccumfaciens</i> (Hedges) Collins & Jones (syn. <i>Corynebacterium flaccumfaciens</i> (Hedges) Dowson)	Bacterial wilt	Beans, Soybean	Turkey, Australia, Bulgaria, Greece, Hungary, Romania, Yugoslavia, Canada, Mexico, USA
4	<i>Corynebacterium flaccumfaciens</i> pv. <i>poinsettiae</i> (Starr & Pirone) Dye & Kemp	Bacterial canker, leaf spot	Poinsettia, Phaseolus spp., maize	New Zealand, USA, Australia
5	<i>Corynebacterium michiganense</i> pv. <i>insidiosum</i> Dye & Kemp (syn. <i>Corynebacterium insidiosum</i> (Mc Culloch) Jensen)	Bacterial wilt, root rot, heart rot	<i>Medicago</i> spp.	South Africa, Saudi Arabia, Australia, New Zealand, Europe, Canada, Mexico, USA, Brazil
6	<i>Corynebacterium michiganense</i> pv. <i>nebraskense</i> (Schuster et al.) Dye & Kemp	Bacterial canker	Maize, tomato, tobacco, Solanum spp.	USA, Canada, Europe, Australia, Africa, New Zealand

Quarantine

Sr.No.	Pathogen	Disease	Host
7	<p><i>Corynebacterium michiganense</i> pv. <i>sepedonicum</i> Dye & Kemp (syn. <i>Corynebacterium sepedonicum</i> (Spieck & Kotth.) Skapt & Burkh.: <i>Bacterium sepedonicum</i> Spieck & Kotth.)</p>	Ring rot	Potato
8	<p><i>Erwinia rhapontici</i> (Millard) Burkholder</p>	Crown rot	Rhubarb, wheat
9	<p><i>Erwinia stewartii</i> (E.F.Smith) Dye (syn. <i>Aplanobacter stewartii</i> (E.F.Smith) McCulloch; <i>Bacterium stewartii</i> (E.F.Smith); <i>Xanthomonas stewartii</i> (E.F.Smith) Dowson</p>	Root and stalk rot	Maize, <i>Euchlaena mexicana</i> , <i>Tripsacum dactyloides</i>
10	<p><i>Pseudomonas andropogonis</i> (E.F.Smith) Stapp. (syn. <i>Pseudomonas stezobii</i> (Wolf) Stapp.; <i>Pseudomonas woodsii</i> (Smith) Stevens.)</p>	Bacterial leaf spot	Clover, <i>Vicia</i> spp., <i>Sorghum</i> spp., maize, <i>Trifolium</i> spp.
11	<p><i>Pseudomonas oryzaicola</i> Klement</p>	Bacterial browning, brown	Rice

Sr.No.	Pathogen	Disease	Host	Distribution
13	<p><i>Pseudomonas syringae</i> pv. <i>coronafaciens</i> Young, Dye & Wilkie (syn. <i>Pseudomonas coronafaciens</i> (Elliott) Stevens; <i>Bacterium coronafaciens</i> Elliott; <i>Pseudomonas avenae</i> Manns)</p>	<p>Basal glum rot</p>	<p>Wheat, Barley</p>	<p>Morocco, Zimbabwe, South Africa, Australia, New Zealand, Europe, Canada, USA</p>
14	<p><i>Pseudomonas syringae</i> pv. <i>coronafaciens</i> Young, Dye & Wilkie (syn. <i>Pseudomonas coronafaciens</i> Elliott; <i>Pseudomonas avenae</i> Manns)</p>	<p>Halo blight</p>	<p>Oats, <i>Hordeum</i> spp., <i>Triticum</i> spp., <i>Lolium</i> spp.</p>	<p>Japan, Ethiopia, Kenya, Zimbabwe, Australia, New Zealand, Europe, Canada, Mexico, USA, Argentina</p>
15	<p><i>Pseudomonas syringae</i> pv. <i>lachrymans</i> Young, Dye & Wilkie (syn. <i>Pseudomonas lachrymans</i> (E.F. Smith & Bryan) Carsner; <i>Bacterium lachrymans</i> E.F. Smith & Bryan; <i>Bacillus burgeri</i> Potebnia)</p>	<p>Angular leaf spot</p>	<p>Cucurbits, Sorghum</p>	<p>Worldwide</p>
16	<p><i>Pseudomonas syringae</i> pv. <i>maculicola</i> Young, Dye & Wilkie. (syn. <i>Pseudomonas maculicola</i> (McCulloch) Stevens)</p>	<p>Bacterial spot</p>	<p>Cucurbits</p>	<p>Worldwide</p>

