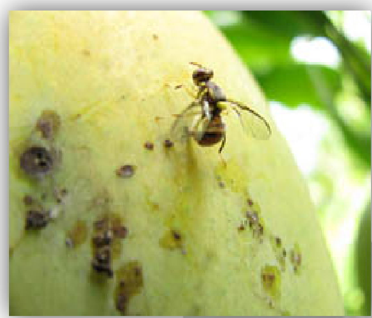
May 2015

Government of the People's Republic of Bangladesh
Office of the Project Director
Strengthening Phytosanitary Capacity in Bangladesh Project
Plant Quarantine Wing
Department of Agriculture Extension
Khamarbari, Farmgate, Dhaka-1205



REPORT ON PEST RISK ANALYSIS (PRA) OF MANGO IN BANGLADESH

DEVELOPMENT TECHNICAL CONSULTANTS PVT. LTD. (DTCL)
Gulshan-1, Dhaka, Bangladesh

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DTCL

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MAY 2015

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FORWARD

The Strengthening Phytosanitary Capacity in Bangladesh (SPCB) Project under Plant Quarantine Wing (PQW), Department of Agriculture Extension (DAE), Ministry of Agriculture conducted the study for the "**Pest Risk Analysis (PRA) of Mango in Bangladesh"** according to the provision of contract agreement signed between SPCB-DAE and Development Technical Consultants Pvt. Limited (DTCL) on 14 November 2014. The PRA study is a four-month assignment commencing from 8 February 2015 under the SPCB-DAE.

The overall objectives of this Pest Risk Analysis are to identify the pests and/or pathways of quarantine concern for a specified area of mango and evaluate their risk, to identify endangered areas, and if appropriate, to identify risk management options. To carry out the PRA study, the consulting firm conducted field investigations in 69 upazila under 19 major mango growing districts of Bangladesh. The study covered the interview 6900 mango growers; 19 FGDs each of which conducted in one district; conducted 53 KII and physical inspection and visits of the mango fields under sampled districts. The consultants also reviewed secondary sources of information related to PRA of mango.

The study findings evidenced that the eight arthropod pests, twelve pathogenic microorganisms and eleven weeds likely to be associated with the mango in Bangladesh. The study also revealed that pests of quarantine importance included two insect pests, six fungi, 2 bacteria, four nematodes and one viral disease and one weeds of mango that could be introduced into Bangladesh through importation of commercially produced mango fruits. The consultant team also conducted the risk assessment for each quarantine pest individually based on the consequences and potential of introduction of each quarantine pest and a risk rating was estimated for each. Based on the risk assessment and risk rating, 14 quarantine pests were identified as high risk and one pest as medium risk rating. The findings also suggested the risk management options for the quarantine pests of mango in line with the pre and post harvest management and phytosanitary measures.

The findings of the PRA study were presented in the National Level Workshop organized by the SPCB-PQW of DAE. The workshop was well attended by the concerned professionals represented by the country's reputed agricultural universities, research organizations and other relevant personnel from different organizations. The online version of this report will be available at www.dae.gov.bd

I would like to congratulate Consultant Team of DTCL for conducting the PRA study successfully and also the concerned SPCB professionals in making the total endeavor a success. I express my heartfelt thanks to the officials of DAE, Ministry of Agriculture, BARI, SCA, Agricultural Universities, research organizations and mango importer and exporters' associations for their assistance and cooperation extended in conducting the PRA study. Thanks are also due to all members of Technical Committees for cooperation. Special thanks to the Secretary, Additional Secretary, DG (Seed Wing), Additional Secretary (Extension), Director General of DAE, Director (Plant Quarantine Wing) and other high officials under the Ministry of Agriculture for providing us valuable advice and guidance. I hope that the report certainly would contribute to enhance the exports and imports of mangoes.

(Sadeque Ibn Shams)
Project Director
Strengthening Phytosanitary Capacity in Bangladesh (SPCB) Project
Plant Quarantine Wing (PQW)
Department of Agriculture Extension (DAE)
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PREFACE

This Final Report intends to respond to the requirement of the client according to the provision of contract agreement signed between Project Director of Strengthening Phytosanitary Capacity in Bangladesh (SPCB) and the Development Technical Consultants Pvt. Limited (DTCL) for **"Conducting Pest Risk Analysis (PRA) of Mango in Bangladesh"** under Plant Quarantine Wing (PQW), Department of Agriculture Extension (DAE), Ministry of Agriculture (MOA), Government of the Peoples Republic of Bangladesh. The PRA study is a four-month assignment commencing from 8 February 2015 under the SPCB-DAE.

Consultancy services for "Conducting Pest Risk Analysis (PRA) of Mango in Bangladesh" was provided by the Development Technical Consultants Pvt. Ltd. (DTCL), Bangladesh. The study team consists of five senior level experts including field and office level support staffs. The major objective of the study is to listing of major and minor pests of mango, identification of pests likely to be associated with pathway, identification of potential for entry, establishment and spread, identification of potential economic and environmental impact, identification of control measures and potential impacts of such measures, assessment of potential loss by the pests, preparation of report on risk analysis of the pests following the relevant ISPMs and make recommendation.

The Report includes study design, sampling framework and data collection instruments, guidelines and checklists, details of survey and data collection method, data management and entry, data analysis and survey finding as well as the stages of PRA, risk assessment strategies of the pests likely to be associated with the commodity to be imported from the exporting countries and the risk management options as recommendations. The report had been reviewed and discussed thoroughly by the SPCB officials along with other experts and representatives through several discussion meetings and national level workshop. The consultants prepared the Final Report of the PRA study based on comments and suggestions of the client and experts.

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ACKNOWLEDGEMENTS

It is indeed a great honor for us that Strengthening Phytosanitary Capacity in Bangladesh (SPCB) Project under Plant Quarantine Wing (PQW) of Department of Agriculture Extension (DAE) has entrusted Development Technical Consultant Pvt. Ltd. (DTCL) to carry out the "**Conducting Pest Risk Analysis (PRA) of Mango in Bangladesh"**. The Draft Report has been prepared based on the past four months (December 2014 to March 2015) activities of the survey study in major 19 mango growing districts of Bangladesh as well as on the review of secondary documents. In the process of working on the setting indicators and sampling as well as for revising the questionnaires for the field survey and data collection, monitoring and supervision, data editing, entry, analysis and report writing, we have enjoyed the support of SPCB-PQW. The principal author is Prof. Dr. Md. Razzab Ali, Team Leader with inputs from Prof. Dr. Md. Abdul Karim, Prof. Dr. Md. Ramiz Uddin Miah, Prof. Dr. M. Salahuddin M. Chowdhury and Dr. B. A. A. Mustafi of the PRA study team.

The authors are grateful to all persons involved in the PRA study. Our special gratitude to Director General, DAE, Bangladesh, who provided his extended support and gave us an opportunity to meet Director of Plant Quarantine Wing (PQW) of DAE. Special thanks to Mr. Sadeque Ibn Shams, Project Director of Strengthening Phytosanitary Capacity in Bangladesh (SPCB) Project; Mr. Md. Ahsan Ullah, Consultant (PRA); Mr. Md. Ayub Hossain, Consultant (Procurement); Mrs. Marina Jebunehar, Senior Monitoring and Evaluation Officer of SPCB for their valuable cooperation, guidance and suggestions to the study team in line with the activities performed during study and report preparation. Our special grateful thanks also to Mr. Chhabi Haridas, Director, PQW of DAE for his kind cooperation and suggestions during the study period. The active support of Dr. M. M. Amir Hossain, Managing Director of DTCL and Kbd. Md. Habibur Rahman, Survey Coordinator of the study and Executive Director of DTLC; Mr. M. Abul Hossain, Director, DTCL and Mr. Md. Mahabub Alam, Manager of DTCL in data collection and monitoring activities also acknowledged with thanks.

(Prof. Dr. Md. Razzab Ali)
Team Leader

ACRONYMS

AEZ	:	Agro-Ecological Zone
BADC	:	Bangladesh Agriculture Development Corporation
BARI	:	Bangladesh agricultural Research Institute
BAU	:	Bangladesh Agricultural University
BBS	:	Bangladesh Bureau of Statistics
BSMRAU	:	Bangabandhu Sheikh Mujibur Rahman Agricultural University
CABI	:	Center for Agriculture and bio-Sciences International
DAE	:	Department of Agriculture Extension
DG	:	Director General
Dr.	:	Doctor
DTCL	:	Development Technical Consultants Private Limited
e.g.	:	For Example
EPPO	:	European and Mediterranean Plant Protection Organization
et al.	:	and associates
EU	:	European Union
FAO	:	Food and Agriculture Organization
FAOSTAT	:	Food and Agriculture Organization Statistics
FGD	:	Focus Group Discussion
HWT	:	Hot Water Treatment
IMOA	:	Indian Ministry of Agriculture
IPPC	:	International Plant Protection Convention
IPM	:	Integrated Pest Management
ISPM	:	International Standard For Phytosanitary Measures
KII	:	Key Informant Interview
MD	:	Managing Director
MPW	:	Mango Pulp Weevil
MSW	:	Mango Seed Weevil
NGO	:	Non-Government Organization
No.	:	Number
NPPO	:	National Plant Protection Organization
^{o}C	:	Degree Celsius
PD	:	Project Director
PFA	:	Pest Free Area
PLRV	:	Potato Leaf Roll Virus
PPW	:	Plant Protection Wing
PQW	:	Plant Quarantine Wing
PRA	:	Pest Risk Analysis
Prof.	:	Professor
PVX	:	Potato Virus X
RH	:	Relative Humidity
SAU	:	Sher-e-Bangla Agricultural University
SCA	:	Seed Certification Agency
SID	:	Statistics and Informatics Division
SPCB	:	Strengthening Phytosanitary Capacity Project in Bangladesh
TTC	:	Triphenyl Tetrazolium Chloride
UK	:	United Kingdom
USA	:	United States of America
USDA	:	United States Department of Agriculture
VHT	:	Vapor Heat Treatment
%	:	Percentage

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EXECUTIVE SUMMARY

The study "Pest Risk Analysis (PRA) of Mango in Bangladesh" documents the pests of *Mangifera indica* L. (Sapindales: Anacardiaceae) available in Bangladesh and the risks associated with the import pathway of fresh mango fruits from the exporting countries into Bangladesh. The findings evidenced that the twenty arthropod pests including nineteen insect and one mite pests, seven disease causing pathogenic microorganisms and two parasitic weeds likely to be associated with the mango in Bangladesh.

The arthropod pests included the major insect pests of mango recorded were mango hopper (*Amritodus atkinsoni*, *Idioscopus clypealis*) and oriental fruit fly (*Bactrocera dorsalis* (Hendel))) in field condition. The important minor insect pests of mango were mango pulp weevil (*Sternochaetus frigidus*), mango mealybug (*Droshicha mangiferae* Green) found in the field condition. Other minor insect pests were mango stone/seed weevil (*Sternochetus mangiferae* (Fabricius)), leaf cutting weevil (*Deporaus marginatus*), mango stem/trunk borer (*Batocera rubus* (Linnaeus, 1758)), mango fruit fly (*Bactrocera tau* (Walker, 1849)), guava fruit fly/peach fruit fly (*Bactrocera zonata* (Saunders)), mango leaf gall midge (*Procontarinia matteiana*), mango common scale (*Coccus mangiferae* (Green)), mango shoot gall psyllid (*Apsylla cistellata* (Cockerell, 1893)), mango defoliator (*Cricula trifenestrata* (Helfer 1837)), mango fruit borer (*Citripestis eutraphera Meyrick), mango leaf webber (Orthaga exvinacea* Hampson), mango leaf miner (*Acrocercops syngramma* Meyrick), mango leaf caterpillar (*Euthalia aconthea*), and pink gypsy moth (*Lymantria mathura* Moore 1865) in field condition. Among these insect pests, mango hopper, oriental fruit fly and mango pulp weevil were more damaging than others. The oriental fruit fly (*Bactrocera dorsalis*) caused damage mango at fruiting stage by feeding the internal pulp by maggots with low to medium infestation severity. The mango eriophyid mite was also reported as the minor pest of mango in the field condition. But the incidence of Mediterranean fruit fly (*Ceratitis capitata*), Queensland fruit fly (*Bacterocera troyni*), and Tapioca scale insect (*Aonidomytilus albus* (Cockerell, 1893)) were not recorded in the field of mango growing areas of Bangladesh. Likewise, mango mealy bug (*Droshicha mangiferae* Green) was recorded in the restricted areas of mango field in Bangladesh.

