Proc. Indian natn. Sci. Acad. **B52** No. 1 pp. 165–187 (1986)

Current Status and Future Requirements of Plant Quarantine in India

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The Plant Quarantine System adjusted itself to the changing conditions as it evolved, but the recent changes, which have rather been rapid, have highlighted the weaknesses of the system. The increasing use of small core germplasm, larger plant population/ha, increased pressure to obtain several crops/yr under assured irrigation and improved cultural methods, have greatly increased the possibility of extensive devastation due to exotic pests and pathogens, should they gain entry. Some of the more important problem areas and weaknesses, including the risks in the exchange of international mail, bulk imports for consumption, processing and propagation, as well as in research imports, have been identified and possible solutions suggested. The future needs of plant quarantine would have to take into account the proposed national development plans over the coming decades. The need to increase food production for the increasing population, for the agriculture and forestry based industries, and to meet the growing demands for newer and better propagating materials of plants of economic importance on the one hand and quick transportation of material through jets and insatiable desire to collect, procure and conserve as much as possible of the fast-eroding genetic variability on the other, clearly define the issues before the plant Quarantine System. The national imports shall have to be made only after a very careful consideration of the risks and facilities available; the factors limiting the imports as well as in the export of surplus agricultural produce shall have to be removed; adequate safeguards like the Off-shore Island Quarantine Laboratory and Post-entry Quarantine Nursery facilities shall have to be created; regular Surveillance System for exotic pests and pathogens that could sneak into the country shall have to be developed, etc. In respect of domestic quartantine also, it shall be necessary to establish a suitable organisation to plan, implement and monitor the quarantine activities in the State, co-ordinate with those of the neighbouring States and evaluate their effectiveness. The need for developing suitable literature and publicising the quarantine problems, the justification for the enforced regulations and about the DOs and DONTs for the general public to elicit their co-operation in the national welfare programmes, a national comprehensive and regular Abstracting Service as well as a well organised Pest Identification Service in the country, as required for plant quarantine purposes, has also been highlighted.

Introduction

Unlike other aspects of crop production, the gains accruing from the enforcement of plant quarantine (PQ) regulations are not felt directly with the result that PQ is considered more as a hurdle in the activities of those interested in obtaining plants and plant materials from abroad. The role of PQ, however, is no less important. By protecting the indigenous flora from the possible devastation due to exotic pests and pathogens, PQ contributes in sustaining the production levels. Stalk rot and southern leaf blight of maize, anthracnose and stem canker of soybean, seedling and stem blight of cotton; the hop cyst nematode (Raychaudhuri et al. 1976), the coffee berry borer (Krishnakumar & Renjhen 1968), the bean weevil on seeds of *Phaseolus* spp., the mediterranean fruit fly on apple (Renjhen & Subramanyan 1960) and many more would have been new problems to India with potential for inflicting serious crop losses, had they not been intercepted in imported material.

Current Status

The first recorded plant quarantine measure in India dates back to 1906 when, perceiving the danger of introducing the Mexican boll weevil, *Anthonomus grandis* Boheman, the Government of India directed that all cotton seeds imported from the New World should be admitted into India after fumigation with carbon bisulphide at the port of entry. However, it soon became apparent that cotton was not the only source for bringing in exotic pests and pathogens into the country; the danger through plant imports was equally serious. Consequently, a Committee was constituted in November, 1911 to go into this entire question. The Committee recommended, among other things, that (*a*) plant imports likely to introduce pests should be fumigated; (*b*) importation of plants from foreign countries should be permitted at seven principal ports only; and (*c*) all living plants excepting only cullinary vegetables or fruits intended for consumption and seeds and a few other specified exceptions, should be fumigated with hydrocyanic acid gas at the place of entry. It was assumed that the importation of plants could be regulated under Section 19 of the Sea Customs Act (VII of 1878), but it was found that this Act could not be used in the manner proposed and that a separate legislation was necessary (Fletcher 1921). Consequently, based upon the recommendations of the Committee, the Destructive Insects and Pests Act (DIP Act) to regulate the introduction into India and transport from one State to another in India, of any insect, fungus or other pest which is or may be destructive to crops, was passed on February 3, 1914.

National Plant Quarantine Organisation

When enacted, the DIP Act included a provision under Section 4 empowering the Officers of the Customs Department to implement the rules framed under the Act. These Officers continued to discharge this function till a Central Government Organisation—Directorate of Plant Protection, Quarantine & Storage, headed by the Plant Protection Adviser to the Government of India, was established in 1946. Even though the technical adoption of quarantine measures was recognised to be the responsibility of this Directorate, this activity was started at Bombay only from October, 1949 and the first Plant Quarantine & Fumigation Station (PQFS) at Bombay was formally inaugurated in December, 1951 (Lal 1956). Today this activity has considerably increased and the Directorate maintains PQFS at eight seaports —Bhavnagar, Bombay, Calcutta, Cochin, Madras, Rameshwaram, Tuticorin and Vishakhapatnam; nine airports—Amritsar, Bombay, Calcutta, Madras, New Delhi,

Patna, Tiruchirapalli, Trivandrum and Varanasi; and seven land frontiers—Amritsar Railway Station, Attari-Wagah Border, Attari Railway Station, Bongaon, Gede Road, Kalimpong and Sukhia Pokria. The Quarantine Unit at the Central Plant Protection Training Institute, Hyderabad, looks after the screening of germplasm imported by the International Crops Research Institute for Semi-Arid Tropics on an *ad hoc* basis till the National Bureau of Plant Genetic Resources is able to establish its Station and take over the responsibility (Anonymous 1980).

Each Plant Quarantine & Fumigation Station is manned by qualified and adequately trained staff and is provided with the necessary facilities for atmospheric and low pressure fumigation as well as for other methods of disinfestation/disinfection. The Stations at Bombay, Calcutta and Madras have also been provided with Quarantine Glasshouses for the isolation growing of suspect material under the supervision of a Quarantine Pathologist to ensure its freedom from exotic pests and pathogens. For the use of Quarantine Officers, a comprehensive account of fumigation and other methods of disinfestation of plants and plant materials at India's ports, together with a list of important pests not so far reported from India (Pruthi 1949) are available. Similarly, the details of the mandatory cyanide fumigation of all imported cotton bales have been published by Subramanyan (1956). The work of the Stations is supervised by the Assistant Director (Plant Quarantine) who in turn is responsible to the Plant Protection Adviser to the Government of India.

Since the Directorate can not cope up with the massive export certification of agricultural commodities, the Government of India have authorised various Officers of the Indian Council of Agricultural Research (ICAR), the Central Government and the State Governments to undertake inspection, disinfection and disinfestation, and issue of phytosanitary certificate for the material under export (Anonymous 1980).

Besides the point of entry quarantine service as provided by the Directorate of Plant Protection, Quarantine & Storage, the Government of India have also approved three National Agencies, as recommended by the National High Level Scientific Committee for Plant & Animal Introduction and Quarantine, for the introduction into India of planting material of various crops for experimental purposes. These agencies are—the National Bureau of Plant Genetic Resources (NBPGR), New Delhi (till recently it was the Division of Plant Introduction of the Indian Agricultural Research Institute, New Delhi) for agricultural and horticultural plants; the Forest Research Institute, Dehra Dun for forest plants; and the Botanical Survey of India, Calcutta for ornamental and other plants. These Agencies have developed/are developing adequate quarantine facilities to ensure that the plant materials passing through them are free from pests and pathogens. If some pest or pathogen is detected or suspected, the material is suitably disinfested, if possible, to salvage the valuable introduction, or grown in quarantine isolation to eliminate the risk before making it available to the user scientist in India. Those Agencies also undertake some problem oriented research work for ensuring a smooth exchange of plant materials. A recent publication (Wadhi 1980) summarises the Plant Quarantine Activity of one of these Organisations (NBPGR) over the last quarter century.

