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# Plant Quarantine: An Effective Strategy of Pest Management in India

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## Abstract

*The quantum of import and export of plant commodities have been increased during the recent years, there is a distinct possibility of moving insect pests and diseases from their original native habitation to new location. Cottony cushion scale, woolly aphid, San Jose scale, golden cyst nematode of potatoes, the giant African snail are some exotic pest introduced into our country and cause extensive damage. So to prevent the introduction of exotic pests, diseases and weeds from foreign countries or within country, legal restrictions are enforced commonly known as Quarantine. Plant Quarantine regulatory measures are taken at the national level (Domestic Quarantine) as well as international level (Foreign Quarantine). The enforcement of the quarantine measures is supported by legal enactments, called quarantine laws. It acts as an important tool in excluding pests from the crop. Effective implementation of quarantine is highly emphasized for manage of pests, which in turn helps in maintaining the productivity of crops.*

**Keywords**: Plant quarantine, phytosanitary measures, exotic pests, NBPGR.

## Introduction

The challenge for all disciplines of agriculture is to increases production and improves quality of produce. This is applicable to the discipline of plant protection as well. Now with the liberalization in trade over the years, movement of agricultural commodities has taken place a lot. The responsibility of plant protection also includes addressing phytosanitary issues concerning trade. In the past many diseases are responsible for food scarcities including famines. In addition to endemic problems there are many crop pests which are entered India from other countries Table-1 because in earlier years India did not have an effective control measure (plant quarantine) system to stop the introduction of exotic pests, diseases and weeds. Cottony cushion scale, woolly aphid, San Jose scale, golden cyst nematode of potatoes, the giant African snail are some exotic pest introduced into our country and cause extensive damage. In view of increases in quantum of import and export of plant commodities during the recent years, there is a distinct possibility of moving insect pests and diseases from their original native habitation to new location. One of the methods of crop protection isto excludes the pests from entering in to new area. The method of exclusion of the pests is enforced through certain legal measures commonly known as Quarantine. The term Quarantine as French word literally means 40 day period. Quarantine can be defined "as a legal restriction on the movement of Agricultural commodities for the purpose of exclusion, prevention or delay in the spread of plant pests and diseases in uninfectedareas[1]".

Plant Quarantine regulations are promulgated by the national and the state governments to prevent the introduction and spread of harmful pests and pathogens. Protection of the plant and plant products by quarantine however only become the governments at the turn of this century, following a series of catastrophic pest and diseases epidemics in different parts of the world table-2. Exotic organisms when introduced have caused extensive damage classical examples of introductions of late blight of potato (*Phytopthora infestans*) was one of the famous examples for what an introduced disease can do to change to course of history, which occur in epidemic form in 1845 devastated entire potato crop in Irish leads to millions of people died due to starvation.

## History of Plant Quarantine in India

The quarantine measures are of almost relevance to a country like India whose economy is largely Agriculture based. The awareness to quarantine measures in India started in early 20th century when the Indian Government in 1906, ordered compulsory fumigation of imported cotton bales to prevent the introduction of the dreaded Mexican cotton boll weevil (*Antonymous grandis*). On February 3, 1914 Comprehensive Plant Quarantine Act, known as Destructive Insects and Pests Act, (DIP Act) become operative. Over the years the DIP Act was revised and amended several times. However it needs to be periodically reviewed and amended to meet the growing requirements of liberalized trade under the WTO.

In 1946, the Directorate of Plant Protection, Quarantine and Storage, under the ministry of Food and Agriculture were set up. In 1946, Plant quarantine activity stared with the initiation of plant introduction scheme in the Botany Division at Indian Agricultural Research Institute (IARI) New Delhi. In October 1949, the Directorate started its quarantine activities at Bombay seaport. On December 25, 1951 the first plant Quarantine and

Fumigation station in India was formally inaugurated. In August, 1976 the National Bureau of Plant Genetic Resource (NBPGR) was created. In 1978, the Division of Plant Quarantine was created with Entomology, Plant Pathology and Nematology sections. In October, 1988, the Plants, Fruits and seeds (Regulation of Import into India) order, 1989 popularly known as PFS order came into force.