The major diseases caused by pathogenic microorganisms included the anthracnose disease (*Colletotrichum gloeosporioides*) of mango fruits and leaves in the field condition. The minor diseases of mango include powdery mildew (*Oidium mangiferae*), mango malformation (*Fusarium moniliforme*), Alternaria leaf spot of mango (*Alternaria alternate* (Fr.) Keissl. (1912)), blossom blight/ grey mould (*Botryosphaeria theobromae*), mango scab (*Elsinoë mangiferae*) caused by fungi, and leaf red rust of mango (*Cephaleuros virescens* Kunze 1827) in the field condition as well as anthracnose and common scab found in the storage condition of fruits. Among these diseases, the anthracnose diseases on leaves and fruits were more damaging than others. The anthracnose disease caused damage mango at vegetative and fruiting stage as well as in storage condition with high infection intensity, but the damage severity was controlled by the farmers through routine application of fungicides in the orchard. The bacterial black spot disease caused by *Xanthomonas campestris* pv. *mangiferaeindicae* was not found in Bangladesh.

The incidences of weeds of mango recorded through this study were loranthus/Indian mistletoe (*Dendrophthae falcate*) and Pathenium weed (*Parthenium hysterophorus* L.) in the field of mango and both of the weeds had minor importance. The parthenium weed (*Parthenium hysterophorus*) was found only some restricted areas such as Rajshahi, Natore, Pabna, Kustia, Jessore districts among 19 sampled districts of Bangladesh. The stakeholders also reported that the parthenium weed might be entered into Bangladesh through cross boundary from India by the transportation system of border trading.

Information on pests associated with mango in the exporting countries-India, Thailand, Pakistan and other countries-reveals that pests of quarantine importance exist. The study also revealed twenty pests of quarantine importance that included thirteen insect pests, six disease causing pathogenic microorganisms including five fungi, one bacterium, and one weed of mango. Without mitigation, these pests could be introduced into Bangladesh through importation of commercially produced fresh mango fruits. Pests of quarantine importance include arthropods: *Ceratitis capitata* (Wiedemann) (Mediterranean fruit fly), *Bactrocera tryoni* (Froggatt) (Queensland fruit fly), *Ceratitis cosyra* (Walker) (marula fruit fly), *Bactrocera caryeae* (Kapoor) (member of oriental fruit fly), *Bactrocera correcta* (Bezzi) (Asian guava fruit fly), *Bactrocera diversa* (Coquillett) (three striped fruit fly), *Coccus viridis* (Green) (green scale insect), *Ceroplastes rubens* Maskell (red wax scale), *Aonidomytilus albus* (Cockerell, 1893) (tapioca scale insect), *Aulacaspis tubercularis* (Newstead) (white mango scale), *Parlatoria crypta* McKenzie (armored scale), *Pseudaonidia trilobitiformis* (Green, 1896) (gingging scale) and *Droshicha mangiferae* Green (mango mealybug).

The quarantine pathogenic fungi of mango included *Phomopsis mangiferae* S. Ahmad 1954 (stem-end-rot of mango), *Cytosphaera mangiferae* Died. 1916 (twig canker), *Actinodochium jenkinsii* Uppal, Patel & Kamat (mango black spot), *Hendersonia creberrima* Syd., Syd. & Butler (mango fruit rot), *Macrophoma mangiferae* (leaf and stem blight)

The quarantine bacterial disease of mango included *Xanthomonas campestris* pv. *Mangiferaeindicae* (Patel *et al.*) Robbs *et al.* (bacterial black spot of mango) and the quarantine weed includes: *Parthenium hysterophorus* L. (Parthenium weed).

The consequences and potential/likelihood of introduction of each quarantine pest were assessed individually, and a risk rating estimated for each. The consequence of introduction value was estimated assessing five elements that reflect the biology and ecology of the pests: the climate-host interaction, host range, dispersal potential-pathway, economic and environmental impacts. The potential of introduction value was estimated by assessing the quantity of the commodity to be imported annually and the potential for pest introduction and establishment. The two values were summed to estimate an overall Pest Risk Potential, which is an estimation of risk in the absence of mitigation.

Out of 20 quarantine pests associated with the pathway, risk assessed 10 quarantine pests were given a pest risk potential of High those include Arthropods: five Tephritid fruit flies such as *Ceratitis capitata*-(Wiedemann) *Bactrocera tryoni* (Froggatt), *Ceratitis cosyra* (Walker), *Bactrocera caryeae* (Kapoor), *Bactrocera correcta* (Bezzi), *Bactrocera diversa* (Coquillett), two coccids scale insects such as *Coccus viridis* (Green), *Ceroplastes rubens* Maskell and one diaspidid scale insects such as *Parlatoria crypta* McKenzie; one weed pest includes: *Parthenium hysterophorus* L. Other ten quarantine pests were given pest risk potential of Medium, those include Arthropods: three diaspidid scale insects such as *Aonidomytilus albus* (Cockerell, 1893), *Aulacaspis tubercularis* (Newstead), *Pseudaonidia trilobitiformis* (Green, 1896); five pathogenic fungi: *Phomopsis mangiferae* S. Ahmad 1954, *Cytosphaera mangiferae* Died. 1916, *Actinodochium jenkinsii* Uppal, Patel & Kamat , *Hendersonia creberrima* Syd., Syd.

& Butler, and *Macrophoma mangiferae* Hing. & O.P.Sharma (1957); one pathogenic bacterium: *Xanthomonas campestris* pv. *mangiferaeindicae* (Patel *et al.*) Robbs *et al.* These mean that these pests pose unacceptable phytosanitary risk to Bangladesh's agriculture. Visual inspection at ports-of-entry for high risk potential pests is insufficient to safeguard Bangladesh's mango industry and specific phytosanitary measures are strongly recommended, while for medium risk potential pest specific phytosanitary measures may be necessary to reduce pest risk.

The following are some mitigative measures that may be considered within a systemic approach to reduce the possible risks associated with the above mentioned quarantine pests:

PQW-DAE of Bangladesh should consider that the risk management measures identified in the previous section, upon which these import conditions are based, are commensurate with the identified risks.

- Import Condition 1. Registration of export orchards
- Import Condition 2. Packinghouse registration and auditing of procedures
- Import Condition 3. Pre-export vapor heat treatment for fruit flies
- Import Condition 4. Pre-export hot water treatment for fruit flies
- Import Condition 5. Pest free places of production or pest free production sites for mango pulp and seed weevils
- Import Condition 6. Targeted pre-export inspection by the respective authority of the exporting countries
- Import Condition 7. Packing and labeling
- Import Condition 8. Phytosanitary certification by the respective authority of the exporting countries
- Import Condition 9. Storage and movement
- Import Condition 10. Targeted on-arrival quarantine inspection and clearance by PQW-DAE of Bangladesh
- Import Condition 11. Audit and review of policy.

CHAPTER 1

RISK ANALYSIS BACKGROUND AND PROCESS

1.1. Background

Pest Risk Analysis provides the rationale for phytosanitary measures for a specified PRA area. It evaluates scientific evidence to determine whether an organism is pest. If so, the analysis evaluates the probability of introduction and spread of the pest and the magnitude of potential economic consequences in a defined area, using biological or other scientific, economic and environmental evidences. If the risk is deemed unacceptable, the analysis may continue by the suggestions of management options that can reduce the risk to an acceptable level. Subsequently, pest risk management options may be used to establish phytosanitary regulations.

Mango is now the most important fruit item by tonnage production and widely cultivated in all the districts of Bangladesh. mango contributes 0.945 million MT from local production. The fruit has really of immense value in respect of money and prosperity. In Bangladesh it is called as “King of the fruit”. Bangladesh is one of the major mango producing countries along with India, Pakistan, Mexico, Brazil, the Philippines, etc. (Alexander, 1989). In Bangladesh, mango occupies about an area of 50,491 ha with a production of 945049 metric tones during 2011-12 according to FAOSTAT, 2014. It is now in an increasing trend in area by 113.15% and in production by 106.28% in the year of 2011-12 compared to 2008-09 (FAOSTAT, 2014).

Mango is the leading seasonal cash crop of the northwestern region of Bangladesh and dominates the economy in Rajshahi and Chapainawabganj districts. There is no large industry here. Most of the people are employed for different jobs on the orchards such as nursing, harvesting and packing mangoes for transportation during the season every year. But for the quarantine importance, importing countries need intensive study findings on the insect pests, diseases and other pests associated with mangoes in Bangladesh. Simultaneously, the mangoes used for consumption in Bangladesh mostly imported from the India as well as from other countries such as Thailand. According to the West-Bengal Exporters Coordination Committee (2014), it is reported that Bangladesh imported annually 300,000 metric tonnes of mangoes from India over the last four years. Therefore, a risk of introduction of quarantine pests associated with mangoes imported from the countries of exports into Bangladesh remains as threat.

The introduction of insect pests, plant diseases, weeds and other pest associated with the commodity is brought about mainly during the accelerated agricultural development in different countries, when plants and plant materials were brought into, or sent out with little or no concern for the insect pests, diseases, weeds and other pests that were transported along with them. There are many instances of accidental introductions of insect pests and destructive diseases from one country to another. Extensive damages, often sudden in nature, have been caused not by indigenous pests, but with exotic ones introduced along with plants, plant parts or seeds in the normal channel of trade or individual interest. Instances may be cited of the introduction of grape *phylloxera (Phylloxera vitifolia*) from the U.S.A. to France which caused destruction of French vineyards; Mexican boll weevil (*Anthonomus grandis)* whose original home was in Mexico or Central America, round about 1892 entered the U.S.A. and later to various countries in the world, causing extensive damage to cotton; European corn borer (O*strinia nubilalis)* which reached North America probably through broom corn from Italy or Hungary and has since become a major pest there. Pink ball worm (*Pectinophora gossypiella*) considered to be one of the six most destructive insects of the world probably a native of India is now established as a highly destructive pest in nearly all cotton growing areas of the world. Downy mildew of grape (*Plasmopara viticola*) introduced in France from the U.S.A. was responsible for the destruction of grape vines till the discovery of Bordeaux mixture. Blight disease of chestnut (*Endothia parasitica*) introduced into the U.S.A. from Europe completely wiped out chestnut plants.

In India, the San Jose Scale (*Aspidiotus perniciosus*) is a pest of apple introduced about 60 years ago, now causing concern to apple growers in Himachal Pradesh, Jammu and Kashmir; wooly aphis (*Eriosoma lanigerum*) an introduced serious pest of apple; fluted scale (*Icerya purchasi*), a native of Australia introduced through Ceylon in 1928 now a serious pest of *citrus spp;* leaf rust of coffee (*Hemileia vastatrix*) introduced from Ceylon in 1876; fire blight of apple and pear (*Erwinia amylovora)* introduced from England in 1940, now a serious disease in Uttar Pradesh; flag smut of wheat (*Urocystis agropyri*) introduced from Australia now established in the Punjab, Rajasthan and Uttar Pradesh; bunchy top of banana introduced from Ceylon in 1940 causing serious damage to dwarf Cavendish varieties in different parts of India.