Avenues of Pest/Pathogen Introduction

The plants and plant materials can be brought into the country through air, sea or land routes. The source of pest/pathogen introductions, as summarised by Maehler (1973)

can be: *In import by air and sea*—aircraft or ship compartments, stores (food), garbage, cargo and passenger baggage; *in import by land routes*—movement of vehicles and trains carrying goods, passengers and their luggage across the land frontiers; and *in import by mail*—mail bags, parcels, packets and letters.

The arriving passengers and their baggage, cargo, mail, aircrafts, ships and vehicles are checked by the Customs Officers and in the process if plants and plant materials are found, these are referred to the Plant Quarantine and Fumigatilon Stations (PQFS). The material is checked by Quarantine Officers and if found free from pests and pathogens, it is returned to the Customs with the recommendation for its release. The detection of pests or pathogens leads to disinfestation/disinfection, if possible. In case of bulk consignments, where the quarantine risk is worked out in advance, the sample inspection is followed by the prescribed treatment. For example, the arriving trucks laden with dry fruit from Afghanistan are fumigated in special sheds and the arriving cotton bales in barges before bringing them ashore.

Nature of Imports

The nature of material processed at the different PQFS in India can be judged from the information summarised in table 1. Broadly speaking, the imports can be divided into four types, viz., for consumption, for processing, for propagation and for research purposes. The imports for processing include items like cotton bales, coffee beans, cacao seeds, unmanufactured tobacco, hops, etc. for consumption item like dry and fresh fruits, vegetables, spices, arecanut, etc. and for propagation purposes items like nursery stock, orchids, flower bulbs and seeds including those of ornamental plants, potato, flax, eucalyptus, etc. (Pathak & Thaneja 1973, Ramchandani et al. 1971, Renjhen 1962, 1963, 1973). Such imports, according to the rules framed under the DIP Act, are to be made only after obtaining the clearance/import permit from the Plant Protection Adviser to the Government of India, who, while issuing the permit, gets the quarantine risk evaluated. Depending upon the findings, suitable conditions are stipulated and port of entry specified to ensure that the necessary facilities would be available for the clearance of the consignment and to minimise the chances of introducing exotic pests and pathogens with the bulk consignments.

The import for research purposes comprises of a very large variety of plants and plant materials of economically important plants as well as their wild relatives (Appendix I), but the imports are normally in small quantities ranging from a few grams to few kilograms of material. It is canalised through one of the National Agencies where it is subjected to detailed quarantine tests before release. At the NBPGR, the material is carefully checked by scientists of Entomology, Nematology and Plant Pathology Sections using techniques like X-ray radiography, incubation and growing-on tests and specialised nematode extraction techniques. Since the Bureau, which was established in 1976, is in the process of developing its isolation growing facilities, some of the seed material (where seed transmission of virus diseases has been demonstrated) imported for the use of scientists working in Agricultural Universities or Crop Institutes of the ICAR, is released for growing in glasshouse/nethouse at these Centres under the personal supervision of a designated Plant Pathologist who accepts the responsibility of preventing the escape and spread of exotic pathogens, if any is detected, from the material.

Domestic Quarantine

DIP Act empowers the Government of India to (*a*) prohibit or regulate the export

Table 1 *Material processed at Plant Quarantine & Fumigation Stations in India during April 1971 to March 1972*

Commodity		Amritsar	Bombay	Calcutta	Madras	New Delhi	Others
Cotton bales	(N)	—	1,93,221	11,799	13,840	—	49,590
Cotton samples ginned	(N)	—	3,010	—	—	—	—
Unmanufactured tobacco	(T)	—	64.1	—	—	—	4.35 kg
Live plants	(N)	—	1,126	400	706	628	647
	(kg)	—	24	135	32.7	276	—
Cut flowers	(N)	—	1,760	1,355	—	63	17
	(kg)	—	27	28	26	60	—
Bulbs & Tubers	(N)	—	—	66	—	3,000	5
	(kg)	—	44	47	11.5	20	—
Fresh vegetables	(kg)	—	—	25	—	—	—
Fresh fruit	(T)	—	1,457	0.11	0.05	33.78	27,631.25
	(N)	—	—	37	—	—	—
Dry fruit	(T)	51,009	0.2	—	—	—	92.88
Wheat	(T)	—	—	—	—	—	97,571
Rice	(T)	—	—	0.5	—	—	56,347
Chicory seed	(T)	—	6.25	—	2.68	—	—
Seed potato	(T)	—	—	214	—	—	233.47
Rubber seed	(N)	—	—	—	4,50,840	—	—
Cocoa seed	(kg)	—	—	—	1,350	—	—
fermented beans	(kg)	—	636.45	—	7,107	—	—
Oil palm seed	(N)	—	—	—	73,500	—	—
	(kg)	—	—	—	500	—	—
Seed	(kg)	—	316	66	4,728.73	489	20.86
Heather sprigs	(N)	—	—	200	—	—	—
Coconuts (nuts)	(N)	—	—	—	129	—	—
	(kg)	—	—	—	110	—	—
Misc.	(kg)	—	—	—	27.5	—	—

Source: Plant Quarantine Information for Customs Authorities issued by Dte. P P Q & S, Faridabad
*Others include Bhavnagar, Cochin, Hussainiwala, Rameshwaram, Sukhia Pokrie, Tiruchirapalli, Tuticorin and Vishakhapatnam
N, Number; *T*, Tonnes; *kg*, Kilogram

from a State/Union Territory or the transport from one State/Union Territory, to another within India, of any article or class of articles likely to cause infection to any crop or of insects generally or of any class of insects; and (*b*) to make rules for detention, inspection, disinfestation or destruction of any insect or class of insects or of any article or class of articles which have been regulated or of any article which may have been in contact or proximity thereto, and for regulating the powers and duties of the officers whom it may appoint in this behalf. But the powers of the Central Government to

act in the State or Union Territory are very limited; agriculture and forestry being the State subjects. The Central Government can claim no right of entry to any private property or control over the movement of plants and plant materials wholly within the State, or compel for the destruction of infested material not connected with inter-State trade. The two have, therefore, to work together for the success of domestic quarantine programmes.

All States (except Assam, Jammu & Kashmir, Meghalaya and Nagaland) and Union Territories (except Arunachal and Mizoram) have the State Pests & Diseases Act (Joshi 1974) which empowers the Government to notify the potentially dangerous and destructive pests, plant diseases and noxious weeds and allows for collective action to be taken against them by the farmers on a community basis. It also provides for the notification of measures necessary to prevent their further spread, the appointment of necessary staff for supervising the effective implementation of the notified measures and penalties. These Acts also empower the respective Governments to take appropriate action directly and to recover the cost as arrears of land revenue.