**Table-1**
**Examples of Pests and Diseases introduced in India from other countries**

| S.No. | Pests | Native Place | Year of introduction |
|---|---|---|---|
| 1 | Coffee rust | Srilanka | 1879 |
| 2 | Late blight of potato | England | 1883 |
| 3 | Flag smut of wheat (*Urocystis tritici*) | Australia | 1906 |
| 4 | Downey mildew of grapes | Europe | 1910 |
| 5 | Rust of chrysanthemum(*Puccinia carthami*) | Japan/Europe | 1904 |
| 6 | Downey mildew of cucurbits (*P. cubensis*) | Srilanka | 1918 |
| 7 | Downey mildew of maize (*S. philippinensis*) | Java | 1912 |
| 8 | Foot rot of Rice (*Fusarium moniliforme*) | South East Asia | 1930 |
| 9 | Black rot of crucifers (*X. campestris*) | Java | 1929 |
| 10 | Leaf spot of sorghum | South Africa | 1934 |
| 11 | Powdery mildew of rubber (*Oidium heveae*) | Malaya | 1938 |
| 12 | Blank Shank of Tobacco (*P. nicotianae*) | Holland | 1938 |
| 13 | Fire blight of pear | England | 1940 |
| 14 | Crown gall of Apple/pear (*A. tumefaciens*) | England | 1940 |
| 15 | Bunchy top virus | Srilanka | 1940 |
| 16 | Canker of apple (*Sphaeropsis* spp.) | Australia | 1943 |
| 17 | Wart of potato (*Synchytrium endobioticum*) | Netherlands | 1953 |
| 18 | Bacterial blight of paddy (*X. oryzae*) | Philippine | 1959 |
| 19 | Golden Nematode of potato | Europe | 1961 |
| 20 | San Jose scale of apple | Italy | 1900 |
| 21 | Wooly aphid of apple | Australia | 1928 |
| 22 | Sunflower downey mildew | Australia | 1985 |

**Table-2**
**Examples of Pests and Diseases which have been introduced world wise**

| S.No. | Pests | Introduced in | Introduced from | Year |
|---|---|---|---|---|
| 1 | Powdery mildew of grape (*Uncinula necator*) | England | USA | 1845 |
| 2 | Downy mildew of grape (*Plasmopara viticola*) | France | USA | 1878 |
| 3 | Golden nematode of potato (*Heterodera rostochinensis*) | USA, Mexica | Europe | 1881 |
| 4 | Citrus canker (*X. citri*) | USA | Asia | 1907 |
| 5 | Blister rustof pine (*Cronartium ribicola*) | USA | Europe | 1910 |
| 6 | Fire blight of apple (*Erwinia amylovora*) | Newzealand | N-America | 1919 |
| 7 | Onion smut (*Urocystis cepulae*) | Switzerland | France | 1924 |
| 8 | Dutch elm (*Ceratostomella ulmi*) | USA | Holland | 1928-1930 |
| 9 | Coffee rust (*Hemilia vastatrix*) | Brazil | Africa and Asia | 1970 |
| 10 | Grape Phylloxera (*Phylloxera vitifoliae*) | France | USA | 1845 |
| 11 | Mexican boll weevil (*Anthonomus grandis)* | USA | Mexica& C-America | 1892 |
| 12 | European corn borer(*Ostrinia nubilalis*) | N-America | Italy | - |

## Plant Quarantine System in India

With a View to provide the farmers the best planting materials available in the world for maximizing productivity per unit area and to encourage the private seed industry in India not only to meet the internal requirements but also to develop export potential for high quality planting materials. The Government of Indian announced a new policy on seed development in

September 1988. The main features of the existing plant quarantine regulations in India are as follows. i. No consignment of seeds /planting materials shall be imported into India without a valid 'import permit ' which is to be issued by a competent authority to be noticed by the central Government from time to time in the official Gazette. ii. No consignment of seeds /planting materials shall be imported into India unless accompanied by a phytosanitary Certificate` issued for the official plant quarantine service of the source country. iii. All consignments of Plants and seeds for sowing propagation /planting purposes shall be imported into India through land customs station, seaport import and such other entry points as may be specifically notified by the central Government from time to time where there shall be inspected by and if necessary, fumigated disinfected by authorized plant quarantine official before quarantine clear once. iv. Seeds /Planting materials requiring isolation grow under deflection shall be grown in post entry quarantine facility approved and certified by the designated inspection Authority (DTP) to conform to the conditions laid down by the plant protection advises to the Govt. of India. v. Hay, straw or any other material of plant origin shall not be used as packing material. vi. Import of soil, earth, sand, compost, and plant deters is accompanying seeds/planting material shall not be permitted. However, soil can be imported for research purpose under a special permit issued by the plant protection advises to the Gov to India. The DIP Act empowers the central Govt. to make rules for regulating the import of seeds/planting materials into India, & also the movements of the material form one state Govt. are also empowered to enact rules/regulation to regular the movement of materials from one region to another with in state.