A number of insect pests of this fruit and over 175 species of insect have been reported damaging mango tree in Bangladesh, but the most abundant and destructive at the flowering stage are the mango hoppers (*Idioscopus clypealis*). Also mango mealy bug (*Drosicha mangiferae*), stem borer (*Batocera rubus*), fruit fly (*Bactrocera dorsalis*), mango nut weevil (*Sternochetus frigidus*) and caterpillar (*Euthalia garuda*) pests played a major role in bringing down the yield (Uddin, 2009). Other insect pests of mango are mango defoliator (*Cricula trifenestrata)*, mango fruit borer (*Antocharis albizonalis),* mango leaf cutting weevil (*Daporaus mangintus),* mango shoot gall (*Apsylla cistellata),* mango leaf gall (*Apsylla cistellata),* meaf miner (*Acrocercops syngramma),* leaf twisting weevil (*Apoderus transquebarius),* red ant (*Oecophylla smaragdina).* Besides, eriophyid mite (*Aceria mangiferae)* also causes damage to the mango leaf*.* A number of fungal diseases also cause damage of flowers, fruits, leaves, seedlings, and twigs of mango. Among these the important diseases are the antracnose (*Coletrotricum gloespriedes*), powdery mildew (*Oidium* sp.), malformation of mango (*Fusarium moniliforme*), fruit end rot (*Lasiodiplodia theobromae*), shooty mould (*Capnodium* sp.), leaf red rust (*Cephaleures* sp.), cladosporium rot (*Cladosporium* sp.), diplodia rot (*Diplodia* spp.), dieback (*Lasiodiplodia theobromae*) (Ashrafuzzaman, 1991; Uddin, 2009). But the incidence and severity of Meditaranean and Oriental fruit fly are not well recognized in Bangladesh. In The incidence of golden and pale cyst nematode and potato wart in the field are not known to occur in Bangladesh. Therefore, the incidence, distribution and infestation severity are need to be investigated.

Due to imports of mangoes with tropical and subtropical countries of the world, the possibility for introduction and establishment of quarantine pests along with the consignment of the commodity remains as threat. Therefore, the pathway risk analysis of mango from exporting countries to Bangladesh is essential. In this context, the Pest Risk Analysis (PRA) of mango in Bangladesh is indispensable. Thus, the assignment on Pest Risk Analysis (PRA) of mango in Bangladesh was undertaken aiming to identify pests and/or pathways of quarantine concern for the mango grown areas and evaluate their risk, to identify endangered areas, as well as to identify risk management options.

1.2. Scope of the Risk Analysis

The scope of this analysis is to findout the potential hazard organisms or diseases associated with fresh mango imported from different exporting countries such as India, Pakistan, Thailand etc. Risk in this context is defined as the likelihood of the occurrence and the likely magnitude of the consequences of an adverse event. For the purposes of this analysis “fresh mango” means the fruits complete with skin and flesh, without attached stems, leaves.

1.3. Impact of PRA

The US Department of Agriculture (USDA) Animal and Plant Health Inspection Service first introduced the plant pest risk analysis to ascertain the potential risks associated with causal agent of flag smut diseases. On the contrary the quarantine was established in 1919 to prohibit the introduction of the fungus *Urocystis agropyri* (*Urocystis tritici* Koemickle) contained in seeds and or other plant parts originating from other countries that have reported flag smut diseases of wheat. At that time no other options for wheat growers to control mechanisms such as resistant variety, use of HYV seeds, effective control of seeds treatment, advanced techniques of control flag smut. But due to continuous effort of the scientist, researchers and growers all together have achieved a greater understanding of effective and practical measures to mitigate flag smut diseases. In 1932 flag smut diseases had essentially been eradicated from USA through use of resistance variety, seed treatment and strictly implementation of quarantine measures. They considered three components of disease triangle- Host, Pathogen and Environment. Now-a- days the researchers and scientists believed on four principles for the prevention of diseases and these are (a) exclusion, (b) eradication, (c) protection, (d) development of resistance/ defense mechanisms.

Each and every year Bangladesh import/export the mango from and to India, Pakistan and Thailand. Therefore, there is every possibility to come foreign pests (Quarantine pests) associated with this imported mangoes. As such the PRA of economically important crops is essential to identify the indigenous, exotic and quarantine pests including their risk assessment and management options for safety production of crops.

1.4. Objective of the study

The overall objectives of a Pest Risk Analysis to identify pests and/or pathways of quarantine concern for a specified area of mango and evaluate their risk, to identify endangered areas, and if appropriate, to identify risk management options.

Specific Objectives of the Study

- List of major and minor pests,
- Identification of pests likely to be associated with pathway;
- Identification of potential for entry, establishment and spread;
- Identification of potential economic and environmental impact;
- Identification of control measures and potential impacts of such measures
- Assessment of potential loss by the pests;
- Preparation of report on risk analysis of the pests following the relevant ISPMs.

1.5. Pathway Risk Analysis Process and Methodology

The overall pest risk analysis (PRA) process includes undertaking pest risk analysis, risk assessment and identify risk management of the pests. The process and methodology of the PRA are described below:

1.5.1. Undertaking of Pest Risk Analysis (PRA)

The study followed a systematic process of pest risk analysis framed as per ISPM No. 2. As per the 3 stages (I) Initiation (II) Pest Risk Assessment (III) Pest Risk Management, the study team evaluated the commodity and regulated articles and detection of pest for initiation stages.

PRA STAGE 1: INITIATION

Initiation is the identification of organisms and pathways that may be considered for pest risk assessment in relation to the identified PRA area.

Steps of initiation stage: The initiation stage involves four steps:

- Step 1: Determination whether an organism is a pest
- Step 2: Defining the PRA area
- Step 3: Evaluating any previous PRA
- Step 4: Conclusion

PRA STAGE 2: PEST RISK ASSESSMENT

The process for pest risk assessment can be broadly divided into five interrelated steps:

- Step 1: Pest categorization
- Step 2: Assessment of the probability of introduction, establishment and spread
- Step 3: Impacts
- Step 4: Overall assessment of risk
- Step 5: Uncertainty

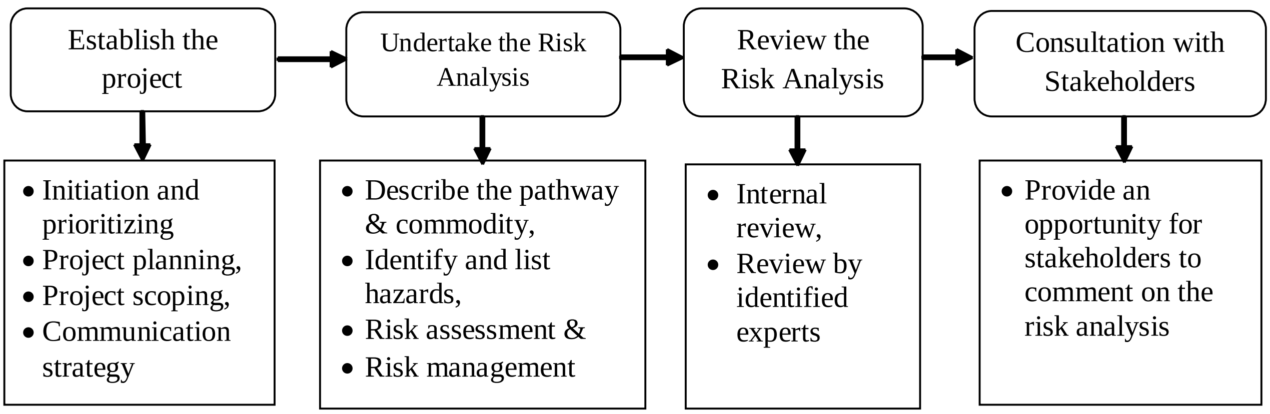
In most cases, these steps will be applied sequentially in a PRA but it is not essential to follow a particular sequence. Pest risk assessment needs to be only as complex as is technically justified by the circumstances. This standard allows a specific PRA to be judged against the principles of necessity, minimal impact, transparency, equivalence, risk analysis, managed risk and non-discrimination set out in ISPM No. 1: Principles of plant quarantine as related to international trade (FAO, 1995).

PRA STAGE 3: PEST RISK MANAGEMENT

The conclusions from pest risk assessment are used to decide whether risk management is required and the strength of measures to be used. Since zero-risk is not a reasonable option, the guiding principle for risk management should be to manage risk to achieve the required degree of safety that can be justified and is feasible within the limits of available options and resources. Pest risk management (in the analytical sense) is the process of identifying ways to react to a perceived risk, evaluating the efficacy of these actions, and identifying the most appropriate options. The uncertainty noted in the assessments of economic consequences and probability of introduction should also be considered and included in the selection of a pest management option.

The following briefly describes the Biosecurity process and methodology for undertaking pathway risk analyses. The risk analysis process leading to the final risk analysis document is summarized in Figure 1 below:

Figure 1: A summary of the risk analysis development process



1.5.2. Commodity Description

Mango: Fresh *Mangifera indica* L. (Sapindales: Anacardiaceae) for human consumption is defined as commercially-produced mango fruits with skin, flesh and seed, with a small portion of stem attached but not including leaves. The **mango** is a juicy stone fruit belonging to the genus *Mangifera* belong to the flowering plant family Anacardiaceae, cultivated mostly for edible fruit. The mango is native to South and Southeast Asia, from where it has been distributed worldwide to become one of the most cultivated fruits in the tropics. The highest concentration of *Mangifera* genus is in the western part of Malesia (Sumatra, Java and Borneo) and in Burma and India (Morton, 1987). *Mangifera indica* the "common mango" or "Indian mango"-is the only mango tree commonly cultivated in many tropical and subtropical regions (Kostermans and Bompard, 1993). It originated in Indian subcontinent and Burma. In Bangladesh it is called as “King of the fruit”. Bangladesh is one of the major mango producing countries along with India, Pakistan, Mexico, Brazil, the Philippines, etc. (Alexander, 1989).It is the national fruit of India, Pakistan, and the Philippines, and the national tree of Bangladesh.

Characteristics: Mango trees grow up to 35-40 m tall, with a crown radius of 10 m. The trees are long-lived, as some specimens still fruit after 300 years. The leaves are evergreen, alternate, simple, 15-35 cm long, and 6-16 cm broad; when the leaves are young they are orange-pink, rapidly changing to a dark, glossy red, then dark green as they mature. The flowers are produced in terminal panicles 10-40 cm long; each flower is small and white with five petals 5-10 mm long, with a mild, sweet odor suggestive of lily of the valley. Over 400 varieties of mangoes are known, many of which ripen in summer, while some give double crop. The fruit takes three to six months to ripen. The ripe fruit varies in size and color. Cultivars are variously yellow, orange, red, or green, and carry a single flat, oblong pit that can be fibrous or hairy on the surface, and which does not separate easily from the pulp. Ripe, unpeeled mangoes give off a distinctive resinous, sweet smell. Inside the pit 1-2 mm thick is a thin lining covering a single seed, 4-7 mm long. The seed contains the plant embryo (toptropicals.com).

Cultivation: The mango is now cultivated in most frost-free tropical and warmer subtropical climates; almost half of the world's mangoes are cultivated in India alone, with the second-largest source being China (Jedele *et al.,* 2003; Rediff.com, 2004). Other cultivators include North America (in South Florida and California's Coachella Valley), South and Central America, the Caribbean, Hawai'i, south, west, and central Africa, Australia, China, Pakistan, Bangladesh, and Southeast Asia. Though India is the largest producer of mangoes, it accounts for less than 1% of the international mango trade; India consumes most of its own production.