Domestic Quarantine Regulations

Both the Central as well as the State Governments have issued domestic quarantine notifications, which regulate the movement of certain articles or class of articles from the infected area to the rest of the State or country, except through certain specified routes (Anonymous 1976). The Central Government notifications have been issued to ensure:

(*i*) against the dispersal of fluted scale, *Icerya purchasi* Maskell from Kerala, Karnataka and Tamilnadu (infected area) to the rest of the country;

(*ii*) against the spread of San Jose Scale, *Quadraspidiotus perniciosus* Comstock, from Jammu & Kashmir, Himachal Pradesh, Punjab, Uttar Pradesh, West Bengal, Assam, Orissa and Tamilnadu, to the rest of the country;

(*iii*) against the spread of banana bunchy top disease from Assam, Kerala, Orissa, Tamilnadu and West Bengal, to the rest of the country;

(*iv*) against the spread of mosaic disease of banana from Gujarat and Maharastra, to the rest of the country;

(*v*) against the spread of wart disease of potato caused by *Synchytrium endobioticum* from West Bengal, to the rest of the country;

(*vi*) against the spread of apple scab disease caused by *Venturia inaequalis* from Jammu & Kashmir State, to the rest of the country; and

(*vii*) against the spread of pests and diseases with the movement of plants and plant materials from the mainland to the Andaman and Nicobar Islands.

Once the pest or disease is notified, the specified host material moving out of the State/Union Territory has to be accompanied by a certificate of health from the State Authorities to the effect that it is free from the notified pest or disease. The notifications issued by the State Governments relate to the golden nematode (*Globodera rostochiensis*), the apple scab (*Venturia inaequalis*), the codling moth (*Carpocapsa pomonella*), wart disease (*Synchytrium endobioticum*). These notifications no doubt regulate the movement of infected material (Anonymous 1976) but their implementation needs to be made more effective. A survey conducted in the United States of America (Jones 1972) proved that certification (of commodity under movement) is not being attained when inspection is not enforced. The shippers and transporters are apathetic about compliance with unenforced regulations. This sums up the present position of the domestic quarantine regulations in India.

Some Problem Areas and Deficiencies

Every system has strengths and weaknesses and it is through continuous efforts to modify it to suit the changing needs that an effective system takes shape. Plant Quarantine system is no exception. It has so far served the country well, but in view of the quick movement of material and the global urge to acquire maximum crop variability, certain weaknesses and deficiencies have surfaced which need to be looked into. Some of these are discussed below:

1. Seeds

Among the definitions in the DIP Act, the word 'crop' has been defined to cover 'all agricultural or horticultural crops and all trees, bushes or plants'. Similarly in the rules framed under the Act, the word 'plant' is defined as a 'living plant or part thereof but does not include seeds' (Anonymous 1976). Thus except for the seeds of berseem, *Castanea*, *Citrus*, cocoa, coconut, coffee, cotton, flax, groundnut, mexican jumping beans, *Pinus*, rubber, sugarcane, sunflower, *Theobroma*, tobacco and *Ulmus*, the import of which is specifically regulated/restricted, all other seeds can freely be imported in small quantities.

While drafting the rules for the import of 'plants' into India, perhaps it was not considered necessary to cover *seeds* also in the definition may be because this dormant stage of plants was considered to be very safe and normally free from pests and pathogens. However, considerable information has since been published (Phatak 1974, Neergaard 1977, Richardson 1979, Wadhi 1967, Wadhi & Verma 1971, 1975, Taylor 1977 etc.) about the seed transmission of viral, fungal, bacterial and other pathogens as well as pests, demonstrating beyond any doubt the role seeds can play in spreading serious plant pests and pathogens. For example, diseases like dwarf bunt (*Tilletia contraversa*) of wheat, bacterial wilt (*Xanthomonas stewartii*) of maize, downy mildew (*Plasmopara halstedii*) of sunflower, blue mould (*Peronospora tabacina*) of tobacco, fire blight (*Erwinia amylovora*) of pears and apples, all of which are seed borne and known to be serious, have not so far been reported from India and no effort would be too great to prevent their introduction (Raychaudhuri et al. 1976).

The seeds may carry pests and pathogens as concomitant contamination on debris or soil; on the surface; or within (Kahn 1977, Sanwal & Mathur 1975). Since the movement of seeds is a must, the only course open is to enlarge the definition of 'plants' to cover seeds also. In cases where grains can also be used as seed, the former shall also have to be taken care of.

2. Disembarcation Card

Passengers visiting abroad often bring plants and plant materials on their return including even those items the import of which is prohibited or regulated. At times the arriving passengers are asked if they are carrying any plants or plant materials, the replies of the travel-weary passengers, often enough, are in the negative even though such may not be the case. The response, however, can be more factual if the passengers are required to make a written declaration. This procedure is already in vogue in many countries where a clause to this effect has been incorporated in the disembarcation card. In India too, this procedure, if adopted, could greatly help in the better implementation of the quarantine regulations in force.

3. Agricultural Imports

The agricultural imports, as stated above, can broadly be grouped as imports for consumption, imports for processing, imports for propagation and imports for research purposes. While the first three groups are

usually imported in bulk and comprise of relatively small variety, the imports of the fourth group comprise of a very great variety but the quantity per variety is very small. Some of the problems in agricultural imports are:

(*a*) *Import for consumption*: Such imports include items like wheat, rice, milo, mungbean, dry and fresh fruits, etc. These imports, being in bulk, receive only a sample inspection or minimal quarantine attention. Perhaps this procedure is justified because commodities are meant for consumption although there is no mechanism to prevent part of it from being used for propagation. It is often argued that wheat imports into India in very small quantities (about 5–20 g per cultivar) for research purposes are subjected to very rigid quarantine tests whereas millions of tonnes imported for consumption is let off with little or no quarantine tests. The point is well taken. Both types of imports can be used for propagation purposes and the risk of spreading exotic pests and pathogens is similar. Since it would not be prudent to relax vigil on wheat imports for research purposes for obvious reasons (Wadhi et al. 1978), it would be necessary to take the minimal quarantine precautions for bulk imports which can be used for propagation. It has been suggested (Wadhi 1982) that the bulk imports of foodgrains be subjected to a compulsory (*i*) fumigation, and (*ii*) mechanical cleaning, immediately upon import as a quarantine precaution to eliminate pests and contaminants like plant debris, soil clods and weed seeds that maybe present in the shipment. Further, the cleaned foodgrains should be stored separately from the indigenous produce and issued *only* to processing units for conversion into products and subsequent marketing. For example, imported wheat could be converted into flour, shorts and midlings (*atta, suji, maida* and *dalia*); rice could be husked and polished or parboiled; mungbeans could be split and marketed as splitbeans (*dals*); etc. The objective of such processing is to minimise the possibility of the imported material being used for propagation.

(*b*) *Import for processing*: Imports of industrial raw material for processing include items like cotton, unmanufactured tobacco, cocoa beans, chicory seed, etc. In case of such imports also, it would be necessary to fumigate the shipment upon arrival and devitalise it to make it useless for propagation purposes. Alternatively, the material could be fumigated and released to the industry for processing under quarantine supervision; the quarantine playing a role somewhat similar to that played by the Excise Department in respect of indigenous production of excisable goods (Wadhi 1982). The objective of such a procedure is to ensure that the imported material is used for the purpose it is imported for. It is on record that the wheat imported into Mexico from Australia, under a certificate for milling purposes only, was so temptingly plump that some of it was sown thus by-passing the strict Mexican quarantine against flag smut of wheat. The disease thus introduced cuased 15–40% crop loss in certain areas in 1950 (Stakmann 1969).