## Guidelines for Import of Germplasm

In this review article, list of viral pathogens table-3, fungal table-4 and bacterial pathogens Table-5 have been given which are intercepted in India due to germplasm importing. To prevent entry of pathogens through germplasm, following are the guidelines to be considered during import of germplasm. i. Import from a country where the pathogen(s) is absent. ii. Import from a country with an efficient plant quarantine service, so that inspection and treatment is done. iii. Obtain Planting material from the safest known source within the selected country. iv. Obtain non-treated seeds so that detection of seed borne pathogens is facilitated. v. Obtain clean, healthy-looking seeds of type of impurities. vi. Obtain an official certificate of freedom from pests and diseases from the exporting country. vii. Import the smallest possible amount of planting material; the smaller the amount, the less the chance of its carrying infection. It will also simplify post entry inspection. viii. Inspect material carefully on arrival and treat. ix. If other precautions are not adequate, subject the material to intermediate or postentry quarantine. x. Salvage infected seeds.

**Table-3**
**List of Viral pathogens intercepted in germplasm importing**

| Virus | Host | Geographical distribution |
|---|---|---|
| Ficus mosaic virus | *Ficus sp.* (p) | North America |
| Grape fan leaf virus | *Vitis vinifera*(p) | South pacific Asia |
| Mosaic virus | *Jasminum sp, Hibiscus cooperi* (p) | Asia, Europe |
| Pea mosaic virus | *Pisum sativum(s)* | South pacific Asia |
| Orchid virus | *Orchid (p)* | Asia |
| Spotted wilt virus | *Chrysanthemum sp. (p)* | Europe |
| Tobacco mosaic virus | *Dahelia variabilis (t)* | Europe, North America |

s=seeds, t=tubers, p=plants

**Table-4**
**List of fungal pathogens intercepted in germplasm importing**

| Fungal pathogen | Host | Origin |
|---|---|---|
| *Alternaria helianthi* | *Helianthus annus*(S), *Sorghum* sp | North America |
| *Ascochyta gossypii* | *Gossypium sp. (s)* | Africa |
| *Ascochyta rabiei* | *Arachia hypogeal (s)* | Africa |
| *Botrytis fabae* | *Viciafaba (s)* | Asia |
| *Cercospora dolichi* | *Betal leaf* | North America |
| *Drecheslera spicifera* | *Thugaplicatu (s)* | North America |
| *Fusarium avenaceum* | *Celosia sp.* | North America |
| *Coniothyrium fuckelii* | *Rosa spp* | Asia, Europe |
| *Drechslera maydis* | *Sorghum sp. (s), Spinaua oleracea (s) Zea mays (s)* | Europe, North America, South America |
| *Fusarium oxysporumf.sp. gladioli* | *Gladiolus sp. (b)* | Europe |
| *Phoma chrysanthemicola* | *Chrysanthemum sp. (s)* | Europe |
| *Phoma coccoicola* | *Cocos nucifera* | Asia |
| *Puccinia helianthi* | *Helianthus annus (s)* | Africa |
| *Septoria gladioli* | *Gladiolus sp. (s)* | Europe |

S= Seeds, b= Bulbs

**Table-5**
**List of Bacterial pathogens intercepted in germplasm importing**

| Bacteria | Host | Geographical distribution |
|---|---|---|
| *Agrobacterium tumefaciens* | *Rosa sp (p)* | Europe |
| *Corynebacterium michiganense* | *Lycopersicon esculentum (s)* | North America |
| *Erwinia carotovora* | *Solanum tuberosum(t)* | Europe, North America |
| *Erwinia herbicola* | *Helianthus annus (s)* | Europe |
| *Pseudomonas maculicola* | *Brassica oleracea var. capitata (s)* | Europe, North America |
| *Pseudomonas marginatum* | *Gladiolus sp. (b)* | Europe |
| *Pseudomonas pisi* | *Pisumsativum (s)* | Europe, North America |
| *Pseudomonas syringae* | *Cucumissativus (s)* | North America |
| *Xanthomonas campestrispvcitri* | *Citrus sp. (f)* | Asia |