Sr.No.	Pathogen	Disease	Host	Distribution
17	<i>Pseudomonas</i> <i>strafaciens</i> pv. <i>strafaciens</i> Young, Dye & Wilkie (syn. <i>Pseudomonas</i> <i>strafaciens</i> (Elliott) Starr & Burkholder	Bacterial stripe, blight	Oats, barley	Zimbabwe, Japan, Korea, Australia, Germany, Canada, USA, Argentina, Colombia
18	<i>Xanthomonas</i> <i>axonopodis</i> Starr & Garces O.	Gummosis	<i>Aconopus</i> spp., <i>Digitaria</i> spp.	Colombia
19	<i>Xanthomonas</i> <i>campestris</i> pv. <i>carotae</i> Dye (syn. <i>Xanthomonas</i> <i>carotae</i> (Kendrick) Dowson; <i>Bacterium</i> <i>carotae</i> ; <i>Phytomonas</i> <i>carotae</i>)	Bacterial blight, bacterial scab	Carrot	South Africa, Australia, Hungary, Italy, Poland, Canada, USA
20	<i>Xanthomonas</i> <i>campestris</i> pv. <i>juglandis</i> Dye (syn. <i>Xanthomonas</i> <i>juglandis</i> (Pierce) Dowson	Bacterial blight	Walnut	Worldwide

Source: Sharma et al, 1990

Table 12.4 Seedborne viruses, mycoplasma and viroides, not known to occur in India

Sr.No.	Pathogen	Host	Distribution
1	Alfalfa mosaic virus	Many hosts	South Africa, Sudan, Iran, Israel, Japan, Australia, Europe, Canada, USA, South America
2	Andean potato mottle virus	Potato	Andean region of South America
3	Arabis mosaic virus	Raspberry, Strawberry, cucumber, lettuce	Europe
4	Arracacha virus A	Arracacha	Peru

Sr.No.	Pathogen	Host	Distribution
5	Arracacha virus B	Arracacha, oca, potato	Peru, Bolivia
6	Artichoke yellow ring spot virus	Artichoke, cardoon, tobacco, French bean	Greece, Italy
7	Asparagus virus 2	Asparagus	USA, Germany, Netherlands, England, Japan
8	Avocado sunblotch viroid	Avocado	Australia, Israel, Peru, South Africa, USA, Venezuela
9	Barley stripe mosaic virus	Barley, wheat	Israel, Japan, Jordon, Pakistan, Europe, Canada, USA, Argentina
10	Black raspberry latent virus	Black raspberry	USA
11	Blueberry leaf mottle virus	Blueberry, <i>Vitis labrusca</i>	Michigan and New York
12	Broad bean stain virus	Broad bean, French bean, pea, clover, <i>Crotalaria spectabilis</i>	Europe, North-West Africa
13	Cacao necrosis virus	Cacao, French bean, sugarbeet	West Nigeria, Ghana West Africa,
14	Cherry leaf roll virus	Cherry, <i>Sambucus racemosa</i> , rhubarb	Europe, USA
15	Cherry rasp leaf virus	Cherry	Canada, USA, Austria, New Zealand, Europe
16	Chicory yellow mottle virus	Chicory, parsley, squash, French bean	Southern Italy
17	Citrus exocortis viroid	Citrus, potato, <i>Gynura</i> spp	Brazile, Argentina, Australia, USA, North Africa
18	Citrus stubborn disease virus	Citrus	Africa, Israel, Lebanon, Syria, Turkey, Europe, USA, Brazil, Surinam
		Clover, chenopodium,	Western USA, Canada