(*c*) *Import for Propagation*: Imports for propagation include items like bulbs, tubers, cuttings, live plants, seeds, etc. Of course, while issuing permits authorising such imports the pest and pathogen risk involved is carefully considered and suitable safeguards are stipulated, but the very size of the consignment and its perishable nature makes it difficult to subject it to a detailed check. The material goes almost straight to the consignee for planting. This category of material presents the most serious quarantine risk and gets only minimal quarantine attention. It is also true that new material must also be constantly introduced to take advantage of the improvements being made elsewhere. The policy, therefore, should be to import only nucleus material, grow it under quarantine conditions and release only the

healthy material or its progeny. Hence, the available glasshouse/nethouse space should determine the quantum of imports or conversely, the quantum of imports should decide the glasshouse/nethouse space required before the import is actually authorised. In other words, if the country or trader desires to introduce material in bulk, commensurate glasshouse/nethouse space should first be created, got approved from the Plant Protection Adviser to the Government of India, so that the material upon arrival can be grown in isolation. Only when it is certified to be free from exotic pests and pathogens should it be released for multiplication and marketing.

(*d*) *Imports for Research Purposes*: In view of the emphasis on developing high yielding and better suited varieties of crop plants, there is an increasing demand for the genetic variability to work upon. Also, with the increasing use of new varieties, the original variability is fast getting eroded. Hence, there is an urgent need to collect and conserve as much variability as possible before it gets lost to humanity. Inherent in this activity is the quarantine risk. As stated above, NBPGR processes the exchange of agricultural and horticultural plants and plant materials required for research purposes. The quantity of material, though small, is more than made up by its variety. Certain problems encountered in its processing are briefly as follows:

(*i*) *Repeat Introductions*: It is quite common that the same material is imported from the same source repeatedly. Import of *Leucaena leucocephala* seed is one example. It will be seen from table 2 that during 1982 seeds of this plant were imported in 8 and 147 lots from Australia and U.S.A., respectively. Included in seed imports from the U.S. are 45 lots of cultivar K-8 (404037) and 65 lots of cultivar K-29 (281608). *Leucaena* spp. seeds are subjected to X-ray radiography upon arrival in view of the likely presence of hidden infestation. The processing of the incoming seed revealed the presence of infestation due to (*a*) a new species of Bruchidae, and (*b*) *Araecerus levipennis* Jordan, in many seed lots. Both these species have not so far been reported from India. The pathological examination also brought out the presence of *Ascochyta pinodella*, *Fusarium oxysporum* and *Phomopsis* sp. (Arora et al. 1984). Such repeated introduction of the same material from the same source not only increases the avoidable workload, heavily taxes the meagre resources and delays the clearance of material from the Quarantine Laboratory, but also considerably increases the chances of escape of exotic pests and pathogens. The best course would be to introduce the desired material once, get it cleared from quarantine angle, multiply it adequately within the country and supply the seed from the indigenous produce.

Table 2 Leucaena leucocephala *seed imports through the National Bureau of Plant Genetic Resources during 1982*

(Number of samples)

S. No.	Cultivar	Australia	U.S.A.
1.	K-4 (284758)	—	1
2.	K-5 (280122)	—	1
3.	K-8 (404037)	2	45
4.	K-28 (435912)	1	65
5.	K-29 (281608)	—	3
6.	K-45 (282458)	—	2
7.	K-67 (435913)	1	12
8.	K-94 (308544)	—	3
9.	Peruvian (18614)	2	7
10.	Hawaiian	—	1
11.	Cunnigham (414771)	2	7
	Total	8	147

(*ii*) *Unplanned Introductions*: Every year thousands of samples of a wide variety of plant materials are processed in the NBPGR. Except for the Trial material coming from the

International Institutes like the International Maize and Wheat Improvement Centre (CIMMYT) in Mexico, the International Centre for Agricultural Research in Dry Areas (ICARDA) in Syria, the Asian Vegetable Research and Development Centre (AVRDC) in Taiwan, or from the Food and Agriculture Organisation of the United Nations (FAO) in Italy, the quarantine staff does not get any advance intimation about the arriving material. Because of the diverse nature of the material it is also not possible to equip oneself with the background information of the pests and pathogens that can be present on every type of material and be prepared to decide in advance as to which detection and disinfestation/disinfection procedure would be most suited. For example, the material processed in the Quarantine Laboratory during 1975 included seeds of 44 different species of *Digitaria*, 26 of *Indigofera*, 34 of *Medicago*, 41 of *Nicotiana*, 44 of *Paspalum*, 23 of *Setaria*, 86 of *Solanum* and 75 of *Trifolium* (Appendix I). A reference to the Dictionary of Economic Plants by Uphof (1968) revealed that 8, 2, 9, 4, 5, 4, 8 and 19 species of these genera, respectively, have been listed as economically important. The remaining species, which may not be important from crop production viewpoint, are wild relatives of the cultivated ones and useful in the crop improvement programmes. It is, therefore, not surprising to find from the literature that pests and pathogens of plants of these species have not been worked out. The absence of this necessary information leads either to the release of the introduced material after superficial examination or to holding it for growing in quarantine isolation. For the latter course the meagre facilities and resources become the limiting factor. This problem can be resolved if the imports are carefully planned in consultation with the Plant Quarantine Staff.

(*iii*) *Quantity to be Imported*: Normally the imports for research purposes are made in small quantities but many times large quantities have also been imported. In such cases there are two major problems. Firstly, the inspection has to be made on a sample basis even though this procedure is far from satisfactory. Secondly, it is now generally recognised that the seeds which were considered to be relatively safe, can carry a large variety of fungal, bacterial and viral pathogens as well as pests. Therefore, as far as possible, only minimal quantities should be imported. When large quantities have got to be imported, each case should be very carefully considered for the possible risks and only such material should be imported where there is either no risk or the risk involved could be effectively eliminated by some means.

(*iv*) *Seed Transmission of Virus Diseases*: Increasing variety of seeds has been shown to transmit virus diseases of economic significance. The list (Bos 1977) includes 67 plant genera of economic importance representing 31 Natural Orders with Leguminosae accounting for the largest number. The intensification of work on grain and fodder legumes in particular and other legumes in general, necessitates considerable exchange of genetic variability which has greatly increased the risk of introducing exotic viruses with the imported seed. The problem is more acute because the viruses in the infected embryos seem to survive storage for as long as the seed remains viable. It is on record that Bean Common Mosaic Virus was detected in a seedling grown from bean seeds stored for 30 years (Pierce & Hungerford 1929). Hence, both freshly harvested as well as those held in long term storage can carry infection unless these are produced under virus free conditions.

For long it was considered safe to import planting material from Research Institutions and Government Organisations because it was supposed to have been produced under

best possible conditions. However, some reputed Research Institutes and Organisations, while supplying seed of plants where seed transmission of viruses has been demonstrated, have started issuing warnings (Appendix II). Since genetic variability has got to be introduced and made available for the crop improvement programme, the only course open to plant quarantine is to grow such exotic material in isolation and salvage the healthy material through tissue culture or other advanced techniques; but this is expensive, time consuming and laborious process. The imports should therefore be made after very careful considerations of the national needs.