Varieties: Many commercial cultivars are grafted on to the cold-hardy rootstock of 'Gomera-1' mango cultivar, originally from Cuba. Its root system is well adapted to a coastal Mediterranean climate. Many of the 1,000+ mango cultivars are easily cultivated using grafted saplings. Dwarf or semi-dwarf varieties serve as ornamental plants and can be grown in containers. A wide variety of diseases and insect pests can afflict mangoes. In Bangladesh, the better varieties of mangoes have exotic names like Fazlee, Langra, Gopalbogh, Himsagar, Khirsapat, Ashhwina, Khisanbogh, Kuapahadi, Lata Bombai, Foria, Bombai, Kohitoor, Laksmanbhog, Mohanbhog, Misribhog etc. Fazli, Lengra, Gopalbhog and Khisrapat are considered to be the premier varieties-food fit for the Gods. Each has its distinctive flavor and arguments about the superiority of one over the other can get very serious.

Production: The Food and Agriculture Organization of the United Nations estimates worldwide production at nearly 38,600,000 tonnes (42,500,000 short tons) in 2011. India is the largest producer of mangoes with nearly 40% of world's production. Controlling attacks of mango mealy bugs on fruiting mango trees, however, is a major challenge. In Bangladesh, the average fruit production is 4.76 t/ha which is quite low compared to India (8-10 t/ha) as well as to the world production of 14-16 t/ha. In Bangladesh, mango occupies about an area of 50,491 ha with a production of 945049 metric tones during 2011-12 according to FAOSTAT, 2014. It is now in an increasing trend in area by 113.15% and in production by 106.28% in the year of 2011-12 compared to 2008-09 (FAOSTAT, 2014).

Consumption: Mangoes are generally sweet, although the taste and texture of the flesh varies across cultivars; some have a soft, pulpy texture similar to an overripe plum, while others are firmer, like a cantaloupe or avocado, and some may have a fibrous texture. The skin of unripe, pickled, or cooked mango can be consumed, but has the potential to cause contact dermatitis of the lips, gingiva, or tongue in susceptible people.

Insect pests: A number of insect pests of this fruit and over 175 species of insect have been reported damaging mango tree in Bangladesh, but the most abundant and destructive at the flowering stage are the mango hoppers (*Idioscopus clypealis*). Also mango mealy bug (*Drosicha mangiferae*), stem borer (*Batocera rubus*), fruit fly (*Bactrocera dorsalis*), mango nut weevil (*Sternochetus frigidus*) and caterpillar (*Euthalia garuda*) pests played a major role in bringing down the yield (Uddin, 2009). Other insect pests of mango are mango defoliator (*Cricula trifenestrata)*, mango fruit borer (*Antocharis albizonalis),* mango leaf cutting weevil (*Daporaus mangintus),* mango shoot gall (*Apsylla cistellata),* mango leaf gall (*Apsylla cistellata),* leaf miner (*Acrocercops syngramma).* Besides, eriophyid mite (*Aceria mangiferae)* also causes damage to the mango leaf.

Diseases: A number of fungal diseases also cause damage of flowers, fruits, leaves, seedlings, and twigs of mango. Among these the important diseases are the antracnose

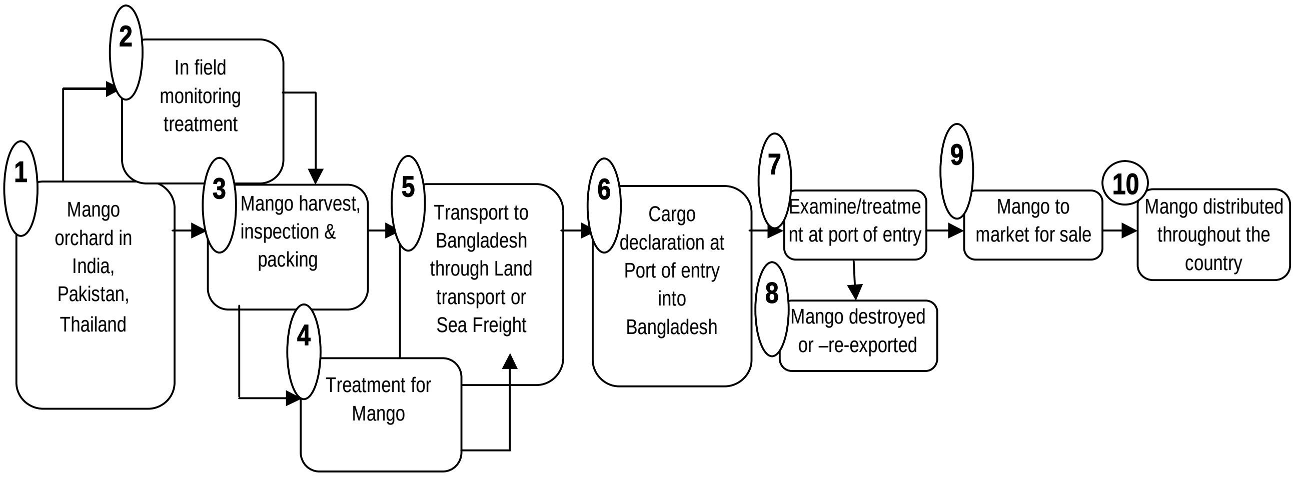
(*Coletrotricum gloespriedes*), powdery mildew (*Oidium* sp.), malformation of mango (*Fusarium moniliforme*), fruit end rot (*Lasiodiplodia theobromae*), shooty mould (*Capnodium* sp.), leaf red rust (*Cephaleures* sp.), cladosporium rot (*Cladosporium* sp.), diplodia rot (*Diplodia* spp.), dieback (*Lasiodiplodia theobromae*) (Ashrafuzzaman, 1991; Uddin, 2009).

1.5.3. Pathway Description

Import of mangoes to Bangladesh from other countries: For the purpose of this risk analysis, fresh mangoes (fruits) are presumed to be from anywhere in exporting countries such as India, Pakistan and Thailand. According to the West-Bengal Exporters Coordination Committee (2014), it is reported that Bangladesh imported annually 300,000 metric tonnes of mangoes from India over the last four years, But the Bangladesh importers are now unwilling to import mangoes from India due to proposal of high tariff. The mangoes used to import using Benapol, Burimari and Hilly land port of the country. In addition of India, mango also imported from Thailand and Pakistan.

To comply with existing Bangladesh's import requirements for fresh mangoes, the commodity would need to be prepared for export by the exporting countries to Bangladesh by ensuring certain pests are not associated with the product. Mango would then be transported from exporting country to Land port or sea freighted to Seaport Chittagong, Bangladesh where it will go to a holding facility before being distributed to the traders, and consumers for consumption.The linear pathway diagram of import risk of mango pests is furnished below:

Figure 2: Linear Pathway Diagram



Export of mangoes from India: India is the largest producer of mangoes in the world, producing over 65% of total world production (Patil and Patil, 1994). India exports fresh mangoes to over 50 countries (Patil and Patil, 1994). The major importers of fresh Indian mangoes are Gulf countries such as the UAE, Saudi Arabia, Kuwait, Bahrain, Qatar and Yemen. Other countries such as Bangladesh, the United Kingdom (UK), France, Belgium, Germany, the Netherlands, Spain, Israel, Singapore, Sri Lanka, Malaysia, Hong Kong and China, Canada and the United States are also important markets. UAE, Saudi Arabia, Kuwait, UK, Bahrain, Qatar, Bangladesh, Singapore and Malaysia together account for 97.17% in total exports of fresh mangoes from India (Patil and Patil, 1994). In 1999-2000, exports of fresh Indian mangoes were 37,109.67 MT (Anon., 2004a), with a value of approximately US$20M (Lal and Reddy, 2002). More or less similar agro-ecological conditions exist in both of India and Bangladesh, because of same borer of India surrounds Bangladesh except south. Therefore, the cross boundary pests may enter into Bangladesh from the provinces of India such as West Bengal, Assam, Tripura and Mizoram.

1.6. Review of Manageement Options

The following assessment of pre- and post-harvest practices reflects the current systems approach for risk management employed for commercially produced mangoes. It is proposed that these practices combined with specific post-harvest treatment (such as vapour heat treatment or irradiation) and other requirements (e.g. phytosanitary inspection) are used to manage the risks to importing countries posed by regulated organisms associated with the importation of mangoes from exporting countries.

1.6.1. Pre-harvest Management Options

The in-field pest management practises for the production of mangoes are in brief:

- Annual flooding of orchards to kill fruit fly pupae;
- Pre-flowering pesticide treatments for arthropods and fungi above threshold levels;
- Post-flowering and fruit pesticide treatments above threshold levels for specific pests such as mango hopper, mealy bug, stem borer, fruit and nut weevil, eriophyde mite and anthracnose, leaf red rust, powdery mildew, dieback;
- Specific pheromone trap and fruit bagging to reduce fruit fly infestation and anthracnose infection;
- Orchard hygiene which involves removal of fallen fruit under a Good Agricultural Practise (GAP) scheme administered by Department of Agriculture Extension (DAE);
- Specific fruit fly trapping programme to reduce and forecast pest prevalence.

1.6.2. Post-Harvest Procedures

Mangoes are routinely graded and washed. The procedure is as follows:

1. De-sapping (quality step);
2. Washing with clean water and drying (likely to remove external arthropods);
3. Sorting/grading to remove damaged/overripe/infested/infected fruit. The grading process is likely to remove fruit showing obvious signs of fungal and bacterial disease;
4. Fruits are packed for disinfestation by vapour heat treatment (into perforated trays) or for irradiation in export cartons.

1.6.3. Visual Inspection

Visual inspection of fruit occurs at several points during the routine production and post-harvest pathway for mangoes. These include:

- In-field monitoring during the growing season
- Harvesting
- Post-washing sorting and grading
- Packaging fruit for treatment
- Packaging of fruit for export (if above differs from packaging for treatment)
- Visual phytosanitary inspection

A visual inspection at multiple points of the pathway provides opportunities to remove infested/infected fruit and is considered an appropriate risk management option for regulated organisms such as mealybugs and scale insects as they are easily detected on the surface of mango fruit (DAFF 2004).

1.6.4. Treatment of arthropods

The current pre- and post-harvest procedures are aimed at reducing regulated organism load rather than removing all risk arthropods associated with mangoes from exporting countries. Therefore, a treatment is necessary to mitigate residual risk, especially from internally feeding arthropods such as fruit fly. Expert has indicated a treatment preference for vapour heat treatment (VHT) or irradiation. Viet Nam exports vapour heat treated dragon fruit to Japan (Viet Nam Net/VNA, 2009) and irradiated dragon fruit to the USA and therefore has the process and quality systems established for these treatment types.

A description and efficacy data for VHT (fruit pulp temperature ≥ 46.5ºC, held for ≥ 30 minutes) and irradiation (at 400 Gy absorbed energy) against arthropod groups has been discussed previously in the risk management proposal for mangoes from India http://www.biosecurity.govt.nz/biosec/consult/draft-ihs-mangoes-india.

Treatment with 150 Gy prevents adult fruit fly emergence from pupae (99.99% efficacy) (FAO 2009). Both treatment types are considered to be efficacious against specific target groups and are required by importing countries for the importation of mangoes from other countries (MAF 1999). However, in the absence of specific efficacy data for the risk organisms or a comprehensive import risk analysis for mangoes from exporting countries, the proposed treatment temperature/dosage requirements are higher than for existing pathways.

1.6.5. Phytosanitary Inspection and Certification

Importing country requires a phytosanitary certificate issued by respective authority of exporting country to accompany mangoes exported from exporting country to importing country. Before a phytosanitary certificate is issued, the respective authority of exporting country must conduct phytosanitary inspection to ensure that the number of packaged fruit is consistent with the number of disinfested fruits, traceability labelling is complete (including an official seal on the sides of packages), packaging is insect-proof and that all other importing country requirements have been met.

Where phytosanitary inspection occurs post-treatment (i.e. vapour heat treatment) the disinfestation facility is suspended from export, if live arthropods are detected on inspection, pending the results of an investigation.

1.6.6. Post-inspection Product Security

The importing country requires methods to be implemented to ensure post-inspection product security include segregation of product, insect-proof packaging, insect screening of storage facilities, at least yearly pre-season insecticide treatment of storage facility, and secure loading and transport of fruit.