F= flowers, s=seeds, t=tubers, p=plants

## Agencies involved in Plant Quarantine

The authority to implement the quarantine rules and regulation formed under DIP Act rest basically with the Directorate of Plant Protection, Quarantine and Storage, under the ministry of Agriculture. The organization handles bulk import and export of seed and planting material for Commercial purposes. Presently there are total '26'different quarantine stations located 10 at Airports (Amritsar, Bombay, Kolkata, Hyderabad, Chennai, New Delhi, Patna, Tiruchirpally, Trivandrum, Varanasi), 9 at Seaports (Bhavnagar, Mumbai, Kolkata, Cochin, Nagapatnam, Rameshwaram,Tuticorin, Vishakapatnarn) and 7 at Land Frontiers (Amritsar railway station, Attari-Wagha Border, Attari-Raiway station, Bongaon-Benapol border, Gede Road railwaystation, Panitanki, Kalimpong).

On global level, International Plant Protection Convention (IPPC) under FAOwas established to prevent the introduction and spread of diseases and pests through legislation and Organization across international boundaries. This convention provided a model phytosanitary certificates to be adopted by member countries with in this convention ten-region plant protection organization have been refurbished on the basis bio geographical areas.

## N.B.P.G.R.S Responsibilities

As the National Bureau of Plant Genetic Resources (NBPGR), New Delhi has been designated as the national nodal agency for exchange of germless, material of agri-horticultural and Agri-silvicultural crops for research purposes in the country. It has also been entrusted with the quarantine responsibilities in respect to germplams of their crops. The Director of NBPGR has been empowered to issue "Permits" forimports of seeds /planting materials for Research purpose.

## Inspection Procedures followed in quarantine station

Inspection method: i. Visual inspection - To detect sclerotia, nematode galls, buntgalls, smuts, insect infestations, weedseeds insect eggs, inert mater etc. ii. X-ray test - Insect infestation (hidden), iii. Washing test - Spores of fungus eggs of insect adhering toseeds, nematode galls, iv. Sedimentation test - Stem eelwarm (*Ditylenchus dipsaci*)(Baerman Funnel Test), v. Incubation test - Seed borne fungi/ bacteria (Blotter/agar test), vi. Grow out test - Seed borne bacteria/viruses/downy mildews, vii. Electron microscopy - Potentially used for identification andcharacterization of all plant viruses. viii. Serological methods: (a) ELISA (Enzyme Linked Immuno sorbant Assay) (b) DIBA (Dot Immuno-binding Assay) (c) ISEM (Immuno sorbant Electron Micro Scopy) (d) Latex agglutination test. ix. Nucleic acid hybridization, x. Polymarised chain reaction (PCR).

**Plant quarantine measures:** The measures suggested for effective plant quarantine are as follows[2, 3]

**Import control: Regulations of importing country:** i. 1. Embargoes: Total prohibition of import of certain kind of infected material from particular region /country. This is most effective measure to exclude infected plant material. ii. Inspection of seed lots: The examination of seed samples must be by the most sensitive and reliable method for detection of dangerous pathogens. A sample may subject to more than one method. iii. Post Entry Quarantine (PEQ): because it is difficult to detect all types of seed born pathogens by simple tests, it may be necessary to subject seeds to PEQ. Seeds are subjected to a period of grow in quarantine station under strict supervision in importing countries.

**Export control: Regulations of the exporting country:** i. Field inspection of field crops: The seed crop is inspected regularly for diseases, infected plants are rouged. The crop should meet requirements of the importing country. ii. Inspection of seed lots: The seed lot is thoroughly examined for the presence or absence of the microorganisms before export. The sample should meet the importing country. iii. Seed treatment: The seed lot should be treated as per the requirements of the exporting country. However the treatment should confine to regulations of the importing country. iv. Phytosanitary certificate: Phytosanitary certificates are issued by the exporting country along with the seed as per the international plant protection convention of 1951.

**Intermediate quarantine:** This is an international cooperative effort to lower the risk of introducing a pathogen to one country with the germplasm from other by passing this germplasm

through isolation or quarantine in a third country because either the crop is not grown these or the pathogen, even if it escapes, will not become established because of the environment. The third country quarantine locations are Plant quarantine facility, Glenn Dale, US sub. tropical Horticultural Research unit, Miami. Kew botanical Gardens, UK. Royal Imperial institute, Wageningen, Netherlands. IRAT at Nogentsur Marne, France. The US serves as the third country for the international exchange of coffee, tea, rubber and cocoa.