(*v*) *Pre-export Seed Treatment*: In the quarantine examination of seed, the presence of seed discolouration, malformation, shrivelling, fructifications of pathogens, spores, sclerotia, etc., provide a very useful clue to the health status of the material, but often large number of seed samples under import are given heavy pesticidal coatings and at times even dyes are added to impart colour to the treated seed. Such seed can hardly be recognised as to which plant it belongs to and the external symptoms of the likely presence of pathogens are completely masked. In fact, there have been instances when soil clods and weed seeds present as contaminants in the seed sample, also received the coating and looked very similar to the seed under import.

The fungicidal treatment can act in one of the three ways: (*a*) it may kill the inoculum of the pathogen, or (*b*) it may have no effect on the inoculum, or (*c*) it may act as fungistat i.e., so long the chemical is present, it will in most cases, not allow the pathogen to develop. But once the action of the chemical is lost or removed, the pathogen may develop and create problems. As long as the given treatment behaves as at (*a*) above, there is no problem. But if it behaves as at (*b*) or (*c*) above, the quarantine problem is there. To determine if the fungicidal treatment is ineffective or does not allow the fungal inoculum to develop, some heavily treated imported seed samples were incubated by blotter method in the Quarantine Laboratory after three washings with acetone to remove the chemicals. The washed seeds were found to carry viable inoculum of a variety of pathogens (table 3) thus demonstrating the inadequacy of the treatment. Similar unwashed seeds did not show the pathogens (Majumdar et al. 1980). Besides the masking effect of the treatment, the chemicals used for treating can also be a source for health hazards for the quarantine workers who examine the material. "The treated seed can even be

Table 3 *Pathogens detected from seeds given pre-export seed treatment**

(*Source :* Majumdar et al. 1980)

Seed	Origin	Preexport treatment	Pathogen detected
Maize	Pakistan	Vitavax	*Drechslera maydis*
	U.S.A.	Not specified	*Drechslera maydis*
Sorghum	U.S.A.	Not specified	*Drechslera maydis*
Soybean	U.S.A.	Not specified	*Colletotrichum dematium*, *Phomopsis phaseolorum*, *Cercospora kikuchii*, *Verticillium* sp.
Barley	Canada	Mercury dust	*Drechslera sorokiniana*

* Before testing the seeds were given a thorough wash with three aliquots of acetone to remove the treatment

denied entry into the United States because it becomes impossible to ascertain the (quarantine) risk involved in such imports" (Kahn 1977).

The pre-export seed treatment, unless given after determining the health status of the seed, not only it does not serve the purpose of killing the seed-borne inoculum, but also interferes with the seed health testing work in the importing country. Thus even for seed which could normally be tested for their health status in the laboratory, pre-export treatment makes it necessary to subject the material to growing-on tests. Therefore, unless the foreign suppliers co-operate by supplying untreated seed, the growing-on tests have to be carried out for such seed. This procedure would not only require the imports to be staggered to accomodate in the growing space available, but would also greatly delay the clearance and reduce the quantity/variety that could be so processed.

4. Import through Mail

It is quite common to send small samples of seed and other plant material for vegetative propagation by letter or parcel post. The material once posted is delivered to the consignee without the latter having to exert for getting it cleared from the Customs or Plant Quarantine. This method is thus convenient as well as less expensive than if the material is to be sent by air freight. The quantum of international mail received in most countries is so large that it is extremely difficult to examine even a part of it. In many countries, including the developed ones, only a percentage of the incoming mail is examined and it is not infrequent to receive packets containing plants and plant materials without their having been checked by Plant Quarantine. The inherent risks of introducing exotic pests and pathogens through this channel were recognised very early and the rules for regulating the import of plants into British India, as promulgated through notification dated July 20, 1936, stated that 'no plants shall be imported by means of letter or sample post'. At that time perhaps the quantum of mail received in the country was small and also the means of transporting it were not fast enough to attract plants and plant materials. Today, however, this method is cheap, convenient and fast. It is understandable as to why it is being used for the exchange of plant material. This channel needs to be properly monitored and the necessary regulations for doing so are there. In this connection two suggestions have been made:

(*i*) *Use of Coloured Labels*: Everyone is familiar with the airmail label or the airmail envelope. The moment one sees it, it is clear that the item is to be or has been carried by air. This very principle of using coloured labels/stickers has been suggested (Wadhi 1982) for letters/packets containing plant material before these are handed over at the Post Office of origin. A suitable colour code for these labels can be evolved through the good offices of international organisations like the International Postal Union (IPU), the International Plant Protection Convention (IPPC), the International Board of Plant Genetic Resources (IBPGR), the FAO, etc. When the arriving mail is subjected to sorting in the destination country, the letters/packets bearing such lables/stickers would catch the eye of the sorters and can easily be sorted into a separate bag which could be sent to the Plant Quarantine Authorities for checking. However, it would be necessary to ensure that the sender affixes such labels. This can be achieved through intensive publicity and if it still does not work, suitable fines could be imposed on persons who wilfully violate this requirement.

(*ii*) *X-ray Screening of International Mail*: Many countries today are using X-rays for screening the baggage of international passengers at the airports. A similar screening procedure for the incoming international mail

can be used to detect the presence of plants and plant materials in items of the mail. By using an X-ray plant connected to a closed circuit TV and located over a conveyor system carrying the mail, it can be possible to separate the suspected packages for detailed examination just by monitoring the TV screen (Wadhi 1983). Such packages can then be seen by the Plant Quarantine.

5. Checking of Violations

The rules framed by the Government of India are, by and large, observed by the common man and violations, if any, are through ignorance. These can be reduced through publicity of the requirements. However, there is always a section of the public that wilfully bends or violates the rules and it is these persons who need to be dealt with severely. Meaningful penalties would have to be stipulated which could act as deterrents. As it stands today, the Section 4 of the DIP Act provides that a notification issued under Section 3 shall operate as if it has been issued under Section 19 of the Sea Customs Act, which in turn provides for the confiscation of the goods imported in contravention to the rules enforced. Mere confiscation of the goods, however, is not enough. Also Section 5A of the DIP Act provides for penalties for wilful violations of the rules but these relate to domestic quarantine only. This deficiency needs to be corrected.

6. Public Co-operation

Public co-operation is a vital factor in the successful implementation of a community welfare programme like the international and domestic quarantine. To ensure public co-operation, it is necessary that public recognises the reason for the formulated regulations as well as for the presence of regulatory staff. They should also know the consequences and how best these could be avoided. These objectives can be achieved by giving wide publicity to the dangers due to pests and pathogens of quarantine significance, their biology and potential for damage, their area of occurrence and means of spread, measures necessary to contain or eliminate them, etc. The publicity can be made by projecting short films in theatres, on television, in schools and colleges, etc.; by providing suitably prepared literature to students, extension workers and tourists along with literature of tourist interest, etc.

7. Implementation of Domestic Quarantine Regulations

The notifications regarding the domestic quarantine regulations give the relevant details about the infected area, the articles that can spread the pest or pathogens, the land routes, the rail routes and the waterways to be used for the transport of notified articles, etc. (Anonymous 1976). But these instructions are not well known and the implementation also needs to be made more effective. Intensive publicity of the regulations together with instructions to the public and those engaged in transport business as to what they should do and what they should not do is the prime need. Equally important is the need for a system of enforcement to ensure that the regulations are being observed both in letter as well as in spirit.