1.6.7. Verification inspection on arrival in importing country

The respective authority of imporing country may inspect a sample taken from each lot on arrival in importing country to verify risk management actions undertaken were effective. The sampling procedure will be in accordance with design followed by the PQW-DAE of Banlgadesh. If a treatment has failed, or regulated organisms, extraneous plant material or trash are intercepted, one or more of the following actions will be undertaken: re-sorting of the consignment, treatment where an efficacious treatment is available, re-shipment or destruction of the consignment and/or the temporary suspension of the pathway on the detection of regulated organisms for which pre-export phytosanitary measures are required. The suspension will continue until the cause of the non-compliance has been identified and corrective actions have been implemented and approved by respective authority of importing country.

1.6.8. Auditing

The Quarantine Department of the importing country will monitor interceptions of hitchhikers and the appropriateness/effectiveness of phytosanitary measures on the commencement of trade.

1.7. Bangladesh Climate-General

Bangladesh has a subtropical monsoon climate characterized by wide seasonal variations in rainfall, high temperatures and humidity. There are three distinct seasons in Bangladesh: a hot, humid summer from March to June; a cool, rainy monsoon season from June to October; and a cool, dry winter from October to March. In general, maximum summer temperatures range between 30°C and 40°C. April is the warmest month in most parts of the country. January is the coldest month, when the average temperature for most of the country is about 10°C. http://www.weatheronline.co.uk/reports/climate/Bangladesh.htm

The minimum termperature in different locations of the country ranges from 10.0^{o}C to 15.40^{o}C and lowest recorded Srimangal under Habiganj district and highest recorded in Cox's Bazar district on the bank of Bay of Bengal. The maximum normal temperature in different locations of the country ranges from 31.80°C in Mymenshing district to 36.10°C in Chuadanga district.

Heavy **rainfall** is characteristic of Bangladesh. Most rains occur during the monsoon (June-September) and little in winter (November-February). With the exception of the relatively dry western region of Rajshahi, where the annual rainfall is about 1600 mm, most parts of the country receive at least 2000 mm of rainfall per year. Because of its location just south of the foothills of the Himalayas, where monsoon winds turn west and northwest, the regions in northeastern Bangladesh receives the greatest average precipitation, sometimes over 4000 mm per year. About 80 percent of Bangladesh's rain falls during the monsoon season (WeatherOnline, 2015). http://www.weatheronline.co.uk/reports/climate/Bangladesh.htm

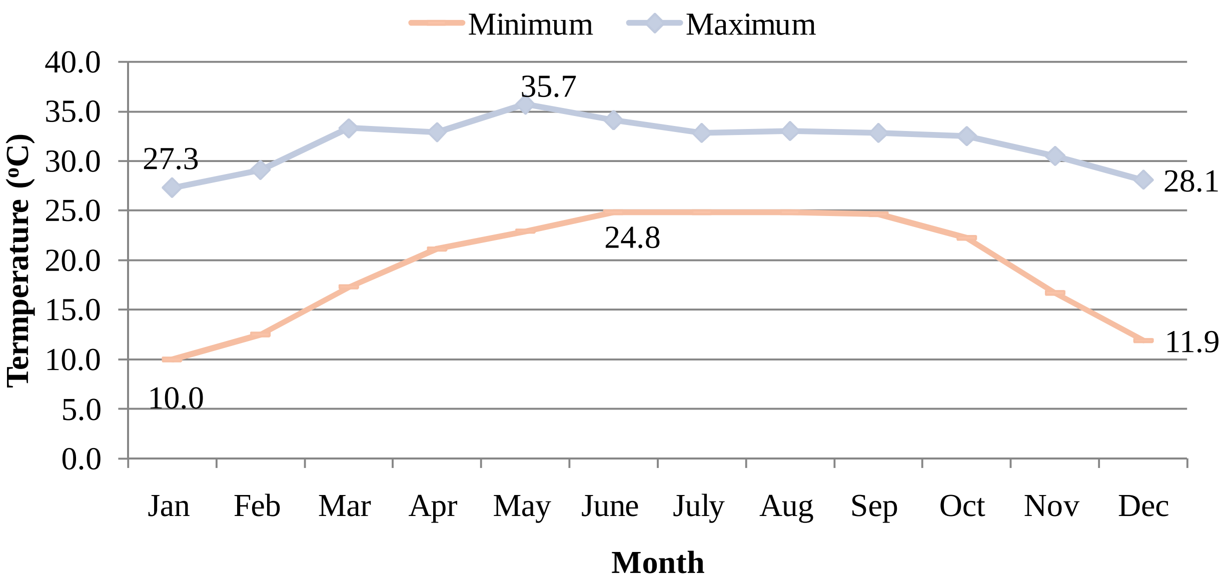


Figure 3. Monthly distribution pattern of standard normal temperature in Bangladesh, 1981-2012

Source: BBS (2013)

Köppen climate classification

The Climate of Bangladesh can be divided in different climate zones. The central and southern part can be classified as **Aw** climate, a hot, tropical climate with all months above 18°C and a dry period in the winter. The northern mountainous areas can be classified as **Cwa** climate; a Temperated, humid climate with the warmest month above 22°C and a dry period in the winter (Arnfield, 2014). http://www.weatheronline.co.uk/reports/climate/Bangladesh.htm

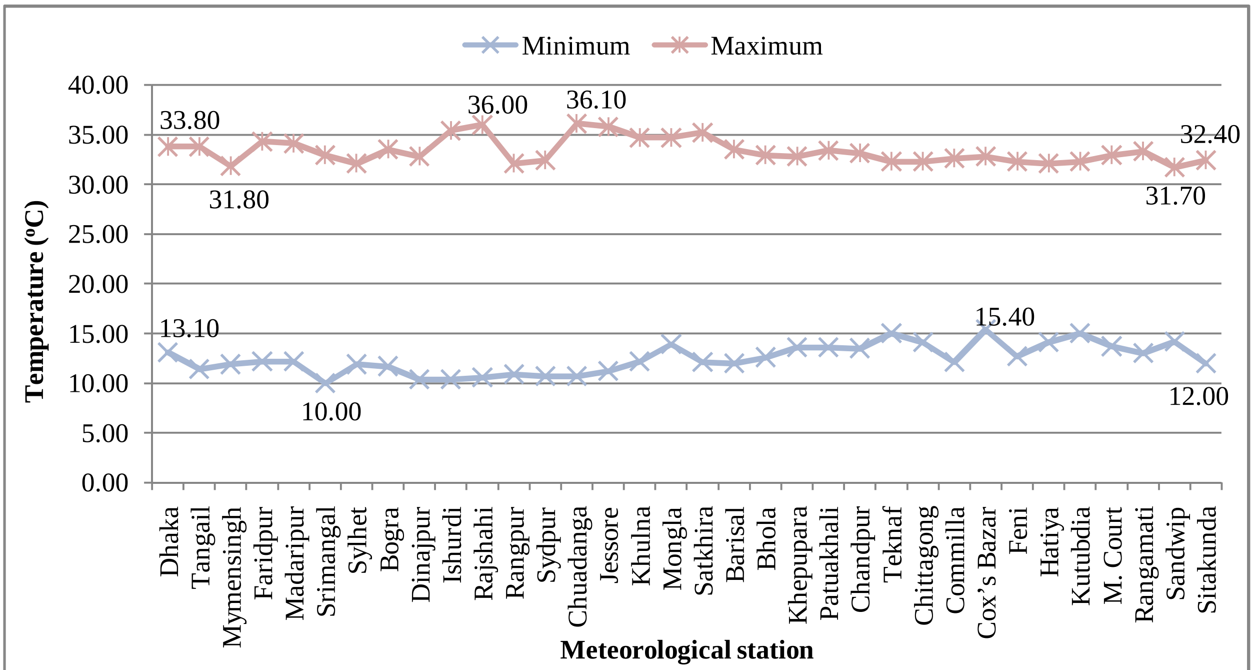


Figure 4. Location-wise distribution pattern of standard normal temperature in Bangladesh, 1981-2012

Source: BBS (2013)

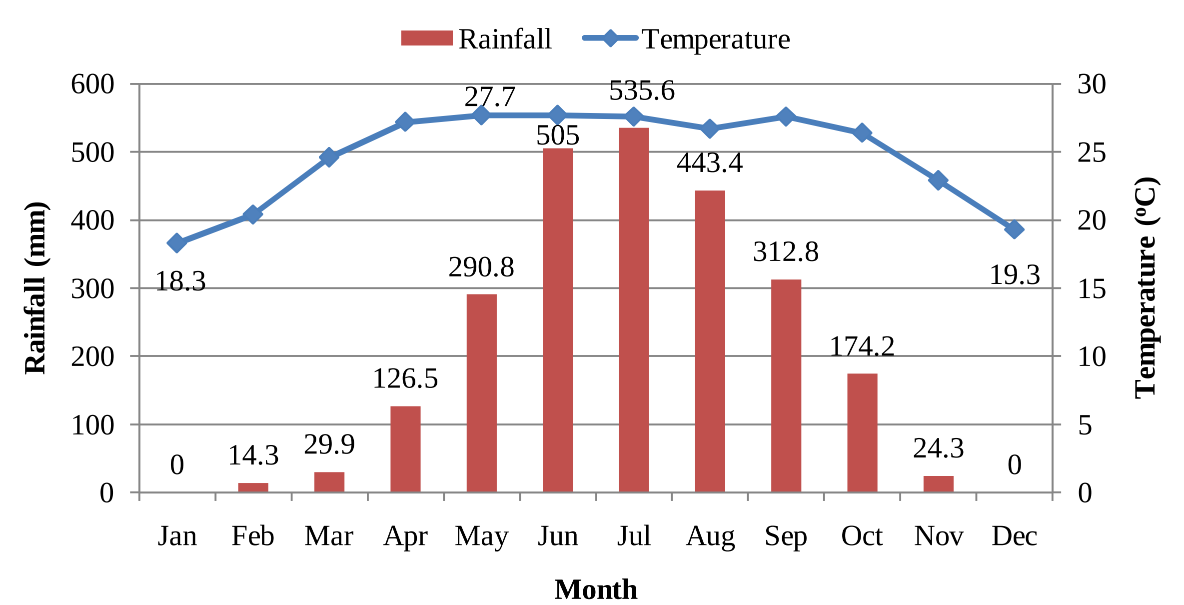


Figure 5. Average monthly Temperature and Rainfall for Bangladesh from 1960-1990

Source: World Bank Group (2015)

1.8. Climate of Exporting Countries-General

1.8.1. India-General Climate

India's climate can be classified as a hot tropical country, except the northern states of Himachal Pradesh and Jammu & Kashmir in the north and Sikkim in the northeastern hills, which have a cooler, more continental influenced climate.

In most of India summer is very hot. It begins in April and continues till the beginning of October, when the monsoon rains start to fall. The heat peaks in June with temperatures in the northern plains and the west reach 45° C and more. The monsoons hit the country during this period too, beginning 1st of June when they are supposed to find the Kerala coast, moving further inland from day to day. Moisture laden trade winds sweep the country bringing heavy rains and thunderstorms; sometimes these monsoon rains can be very heavy, causing floodings and damage, especially along the big Rivers of India, Bramaputhra and Ganges.

The plains in the north and even the barren countryside of Rajasthan have a cold wave every year in December-January. Minimum temperatures could dip below 5°C but maximum temperatures usually do not fall lower than 12°C. In the northern high altitude areas of the northern mountains it snows through the winter and even summer months are only mildly warm. Typhoons are usually not an danger, these tropical storms are quite seldom in India. The Typhoon Season is from August to November; the East coast of India has the highest Typhoon risk.