## Review of Domestic Quarantine Regulations

The legislature measures to prevent the introduction and spread of destructive pests of crops are operative through the "Destructive insect and pest act, 1914". The domestic quarantine regulations are operative by the central government through powers vested under section 4A, B & D and section 5 authorizes the state government to enact similar regulations and section 5A provides for the penalties. The first domestic quarantine notification was issued by central, government in 1944 against fluted scale (*Icerya purchasi*) and San Jose scale (*Quadraspidiotus perniciosus*) in 1953. To prevent the spread of Banana bunchy top virus disease from states of Assam, Kerala, Orissa, Tamil Nadu Govt. of India issued a notification in 1951. A notification was issued by the central government in 1959 against potato wart (*Synchytrium endobioticum*) prohibiting the movement of potato from the states of West Bengal. Inorder to prevent the spread of apple scab (*Venturia inequalis*) from state Himachal Pradesh, central government issued a notification in 1977 prohibiting export of planting materials of apple from Himachal Pradesh[4].

## Salvaging of infected material

Keeping in view the importance of germplasm, all efforts are made to salvage the infested/ infected and contaminated germplasm. The methods used for salvagingare mechanical cleaning, hot water treatment, X-ray, radiography, fumigation chemical treatments and growing in isolation of chemically treated seed material[5]. i. Spirit wash: Investigations were made eliminate safflower rust that was intercepted in a consignment consisting of 1474 safflower germplasm samples received for quarantine clearance. This method is recommended for quarantine clearance and seed certification Programme of safflower. ii. Acid wash: Concentrated acid was used for destroying the rust spores of *Uromyces betae* in sugar beet seeds. The contaminated seeds were stirred with a glass rod in the acid for min. iii. Treatment of seed with fungicides to control seed borne pathogen.

## Pest Risk Analysis (PRA) in Plant Quarantine

In view of manifold increase in the quantum of import and export of the plant commodities during the current years, the existing plant quarantine process seem to be far from being satisfactorily equipped. To cope with these difficulties, there hamper free market accessibility to the plant commodities and the quarantine should be based on the PRA[6]. Risk can be defined as expected magnitude of loss.

Hence, pest risk analysis aimed at identifying, quantifying and reporting of the possible management options on account of probable, introduction of a pest along with an imported plant commodity. Analysis of pest risk while introducing seeds planting materials is essential to determine the potential of a pest to cause damage. In general, risks are more with the introduction vegetative propagules than true seed. In case of true seed, risks are more with deep seated infections than surface contaminated seed. Further, risks are more with virus, viroid smuts, downy mildew etc. Risk increases with size of import. Bulk import creates more quarantine problems[7]. i. Complete prohibition: When the pest risk is high and safeguard against it is not available in the country, hence import should be prohibited. ii. High risk -adequate safeguard: The pest risk is very high but adequate safe guard in the form of post entry isolation facilities or salvaging techniques are available. iii. Restricted: Pest risk is not very high and import permit is require indicating condition for entry, inspection and treatment.

## Pest surveillance in Plant Quarantine

As far as quarantine pests are concern we generally discuss about those exotic pests, which have not entered into India but have potential and probability of entering into India through international trade or otherwise we also discuss about the exotic pests, which have already entered, in our country through the movement of imported agricultural material. There are various illegal ways and means by which certain pest shave been introduced in our country and for such pests the plant quarantine regulations are not applicable. Since plant quarantine is legal strategy to restrict the entry of any exotic pest, other possibilities of the entry of exotic pests such as barrier free border, smuggling etc, have largely been ignored. Leaf curl virus of cotton has entered in Rajasthan and Punjab bordering Pakistan during early nineties.

Pest surveillance should be an integral component of plant quarantine services to make them useful and effective. Pest surveillance is essential to detect occurrence of exoticpest/disease in the early stages of their introduction so as to adopted and enforce domestic quarantine regulation to ward off their further spread or to check the movement of seed and seed material to other areas[8].

## Limitations and Constraints

i. Lack of organized services of PQ at state level, ii. Lack of inert state border PQ check posts at railway and road links, iii. Lack of concerned and coercive action at the state Govt. level, iv. Lack of rigorous seed/stack certificates or nursery infection.

## Conclusion

The PQ measures acts as an important tool in excluding pests from the crop. Effective implementation of quarantine is highly emphasized for management of pests, which in turn helps in maintaining the productivity of crops.

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