8. Additional Safeguards

In India the organised sector markets the bulk of certified seed and vegetatively propagated material, but the certificate covering the material normally does not include any information about the health status of the material. The inclusion of this information in the certificate would not only help to bolster the confidence of the users, but would also considerably help in preventing the spread of seed-borne pests and pathogens with shipments of certified seed from areas of production to the areas of use. Of course, this leaves out the small sector, but as the

seed health certification facilities develop in the country, such certificates can be made compulsory for all who are in this trade. The eventual intensive publicity of this requirement would make the users aware of the likely problems and the benefits they derive through its use. The farmers in India today are far more enlightened than what they were say twenty years ago and it should not be difficult to achieve this objective.

Future Requirements

International Quarantine

An effective plant quarantine system presupposes that the pest and pathogen risk in the proposed imports would be evaluated before the imports are authorised; only minimum imports would be allowed; the plant quarantine agencies would always remain alert for the unknown and unrecorded pests and pathogens as well as for the symptomless carriers because they constitute the greatest risk; that in case of suspected material isolation growing or multiplication of healthy material through tissue culture or other techniques would be resorted to, etc. But to achieve the desired objectives, the system requires adequate back-up support, resources and facilities. While the basic facilities and organisation are already available in the country, it would be necessary to strengthen them. However, there are certain aspects, which if started, would make the system more effective to meet the challenges of tomorrow. Some of the more important aspects and the role they would play are discussed below:

1. Regional Co-operation

The countries of the Indian Sub-Continent viz, Pakistan, India, Nepal, Bhutan and Bangladesh, because of their contiguous cropping areas, similar cultivation practices, identical cropping patterns and near similar pest and disease situation on either side of the international borders, have similar quarantine problems. In the absence of geographical barriers the national plant quarantine organisations can do little to prevent the natural spread of the pests and pathogens from one side of the border to the other. For example, the unwitting introduction of the weed *Parthenium hysterophorus*, into the country with bulk imports and its rapid spread from end to end can hardly be expected to respect the international borders. Again as per the recommendations of the South East Asia & Pacific Region Plant Protection Committee (Reddy 1978), the quarantine regulations for the import of potato into the South Asian countries relates to three pathogens—the wart disease caused by *Synchytrium endobioticum*, the bacterial ring rot caused by *Corynebacterium sepidonicum*, and the golden nematode *Globodera* (*Heterodera*) *rostochiensis*, and a pest—the Colorado potato beetle, *Leptinotarsa decemlineata*. But besides these four quarantinable objects there are other pests like Andean potato weevils (*Premnotrypes* spp.), tuber moths (*Gnorimoschema plaesiosema, G. gudmanella*), the weevil (*Epicaerus cognatus*) and pathogens like the deforming rust (*Ascidium cantensis*), Andean rust (*Puccinia pittieriana*), black blight (*Phoma macrospora*), smut (*Thecaphora solani*), gangrene (*Phoma exigua* var. *feviata*), the viruses—Andean Potato latent virus, Andean Potao Mottle virus, etc. which have still not been reported from the region (Ramnath et al. 1979). Any laxity on the part of countries of the region leading to the entry of any of these pests or pathogens can result in devastating consequences. The situation can perhaps be remedied through close co-operation between the countries and by their agreeing to import the needed material through a common regional quarantine agency suitably located and adequately staffed and funded. Such

a centre can handle all the high risk imports into the region and ensure that only pest and disease free material is released for use in the constituent countries. The Centre, besides bringing a uniformity of approach to quarantinable objects, can serve effectively at less cost, can serve as a Training Centre for the quarantine staff, and as a clearing house for quarantine information for the member countries. No doubt the attempt would be new to the region and may run into initial difficulties, the concept is not new; it is already in practice in Malayasia and Africa among the developing countries. Such a centre can be located on one of the Islands in Andaman & Nicobar group or at some other convenient place.

2. National Body

One of the most important future requirement for Plant Quarantine in India is the setting up of a National Body which should decide as to what should be imported, in how much quantity and under what conditions. To enable it to decide on this matter, all information regarding the need, quantity proposed to be imported, origin, pest and disease risk in the import, possible measures to eliminate the risk, etc., should be placed before it. This body should also take the decision if repetitive imports can be allowed or only one time imports can be made. Today, except for the bulk imports for consumption and processing, which become necessary on annual basis, there seems to be no import policy. For example, the bulk import of flower bulbs every year or the repetitive import of cotton seed, soybean or other crops from the same source, is a regular feature. Even for a crop like sunflower the seeds of which can carry the pathogen *Plasmopara halstedii* necessitating isolation growing (Leppik 1962), is imported as replicated trials without even consulting Plant Quarantine to ascertain if isolation growing facilities would be available. In this context the National Body can play a very significant role. It can allow only new cultivars to be imported and if isolation growing is necessary, in quantities that can be accommodated in the available post-entry quarantine facilities.

3. Plant Quarantine Research & Training Institute

During the last fifteen years the progressive adoption of high yielding varieties and the technology for intensive agriculture has led to substantial increase in production level. In the coming years, it is hoped, the production would further increase substantially. Already the problems of scarcity of yester years have given way to problems of plenty and there is increasing pressure to develop newer markets for our surplus. Even if foreign markets are identified the presence of pests and pathogens can limit the exports. The presence of fruit fly infestation in fresh fruit and vegetables, karnal bunt on wheat or pests in shipments of walnut, are but a few examples. To make full use of the indigenous produce, it is necessary to develop techniques which can assure the foreign buyers of the freedom of the material from pests and pathogens. Similarly, in the case of imports, especially those for research purposes, it would be necessary to develop suitable disinfestation/disinfection or other procedures so that the valuable germplasm procured with difficulty and imported at considerable expense could be salvaged despite the presence of exotic pests and pathogens. To carry out such activities and to develop adequate back-up support for the plant quarantine workers including preparation of keys for the identification of pests, checklists of indigenous pests and pathogens, suitable publicity material for quarantine pests and pathogens, surveillance work in areas where introduced plants and plant materials are grown, etc., it would be essential

to set up a Plant Quarantine Research & Training Institute with adequate staff, facilities and funds.

Training in Plant Quarantine is another important aspect for which adequate facilities do not exist in the country. There is only an occasional short course in Plant Quarantine offerred by the Central Plant Protection Training Institute, Hyderabad (Anonymous 1980) although there is need for training in detection procedures, identification of pests and pathogens intercepted, seed health testing methods, fumigation techniques and other procedures for disinfestation, techniques for salvaging, requirements of isolation growing, etc. With the increased quarantine activity in the coming years the need for training would be felt even more–both for fresh entrants as well as for refresher courses. These requirements can also be met by the proposed Plant Quarantine Research & Training Institute.

4. Off-shore Island Quarantine Laboratory

Establishment of an off-shore Island Quarantine Laboratory would provide a facility for the isolation growing of exotic high pest and pathogen risk imports which have to be made for the improvement of indigenous cultivars. The introduced material can be grown under quarantine supervision and tested for freedom from exotic pests and pathogens before it is brought to the mainland. Such a procedure is particularly justified in view of the economic importance of crops where even the chance introduction could lead to serious consequences. For example, the need for coconut germplasm cannot easily be met because of the incidence of a large number of serious diseases including about a dozen of unknown etiology. Such high risk introductions, however, can be made either through third country quarantine or through off-shore Island Laboratory facility. The former can only be a specific arrangement while the latter can be used for a variety of material as per national needs.