Koeppen-Geiger classification:

The Climate of India can be divided in different climate zones. The eastern part of India and the west coast can be classified as Aw climate, a hot, tropical climate with all months above 18°C and a dry period in the winter. The southern Tip of india can be classified as Am climate, a hot tropical Rainforest climate with monsoon rains and all months above 18°C. Central and Northwest India have a BSh climate, a dry Steppe climate with an annual average Temperature above 18°C. Finally, The northern mountainous areas can be classified as Cfa climate; a Temperated, humid climate with tha warmest month above 22°C.

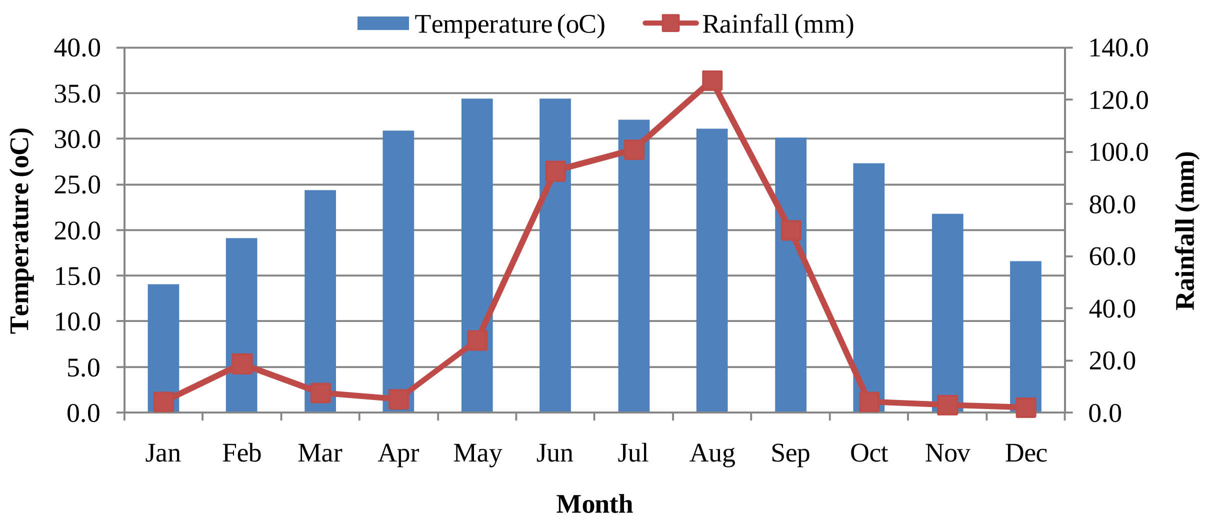


Figure 6. Monthly distribution pattern of standard normal temperature and rainfall in India from January 2000 to December 2014

Source: WeatherOnline (2015a)
http://www.weatheronline.co.uk/weather/maps/city?LANG=en&PLZ=_____&PLZN=_____&WMO=42182&CONT=asie&R=0&LEVEL=162&REGION=0024&LAND=II&MOD=tab&ART=PRE&NOREGION=1&FMM=1&FYY=2000&LMM=12&LYY=2014

1.8.2. Pakistan General Climate

Pakistan has recorded one of the highest temperatures in the world - 53.5 °C - on 26 May 2010. It is not only the hottest temperature ever recorded in Pakistan, but also the hottest reliably measured temperature ever recorded in the continent of Asia.[1][2] As Pakistan is located on a great landmass north of the tropic of cancer (between latitudes 25° and 35° N), it has a continental type of climate characterized by extreme variations of temperature, both seasonally and daily. Very high altitudes modify the climate in the cold, snow-covered northern mountains; temperatures on the Balochistan Plateau are somewhat higher. Along the coastal strip, the climate is modified by sea breezes. In the rest of the country, temperatures reach great heights in the summer; the mean temperature during June is 38 °C in the plains, the highest temperatures can exceed 47 °C. In the summer, hot winds called Loo blow across the plains during the day. Trees shed their leaves to avoid loss of moisture. The dry, hot weather is broken occasionally by dust storms and thunderstorms that temporarily lower the temperature. Evenings are cool; the diurnal variation in temperature may be as much as 11°C to 17°C. Winters are cold, with minimum mean temperatures in Punjab of about 4 °C in January, and sub-zero temperatures in the far north and Balochistan.

Fog occurs during the winter season and remains for weeks in upper Sindh, central Khyber Pakhtunkhwa and Punjab. Southwest Monsoon occurs in summer from the month of June till September in almost whole Pakistan excluding western Balochistan, FATA, Chitral and Gilgit–Baltistan. Monsoon rains bring much awaited relief from the scorching summer heat. These monsoon rains are quite heavy by nature and can cause significant flooding, even severe flooding if they interact with westerly waves in the upper parts of the country. Tropical Storms usually form during the summer months from late April till June and then from late September till November. They affect the coastal localities of the country.

Pakistan has four seasons: a cool, dry winter from December through February; a hot, dry spring from March through May; the summer rainy season, or southwest monsoon period, from June through September; and the retreating monsoon period of October and November. The onset and duration of these seasons vary somewhat according to location. http://en.wikipedia.org/wiki/Climate_of_Pakistan

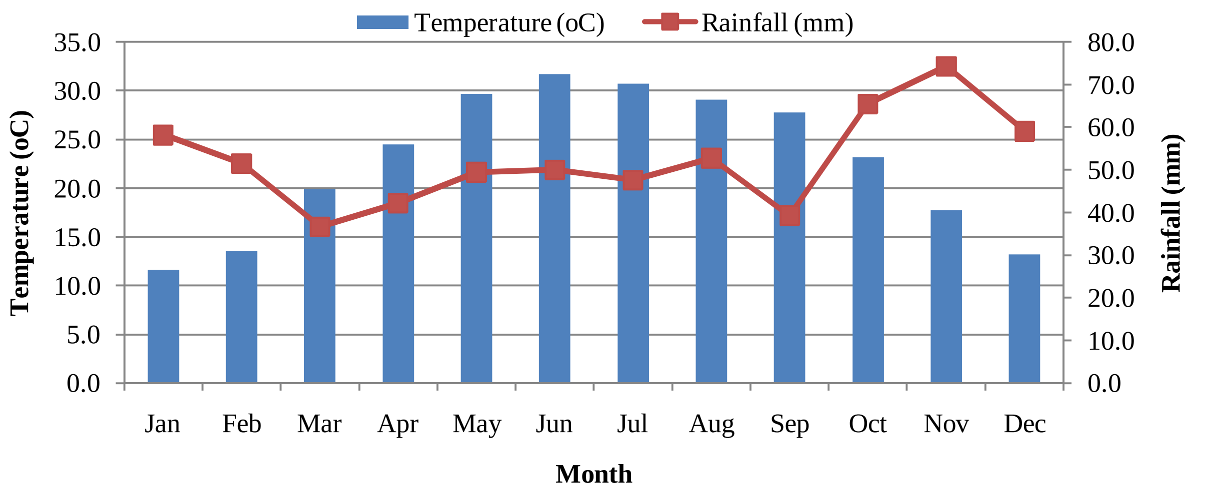


Figure 7. Monthly distribution pattern of standard normal temperature and rainfall in Pakistan from January 2000 to December 2014

Source: WeatherOnline (2015b)
http://www.weatheronline.co.uk/weather/maps/city?FMM=1&FYY=2000&LMM=12&LYY=2014&WMO=03772&CONT=ukuk&REGION=0003&LAND=UK&ART=PRE&R=0&NOREGION=1&LEVEL=162&LANG=en&MOD=tab

1.8.3. Thailand -General Climate

Thailand's Climate can be described as tropical monsoon climate. It is characterized by strong monsoon influences, has a considerable amount of sun, a high rate of rainfall, and high humidity that makes it sometimes feel quite uncomfortable.

The annual average temperature ranges from 22°C to 27°C year-round. There are two distinguishable seasons in Thailand, a dry period in the winter and a humid rain period in the summer.

Koeppen-Geiger classification: The Climate of Thailand can be classified as Aw climate, a hot, tropical climate with all months above 18°C and a dry period in the winter. The southern coast of Thailand has an Af climate, a hot, humid climate with all months above 18°C. http://www.weatheronline.co.uk/reports/climate/Thailand.htm

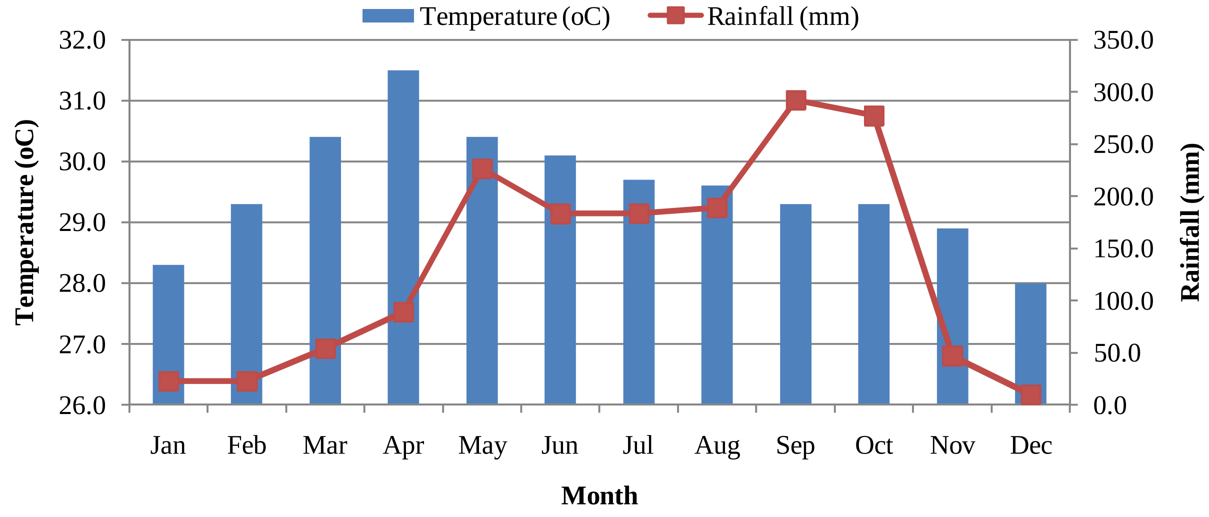


Figure 8. Monthly distribution pattern of standard normal temperature and rainfall in Thailand from January 2000 to December 2014

Source: WeatherOnline (2015c)
http://www.weatheronline.co.uk/weather/maps/city?FMM=1&FYY=2000&LMM=12&LYY=2014&WMO=48455&CONT=asie&REGION=0027&LAND=TH&ART=PRE&R=0&NOREGION=1&LEVEL=162&LANG=en&MOD=tab

1.9. Methodology

The methodology for the present PRA study used system-wide approach, which involved wide-ranging and sequenced discussion with relavent stakeholders aiming to identify the insect pests, diseases and other associated pests of mangoes, their potential hazards, quarantine concern of the pests, their risk and management options. The study involved the use of (i) field survey through structured questionnaire, (ii) semi-structured interviews by means of focus group discussions (FGD), (iii) formal and non-formal interviews through Key Informant Interview (KII); (iv) collection of primary and secondary information, reviewing the available reports and (v) physical field visits to the sampled area.

1.9.1. Major Activities of the PRA Process

Field survey

The study survey was conducted with the direct interview of mango growers in 19 major growing districts of Bangladesh for quantitative data aiming to identify insect pests, diseases, weeds and other pests, their status, damane severity, and management options; quarantine pests with their entry, establishment, risk and their management. The qualitative data were also collectected through focus group discussions (FGD) with mango growers and through key informant interviews (KII) with extension personnel at field and headquarer level, Plant Quarantine Centres at Sea and land port, officials of Ministry of Agriculture, Entomologist and Plant Pathologist of Bangladesh Agricultural Research Institute (BARI), Agricultural Universities, and Mango Imorters and Exporters.