5. Chain of Post-entry Quarantine Nurseries

With the increasing knowledge on seed transmission of pests and pathogens, seeds are no longer considered to be as safe a means of introducing plants as they were once thought to be. While many seed-borne pests and pathogens can be detected through laboratory tests and eliminated through the use of available disinfestation procedures, large number can only be detected on growing plants because the seeds often serve as symptomless carriers. The role of vegetatively propagated material in spreading pests and pathogens is too well known to be recounted here. When such material is received in quarantine, it has to be rushed through because of its perishable nature. This limits the scope of laboratory testing. Also the material with pre-export treatment requires to be grown to determine its freedom from pests and pathogens. It is therefore necessary to establish a chain of post-entry quarantine nurseries in the country where such materials could be tested. The provision of well appointed tissue culture laboratories with some of the nurseries can further enlarge the scope of salvaging valuable material. Sheffield (1968) has summarised the quarantine requirements of such nurseries and their number and location would depend upon the quantity of material required to be processed and the suitability of the area.

6. Identification and Designation of Centres to Maintain Introduced Material of Perennial Plants

The problem of exotic pathogens is more severe in perennial plants than in annuals. Not only that the number of pathogens involved is more but it is also more acute because perennial plants remain much longer in the field accumulating pathogens and

serve as reservoir for their spread. Since the introduction of such plants is a must and the introduced material has to be grown and examined under isolation, it will be necessary to identify and designate certain Centres for different perennial plants where the introduced germplasm could be tested and maintained so that the need for repeat introductions could be avoided. Also such Centres would serve to provide certified disease free material for users within the country and abroad. Such centres would be required for most of the fruit plants, plantation crops, forest plants, etc.

7. Abstracting Service

From Plant Protection point of view, the review publications of the Commonwealth Agriculture Bureaux—Review of Applied Entomology, Review of Plant Pathology, Helminthological Abstracts, and other similar publications are very useful but the coverage of Indian Publications is only partial. For an effective plant quarantine service it is necessary to have a well documented record of pest and disease incidence, host range, distribution, biology, etc., so that it can easily be known as to what is present in the country and what is not. Also for want of a comprehensive abstracting service the information about records of pests and pathogens in the country gets to be known after a significant lapse of time. By organising an Abstracting Service and at the same time making it compulsory for all publishers of books and periodicals to send a copy of the publication free to this service, a quicker and better coverage of Indian literature would be achieved.

8. Pest Identification Service

A strong pest identification service backed up with a well represented reference collection is a pre-requisite for the identification of the intercepted pests. The identity being the key to the literature regarding its distribution, host range, nature and extent of damage, economic importance, etc. has got to be known before the published literature could be used. Among the Insecta, the groups are so numerous that as at present constituted no single centre can have specialists working on all groups. Either we can encourage our regional Centres to develop excellence in selected groups or we may develop a national facility as an identification centre-cum-museum.

9. Surveillance Division

If past experience is any guide, bulk imports of plants, plant materials and plant products shall continue to be made. If the material is for consumption, it has been suggested that the imported material, after fumigation and mechanical cleaning, be released to processing units so that it is converted into such forms which could not be useful for propagation purposes. Again if the material is for processing, it has to be fumigated and suitably devitalised before release, or released for processing under quarantine supervision. in case of imports for research purposes or for propagation, the imported material when released for growing in isolation at various centres in the country would require to be kept under surveillance. A Surveillance Wing would therefore be very necessary in the future Plant Quarantine set up.

10. Containerisation

The use of containers in the international transport of wide ranging material is steadily increasing and most ports in industriallised countries now have all the technical facilities for handling containers (Piltz 1981). Containers have simplified packaging, dispatch and handling of the material. These can now be packed at the premises of the producers/processors and delivered to the users often far away from the nearest point of entry into the country. This has greatly

increased the risk of spreading pests and pathogens (Anonymous 1970, Keall 1981, Somerfield 1983). Since container shipping has come to stay, we shall have to adopt it and prepare ourselves for this change. The required facilities like container depots, container handling equipment, equipment for container fumigation, container inspection, container cleaning etc., shall have to be carefully planned and developed in such a way that the inspection and clearance could be done in a smooth manner and without loss of time. It would also be necessary to formulate the procedures for inspection, treatment and clearance as well as to develop working guide like the one prepared for use in Australia (Anonymous 1971).

Domestic Quarantine

1. Plant Quarantine Centre

While listing the problems and deficiencies in the present Domestic Quarantine set-up, it was suggested that there is need for an effective implementation of domestic quarantine regulations; to enlist public support for the success of domestic quarantine programme and for adequate publicity relating to quarantine problems, the need for imposing restrictions and defining the DO's and DONT's for the public, etc. In addition there are other aspects like the need to determine if eradication campaign against a specific pest or pathogen is feasible, to monitor the progress of eradication and containment efforts, to evaluate the efficiency of adopted/proposed measures and their adverse effect, if any, on the general economy of the State; to keep a watchful eye on the pest and pathogen problems in the State and adjoining areas with particular reference to those of quarantine significance, to develop suitable publicity material for pests and pathogens of domestic quarantine significance, etc., which require to be attended to. For carrying out such work within the State/Union Territory, a State level Plant Quarantine Centre would be necessary.

2. Surveillance Units

The activities envisaged in enforcing domestic quarantine regulations would involve a lot of field work such as visit to properties for survey of pests and pathogens, to keep a watch on the implementation of regulations, to evaluate their effectiveness, supervise the inter- and intra-State movement of restricted articles, assisting the Central Surveillance Staff in their State level activities, etc. To ensure that the work is properly carried out Surveillance Units shall be very necessary.

3. Seed Certification Agencies

It has been stated earlier that addition of information on the health status of seed in the certificate accompanying the certified seed, would greatly help in developing confidence among the users about the quality of seed purchased and in checking the spread of pests and pathogens through shipments of certified seed. To be able to provide this information it would be necessary to add Seed Health Testing wings to each of the Seed Testing Laboratories both existing and proposed, in the State.

Conclusions

Plant Quarantine is an activity for the welfare of the community, country or a region on a collective basis as it aims to prevent or delay the entry of exotic pests and pathogens into the area. Thus it indirectly protects the indigenous plants. The advantages of effective implementation of plant quarantine are not easily perceived but the long list of interceptions of serious pests and pathogens like *Acanthoscelides obtectus*, *Oscinella frit*, *Ditylenchus destructor*, *Heterodera humuli*, *Rhadinaphelenchus cocophilus*, *Fusarium nivale*, *Peronospora manschurica*, *Puccinia carthami*, etc., from the imported plants and plant materials (Mehra & Arora 1982, Wadhi 1980) clearly illustrate the continuing

threat from the exotic pests and pathogens and highlights the need for the adoption of comprehensive and effective quarantine measures with sincerity. Any relaxation in this regard can only lead to devastating consequences. The quarantine procedures and the set-up for the coming years shall, therefore, have to be very carefully considered and thoughtfully implemented so that while the purpose of quarantine is served, the introduction of desirable material from abroad does not get unduly held up.

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APPENDIX-I

SPECIES OF SOME PLANT GENERA, THE SEEDS OF WHICH WERE

(Figures in parenthesis after the generic names give the total

DIGITARIA (44)	INDIGOFERA (26)	MEDICAGO (34)	NICOTIANA (41)	PASPALUM (44)
adscendens	*arrecta*	aculeata	accuminata	alcalinum
argyrograpta	brevipes	*arabica*	*alata*	almum
brownii	cardiophylla	*arborea*	arentsii	boscianum
chevalieri	circinella	aschersoniana	*attenuata*	brunneum
ciliaris	colutea	ciliaris	benavidesii	commersonii
commutata	confusa	coronata	bigelovii	*conjugatum*
ctenantha	cryptantha	disciformis	clevelandii	corypheum
debilis	echinata	*falcata*	cordifolia	cromyorrhizon
decumbens	endecephylla	gerardi	debneyi	densum
diagonalis	hirsuta	*hispida*	exigua	*dilatatum*
diversinervis	hochstattari	intertexta	forgetiana	distichyum
enodis	microcarpa	littoralis	glutinosa	exaltatum
eriantha	mucronata	*lupulina*	goodspeedii	floridanum
eriostachya	neglecta	meyeri	ipomopsiflora	geminiflorum
friesii	parodiana	minima	knightiana	guaraniticum
fuscescapus	psuedotinctora	murex	langsdorfii	guenoarum
gazensis	retroflexa	muricata	longiflora	hierohymii
geniculata	rhytidocarpa	obscura	maritima	intermedium
glauca	semitrijuga	*orbicularis*	miersii	juergensii
horizontalis	spicata	polymorpha	noctiflora	macrophyllum
iburus	subulata	praecox	nudicaulis	maculosum
ischaemum	suffruticosa	pubescens	otophora	malacophyllum
kilimandschurica	sumatrana	rigidula	paniculata	*mandiocanum*
longiflora	tetelensis	rotata	petunioides	missiones
macroblephera	*tinctoria*	rugosa	plumbaginifolia	nicorae
macroglossa	vicodes	*sativa*	*quadrivalvis*	*notatum*
milanjiana		*scutellata*	raimondii	paniculatum
mombasana		sinskial	repanda	pauciciliatum
monodactyla		tornata	sandarae	platyphyllum
natalensis		*tribuloides*	setchellii	plicatulum
pentzii		truncata	solanifolia	polystachyum
phaeothrix		truncatula	spegazzini	pubiflorum
polevansii		tuberculata	stocktonii	pumilum
sanguinalis		turbinata	suaveolens	quadrifarium
Scalarum			sylvestris	rojasii
seriata			*tabacum*	*scrobiculatum*
setivalva			thyrsiflora	tenellum
smutsii			tomentosa	thunbergii
swazilandensis			tomentosiformis	umbrosum
ternata			viscosa	urvillei
valida			wigandioides	vaginatum
vestita				virgatum
violascens				wettsteinii
yokoensis				yaguaronanse

Species *underlined* are considered to be economically important (Uphof 1968)

IMPORTED INTO INDIA FOR RESEARCH PURPOSES DURING 1975
number of species of that genus imported during the period)

SETARIA (23)	SOLANUM (86)		TRIFOLIUM (75)	
adhaerans	acaule	microdontum	agrarium	medium
almaspicata	acroglossum	mochicense	*alexandrinum*	meneghenianum
argentina	acroscopicum	morelliforme	alpestre	michaleamum
chevalieri	ambosinum	moscopanum	*amabile*	*nigrescens*
flabellata	andreanum	multidissectum	angustifolium	obscurum
geniculata	berthaultii	multiinterruptum	argutum	palaestinum
gerrardi	boliviense	*nigrum*	arvense	pallidum
glauca	brachycarpum	ochranthum	balansae	*pannonicum*
grisebachii	brevidens	oplocense	batmanicum	*parviflorum*
holstii	bulbocastaneum	oxycarpum	bocconei	patens
hybrida	canasense	papita	burchellianum	pauciflorum
italica	capsicastrum	phureja	*campestre*	petrisavii
kuntzeana	capsicibaccatum	piurae	canescens	phleoides
leiantha	cardiophyllum	pinnatisectum	cernum	pilurae
macrostachya	chacoense	polyadenium	cheranganiense	*pratense*
pallidifusca	chancayense	polytrichon	cherleri	purpureum
perberbis	chomatophylum	*quitoense*	chilense	radiosum
phanerocca	clarum	raphanifolium	clypeatum	*repens*
sphacelata	commersonii	rostratum	dasyurum	*resupinatum*
sulcata	demissum	sanctae-rosae	dichroanthum	*ruppellianum*
verticillata	*dulcamara*	santolallae	diffusum	scabrum
viridis	etuberosum	sisymbrifolium	dubium	scutatum
woodii	*fendleri*	*sodomeum*	echinatum	semipilosum
	fernandezianum	sogarandinum	*fragiferum*	spadiceum
	gandarillasii	sparsipilum	gemellum	spumosum
	gourlayi	spegazzinii	globosum	squarrosum
	hjertingii	stenophyllidium	*glomeratum*	stellatum
	hougasii	stenotomum	haussknechtii	steudneri
	huancabambense	stoloniferum	*hirtum*	*striatum*
	immite	sucrense	*hybridum*	strictum
	infundibuliforme	tarijense	*incarnatum*	*subterraneum*
	jalcae	*topiro*	isodou	tricocephalum
	jamesii	toralapanum	isthmocarpum	variegatum
	kurtzianum	trifidum	lagopus	vesciculosum
	laciniatum	*tuberosum*	*lappaceum*	wieldesonii
	laxissimum	tuquerrense	leucanthum	tomentosum
	lesteri	venturii	ligusticum	
	lignicaule	vernei	*lupinaster*	
	lycopersicoides	verrucosum	maritimum	
	maglia	violaceimormoratum		
	mammosum	weberbaueri		
	marginatum			
	merinasense			
	medians			
	megistacrolobum			

APPENDIX II

Exporters Warnings about the Risk in Germplasm Imports

1. Plant Introduction has accummulated beans from all over the world. This collection contains a great deal of diverse germplasm which may carry some seed borne diseases. These beans are all planted in the same fields; so it is impossible to prevent infection of susceptible types which may have been previously clean. Spraying to eliminate vectors is useless in the field as additional pests infest the planting within a few days. Hence a line resistant to one disease may become a carrier for another disease. For this reason we are issuing the following notice:

NOTICE

Any line of Plant Introduction beans may carry seed-borne virus and/or other disease organisms. At this time *we are unable to provide a phytosanitary permit.* If you still wish to have these beans sent, you are advised to have a plant pathologist check this material prior to planting and several times during its growth period to prevent the introduction and/or escape of a new or more virulent disease in the area where grown. You are cautioned that this responsibility rests entirely with those requesting the germplasm.

IMPORTANT NOTICE

2. The seeds contained in this packet have been produced under appropriate conditions expected to reduce seed-borne diseases to a minimum. However, due to the risks inherent in this crop of seed-borne diseases escaping detection, it is recommended that this seed be used for planting under controlled conditions of greenhouse or screenhouse for seed increase.

WARNING

3. In distributing seeds there is always the potential presence of seed-borne disease(s). While none is suspected, we urge co-operators to observe in planting carefully and, if suspicious symptoms are noted, to destroy the strain in which they were noted, or even the entire plot.