Secondary data collection and review

The current PRA related secondary data were collected and gathered from secondary sources such as journals, books, proceedings, CD-ROM search, internet browsing especially through websits of CAB International, EPPO Bulletin and others. The documents were then critically reviewed, synthesized in relation to identify the quarantine pests of mango available in the mango exporting counties such as India, Pakistan and Thailand as well as PRA related activities performed there. Ultimately, formulated all of these synthesized information based on the requirement of the current PRA.

Listing of pests of mango

The insect pests, diseases, weeds and other associated pests of mango were identified through the field survey, focus group discussion, Key Informant Interview and direct field visit and prepared a list of insect pests, diseases, weeds and other associated pests of the target crops following the framework for pest risk analysis adopted by the IPPC in International Standard for Phytosanitary Measures (ISPMs) and other related ISPMs. The quarantine pests of mango in Bangladesh were also listed.

Use of Pheromone traps for capturing and identification of fruit fly

The pheromone traps for capturing adult flies were set up in the mango orchard of all 19 sampled distrcts aiming to identify different species of fruit fly available there. The pheromone traps were set up in the mango orchard during the field visit by the enumerators and the captured adult fruit flies were then collected and preserved in the boxes. All the captured adult fruit flies collected from 19 sampled districts were then identified for species diversity under the direct supervision of the Team Leader in the laboratory under the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka

1.9.2. Survey location and sample sizea

The survey study sas conducted in the 19 major mango growing districts of Bangladesh asselected by the client-Project Director, Stenghthening Phytosanitary Capacity in Bangladesh (SPCB) under Plant Quarantine Wing (PQW), DAE, Bangladesh. A total 69 upazilas (sub-district) were selected under the 19 sampled distrcts, where 10 agricultural blocks were covered under each upazilla and 10 mango growers/farmers were interviewed in each block through pre-tested questionnaire. Thus, a total of 6,900 growers/farmers were interviewed from all of 19 sampled districts. The focus group discussion (FGD) meeting was also conducted for each of 19 sampled districts with the participation of at least 10 mango growers/farmers aiming to gather qualitative data. Besides, one officer designated as Additional Deputy Director (Plant Protection) for each district had also been interviewed through semi-structured key informant interview (KII) checklist. The district and upazila wise distribution of respondents is given below:

Table-1: Distribution of sample respondents in selected districts of Bangladesh

Sl. No	District	Upazilla	No. of Block	No. of Farmers	No. of FGD	KII at district level DAE
1	Chapainawabgonj	1.Sadar	10	100	1	1
		2. Shibgonj	10	100		
		3. Bholahat	10	100		
		4. Gomostapur	10	100		
		5. Nachol	10	100		
2	Rajshahi	6. Paba	10	100	1	1
		7. Mohanpur	10	100		
		8. Bagha	10	100		
		9. Puthia	10	100		
		10. Charghat	10	100		
		11. Durgapur	10	100		
		12. Bagjmara	10	100		
3	Natore	13. Sadar	10	100	1	1

Sl. No	District	Upazilla	No. of Block	No. of Farmers	No. of FGD	KII at district level DAE
		14. Baghatipara	10	100		
		15. Gurudaspur	10	100		
		16. Lalpur	10	100		
4	Dinajpur	17. Sadar	10	100	1	1
		18. Birol	10	100		
		19. Birgonj	10	100		
		20. Fulbari	10	100		
		21. Birampur	10	100		
5	Thakurgaon	22. Sadar	10	100	1	1
		23. Pirgonj	10	100		
		24. Baliadangi	10	100		
		25. Ranisankail	10	100		
6	Nilphamari	26. Sadar	10	100	1	1
		27. Sayedpur	10	100		
		28. Domar	10	100		
7	Rangpur	29. Sadar	10	100	1	1
		30. Gangachara	10	100		
		31. Badargonj	10	100		
		32. Pirgacha	10	100		
		33. Mithapukur	10	100		
8	Pabna	34. Iswardi	10	100	1	1
		35. Atghoria	10	100		
9	Meherpur	36. Sadar	10	100	1	1
		37. Mujibnagar	10	100		
10	Chuadanga	38. Sadar	10	100	1	1
		39. Damurhuda	10	100		
		40. Alamdanga	10	100		
11	Kustia	41. Sadar	10	100	1	1
		42. Kumarkhali	10	100		
12	Jhenidah	43. Sadar	10	100	1	1
		44. Harinakundu	10	100		
13	Jessore	45. Bagharpara	10	100	1	1
		46. Jhikorgacha	10	100		
14	Satkhira	47. Sadar	10	100	1	1
		48. Kolaroua	10	100		
		49. Tala	10	100		
15	Mymenshingh	50. Sadar	10	100	1	1
		51. Gouripur	10	100		
		52. Muktagacha	10	100		
16	Jamalpur	53. Sadar	10	100	1	1
		54. Islampur	10	100		
		55. Dewangonj	10	100		
17	Khagrachori	56. Sadar	10	100	1	1
		57. Dhiginala	10	100		

Sl. No	District	Upazilla	No. of Block	No. of Farmers	No. of FGD	KII at district level DAE
		58. Panchori	10	100		
		59. Mohalchori	10	100		
		60. Ramghor	10	100		
		61. Matiranga	10	100		
18	Rangamati	62. Sadar	10	100	1	1
		63. Longadu	10	100		
		64. Kaptai	10	100		
		65. Baghichori	10	100		
19	Bandarban	66. Sadar	10	100	1	1
		67. Lama	10	100		
		68. Ruma	10	100		
		69. Naikhongchari	10	100		
Total = 19		**69**	**690**	**6,900**	**19**	**19**

1.9.3. Development of indicators for field survey

Considering the specific objectives of the study, the major indicators for the field survey were indentified in consultation with the Officials of Strengthening Phytosanitary Capacity in Bangladesh (SPCB) Project under Plant Quarantine Wing (PQW) of Department of Agriculture Extension (DAE), Bangladesh. The indicators were mango vatieties cultivated by the growers; occurrence, status and damage severity of insect pests, diseases, weeds and other associated pests of mango; their potential risk, endangered areas in Bangladesh; identification of quarantine pests of mangoo; entry and pathways of quarantine pests; effective measures in controlling these pests; options in preventing the entry and spread of quarantine pests, their risk and management options and phytosanitary measures.

1.9.4. Development of data collection tools

The most appropriate tools used in this field study are discussed below:

Field survey questionnaire: For quantitative analysis, the field survey was conducted in 19 major mango growing districts of Bangladesh through face to face interview with 6,900 mango growers using a set of pre-designed and pre-tested questionnaire (**Appendix-1)** encompassing the relevant study indicators. A field guide emphasizing on the comprehensive list and colorful photographs of insect pests, diseases and weeds of mango was also prepared aiming to enhance the data enumerators and mango growers to ease identification of the respective pests whether these were occurred in their orchard or not.

Focus Group Discussion (FGD): For qualitative analysis, 19 FGD meetings were organized considering one FGD for each sampled districts with the participantion of at least 10 mango growers for each. The FGD meetings were conducted using pre-designed FGD guidelines (**Appendix-2**).

Key Informant Interview (KII): The key informant interviews were conducted with the extension personnel at field and headquarer level of DAE, officials of Plant Quarantine Centres at Sea and land ports; officials of Ministry of Agriculture; Entomologist and Plant Pathologist of BARI, Agricultural Universities, and Mango Imorters. A total of 40 key personnel were interviewed using a semi-structured KII Checklist (**Appendix-3)** encompassing the qualitative issues of the study.

Field visit/physical observation: In addition, the expert team of the study physically visited the sampled districts of the study area aiming to observe the physical status of the insect pests, diseases and other associated pest problems in field condition**.**

1.9.5. Recruitment and training of field staff

The Junior Entomologist and Junior Plant Pathologist having master's degree in Entomology and Plant Pathology respectively were reqruited as data enumerators. A total 19 data enumerators, of which 1 for each of 19 sampled districts were employed for field level data collection. A total 5 field supervisors for 5 administrative divisions (such as Rajshahi, Rangpur, Khulna, Dhaka and Chittagong) of Bangladesh were also reqruited and employed to supervise the activities of data enumerators. After recruitment, all the data enumerators and supervisors had been trained by three-day training course about data collection procedures for this PRA study.

1.9.6. Method of data collection

Direct personal interview approach was adopted for primary data collection. The field enumerators personally contacted the mango growers and filled up the each question of the questionnaire one by one to obtain desired information. In addition, qualitative information was collected through FGD meetings with mango growers using FGD guidelines under supervision of supervisors. The field level data collection was conducted for a month at first stage such as started from February to May 2015.

1.9.7. Data analysis

As soon as the filled up questionnaires received from the field, data entry of the questionnaires were completed using SPSS and MS Access computer packages and the data were analyzed for tabulation of the primary data into data tables.

1.9.8. Laboratory Investigation

The samples for insect pests particularly fruit fly and diseases from the mango orchard were carried out to the Dhaka office and preserved with location wise lebeling in the refreegerator at $4^{o}C$ in the Laboratory under the Department of Entomology and Plant Pathology at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. The evidence for specific pest especially for fruit fly was proved by in-depth investigations. The fruit flies captured through pheromone traps from the 19 sampled districts had been identified using the Stereo Microscope and following the Taxonomic Keys.

CHAPTER 2

Fingdins of Survey Study

2.1. Introduction

The study for “Conducting Pest Risk Analysis (PRA) of Mango in Bangladesh” was done in 19 major mango growing districts of Bangladesh. The sampled districts were selected by the client-Strengthening Phytosanitary Capacity in Bangladesh (SPCB) Project under Plant Quarantine Wing (PQW), Department of Agriculture Extension (DAE), Bangladesh-based on the acreage of cultivation and annual production of mango in the sampled districts. Considering the objectives of the study, data were collected through growers’ level field survey for quantitative analysis as well as focus group discussions and key informant interview were conducted for qualitative analysis encompassing the issues about occurrence and status of insect pests, diseases, weeds and other associated pests of mango, their damane, infestation severity and management options; potential quarantine pests of mango, their entry, establishment, risk and management. The precise findings of the study have been presented below:

2.2. Mango varieties cultivated by the growers

The farmers in different growing areas of Bangladesh were usually cultivating different mango varieties and the most familiar varieties commonly they used for cultivation were Amropali (BARI Aam-3), Langra, Lankhanbhog, Fazli, Gopalbhog, Shirsapati, Himsagar, Mohanbhog, (BARI Aam-1). Other polular varieties used by the farmers were Chosha, Hariabhanga particularly in Rangpur district, Kalapahari, Bombay, Guti Aam, Mishribhog, Surjapuri, Lal Shindur. Most of the farmers used the mango seedlings collected from Local Nursery followed by their own grafted mango seedlings and neighboring mango growers. Other sources of mango seedlings were BADC (Bangladesh Agricultural Development Corporation) nursery, different research organization, NGOs. But the growers do not use the mango seedlings collected neighboring countries.

2.3. Insect and mite pests of mango

A total number of 18 insect pests and 1 mite pest of mango were reported by the stakeholders those were found in the orchard of mango. The incidences and damage potential of reported mango insect pests have been presented below:

Incidence of insect and mite pests: The incidences of major insect pests of mango recorded were mango hopper (*Amritodus atkinsoni*, *Idioscopus clypealis*) and oriental fruit fly (*Bactrocera dorsalis* (Hendel))) in field condition. The important minor insect pests of mango were mango pulp weevil (*Sternochaetus frigidus*), mango mealybug (*Droshicha mangiferae* Green) recorded for the infestation in the field condition. Other minor insect pests were mango stone/seed weevil (*Sternochetus mangiferae* (Fabricius)), leaf cutting weevil (*Deporaus marginatus*), mango stem/trunk borer (*Batocera rubus* (Linnaeus, 1758)), mango fruit fly (*Bactrocera tau* (Walker, 1849)), guava fruit fly/peach fruit fly (*Bactrocera zonata* (Saunders)), mango leaf gall midge (*Procontarinia matteiana*), mango common scale (*Coccus mangiferae* (Green)), mango shoot gall psyllid (*Apsylla cistellata* (Cockerell, 1893)), mango defoliator (*Cricula trifenestrata* (Helfer 1837)), mango fruit borer (*Citripestis eutraphera* Meyrick), mango leaf webber (*Orthaga exvinacea* Hampson), mango leafminer (*Acrocercops syngramma* Meyrick), mango leaf caterpillar (*Euthalia aconthea*), and pink gypsy moth (*Lymantria mathura* Moore 1865) in field condition (Table 2). The mango eriophyid mite was also reported as the minor pest of mango in the field condition. But the incidene of Mediterranean fruit fly (*Ceratitis capitata*), Queensland fruit fly (*Bacterocera troyni*), and Tapioca scale insect (*Aonidomytilus albus* (Cockerell, 1893)) were not recorded in the field of mango growing areas of Bangladesh. Likewise, mango mealybug (*Droshicha mangiferae* Green) was recorded in the restricted areas of mango field in Bangladesh.

Damage potential of insect pests: Among these insect pests, mango hopper, oriental fruit fly and mango pulp weevil were more damaging than others. The adults and nymphs of mango hopper caused damage mango at its flower stage on inflorescence and fruits at pea size stage with medium to high infestation severity, if not controlled properly. Usually Bangladesh's farmers always used chemical insecticides and suppressed the the infestation of mango hopper in every season; both adults and grubs of mango pulp weevil caused damage at fruting stage of mango by feeding the internal pulp of mango with low to medium infestation severity. Besides, the oriental fruit fly (*Bactrocera dorsalis*) caused damage mango at fruiting stage by feeding the internal pulp by maggots with low to medium infestation severity. Other minor insect and mite pests damage mango with low infestation intensity.

Table-2: Insect and mite pests of mango, their identity, status and infestation severity

Name of pest	Pest identiy	Pest status	Stage and plant parts affected	Infestation severity
Mango pulp weevil	*Sternochaetus frigidus* Order: Coleoptera Family: Curculionidae	Minor	Fruit pulp	Low to medium
Mango stone/nut/ seed/weevil	*Sternochetus mangiferae* (Fab.) Order: Coleoptera Family: Curculionidae	Minor	Fruit, seed	Low
Leaf cutting weevil	*Deporaus marginatus* Order: Coleoptera Family: Curculionidae	Minor	Young leaf	Low
Mango stem/ trunk borer	*Batocera rubus* (Linnaeus, 1758) Order: Coleoptera Family: Cerambycidae	Minor	Tree trunk, stem	Low
Oriental fruit fly	*Bactrocera dorsalis* (Hendel) Order: Diptera Family:Tephritidae	Major	Fruits	Low to medium
Cucurbit fruit fly	*Bactrocera cucurbitae* Order: Diptera Family:Tephritidae	Minor	Fruits	-
Mango fruit fly	*Bactrocera tau* (Walker 1849) Order: Diptera Family:Tephritidae	Minor	Fruits	Low
Peach fruit fly/ Guava fruit fly	*Bactrocera zonata* (Saunders) Order: Diptera Family:Tephritidae	Minor	Fruits	Low
Mediterranean fruit fly	*Ceratitis capitata* Order: Diptera Family:Tephritidae	Not recorded in Bangladesh	Fruits	-
Queensland fruit fly	*Bactrocera tryoni* Order: Diptera Family:Tephritidae	Not recorded in Bangladesh	Fruits	-
Mango leaf gall midge	*Procontarinia matteiana* Order: Diptera Family: Cecidomyiidae	Minor	Leaves	Low
Mango hopper	*Amritodus atkinsoni*, *Idioscopus clypealis* Order: Homoptera Family: Cicadellidae	Major	Leaves, stems, flowers, fruits at pea size	Medium to high
Mango common scale insect	*Coccus mangiferae* (Green) Order: Homoptera Family: Coccidae	Minor	Leaves, twigs	Low
Tapioca scale insect	*Aonidomytilus albus* (Cockerell, 1893) Order: Homoptera Family: Diaspididae	Not recordedd in Bangladesh	Leaves, twigs, stem	-
Mango shoot gall	*Apsylla cistellata* (Buckton, 1896)	Minor	Shoot, twig	Low

Name of pest	Pest identiy	Pest status	Stage and plant parts affected	Infestation severity
psyllid	Order: Homoptera Family: Coccidae			
Mango mealy bug	*Droshicha mangiferae* Green Order: Homoptera Family: Monophlebidae	Recorded in restricted areas of Bangladesh	Inflorescences, tender leaves, shoots & fruit peduncles	Low
Mango defoliator	*Cricula trifenestrata* (Helfer 1837) Order: Lepidoptera Family: Saturniidae	Minor	**Leaves,** Twigs	Low
Mango fruit borer	*Citripestis eutraphera* Meyrick Order: Lepidoptera Family: Pyralidae	Minor	Fruits	Low
Mango leaf webber	*Orthaga exvinacea* Hampson Order: Lepidoptera Family: Pyralidae	Minor	Leaves, twigs	Low
Mango leafminer	*Acrocercops syngramma* Meyrick Order: Lepidoptera Family: Gracillariidae	Minor	Leaves, twigs	Low
Mango leaf caterpilla	*Euthalia aconthea* Order: Lepidoptera Family: Gracillariidae	Minor	Leaves, twigs	Low
Pink gypsy moth	*Lymantria mathura* Moore 1865 Order: Lepidoptera Family: Lymantriidae	Minor	Leaves, twigs	Low
Mango eriophyid mite	*Aceria mangiferae* Sayed Order: Acarina Family: Eriophyidae	Minor	Leaves, fruits	Low

Idenfication of fruit fly: The fruit flies collected from 19 sampled districts using pheromone traps had been identified through the use of Stereo Microscope following the Taxonomic Key. Twenty adult fruit flies were studied for each of the sampled districts and it was evident that all of the studied adult fruit flies were oriental fruit fly, *Bactrocera dorsalis*, belonging to the Order Diptera and Family Tephritidae.

2.4. Diseases of mango

A total number of 8 diseases of mango among which 7 caused by fungi, 1 by algae were reported by the stakeholders those were found in the field of mango and or storage condition. The incidences and damage potential of reported mango diseases have been presented below:

Incidence of diseases: The incidences of major diseases of mango found in the study were anthracnose disease (*Colletotrichum gloeosporioides*) of mango fruits and leaves in the field condition. The incidences of minor diseases of mango were powdery mildew (*Oidium mangiferae*), mango malformation (*Fusarium moniliforme*), Alternaria leaf spot of mango (*Alternaria alternate* (Fr.) Keissl. (1912)), blossom blight/ grey mould (*Botryosphaeria theobromae*), mango scab (*Elsinoë mangiferae*) caused by fungi, and leaf red rust of mango (*Cephaleuros virescens* Kunze 1827) in the field condition as well as anthracnose and common scab found in the storage condition of fruits (Table 3). The bacterial black spot disease caused by *Xanthomonas campestris* pv. *mangiferaeindicae* was not found in Bangladesh.

Damage potential of diseases: Among these diseases, the anthracnose diseases on leaves and fruits were more damaging than others. The anthracnose disease caused damage mango at vegetative and fruiting stage as well as in storage condition with high infection intensity, but the damage severity was controlled by the farmers through routine application of fungicides in the orchard. But the mango leaf red rust disease caused damage mango leaves at vegetative stage with high infection intensity in the hilly areas such as Khagrachari, Rangamati and Bandarban districts. Other diseases caused damage mango with low infection intensity. But all these diseases of mango were being regularly controlled by the application of chemical pesticides in the field. Therefore, the severity of these diseases stayed behind, otherwise they could become severe.

Table-3: Diseases of mango, their categorical identity, status and infection severity

Disease	Pathogen identiy	Disease status	Stage and plant parts affected	Infection severity	Pest category
Mango anthracnose	*Colletotrichum gloeosporioides* Order: Glomerellales Family: Glomerellaceae	Major	Panicles, leaves, branch terminals, fruits	Medium	Fungi
Powdery mildew	*Oidium mangiferae* Order: Erysiphales Family: Erysiphaceae	Minor	Leaves, inflorescences, fruits	Low	Fungi
Mango malformation	*Fusarium moniliforme* Order: Hypocreales Family: Nectriaceae	Minor	Inflorescences, twigs, seedlings,	Low	Fungi
Alternaria leaf spot	*Alternaria alternate* (Fr.) Order: Pleosporales Family: Pleosporaceae	Minor	Leaves	Low	Fungi
Blossom blight/ grey mould	*Botrytis cinerea* Pers.1794 Order: Helotiales Family: Sclerotiniaceae	Minor	Flowers and fruits	Low	Fungi
Die back	*Botryosphaeria theobromae* Order: Botryosphaeriales Family: Botryosphaeriaceae	Minor	Shoots, leaves, twigs	Low	Fungi
Mango scab	*Elsinoë mangiferae* Order: Myriangiales Family: Elsinoaceae	Minor	Leaves, fruits	Low	Fungi
Leaf red rust	*Cephaleuros virescens* Kunze Order: Trentepohliales Family: Trentepohliaceae	Minor	Leaves, petioles, twigs	Low	Algae
Bacterial black spot	*Xanthomonas campestris* pv. *mangiferaeindicae* Order: Xanthomonadales Family: Xanthomonadaceae	-	Not found in Bangladesh	-	Bacteria

2.5. Weeds of mango

A total number of 2 weeds were reported by the stakeholders those were found in the field of mango. The incidences and damage potential of reported mango weeds have been presented below:

Incidence of weeds: The incidences of weeds of mango found in the study were loranthus/Indian mistletoe (*Dendrophthae falcate*) and Pathenium weed (*Parthenium hysterophorus* L.) in the field of mango and both of the weeds had minor importance. The incidence of loranthus was as the parasitic plant on mango trees, but parthenium grows on the lands of mango orchards (Table 4). The parthenium weed (*Parthenium hysterophorus*) was found only some restricted areas such as Rajshahi, Natore, Pabna, Kustia, Jessore districts among 19 sampled districts of Bangladesh. The stakeholders also reported that the parthenium weed might be entered into Bangladesh through cross boundery from India by the transportation system of border trading.

Damage potential of weeds: Among these diseases, the Parthenium was more damaging than other and caused damage in the whole season with low infestation intensity. As a newly introduced weed, though parthenium caused damage with low infestation intensity, but it could cause severe damage and spread to other areas, if not controlled properly. The loranthus caused damage mango plants throughout the year with low infestation intensity, where it was severely found on the very much older mango plants with high infestation intensity.

Table-4: Weeds of mango, their identity, status and infestation severity

Weed	Weed identiy	Pest status	Stage of plant affected	Infestation severity
Loranthus/ Indian Mistletoe	*Dendrophthae falcate* **Order: Santalales** **Family: Loranthaceae**	Minor	Stem, twigs, tree	Low
Parthenium weed	*Parthenium hysterophorus* **Order: Asterales** **Family: Asteraceae**	Minor (limited areas)	Annual herb aggressively disturbed sites	Low

2.6. Endangered areas of serious pests of mango

The fruit flies of mango reported in all over the sampled districts, whereas the mango pulp weevil was reported from Pabna, Khagrachari, Rangamati and Bandarban districts districts of Bangladesh. The parthenium weed (*Parthenium hysterophorus*) also found in Rajshahi, Natore, Pabna, Kustia, Jessore districts among 19 sampled districts of Bangladesh. The stakeholders also reported that the parthenium weed might be entered into Bangladesh through cross boundery from India by the transportation system of border trading. Therefore, the restriction shoul be taken to prevent the dessimination of these quarantine disease and weed to other areas as well as to take management against these noxous pests.

2.7. Management options for mango pests

Management options for insect pests: According to the responses by the stakeholders, the most effective and commonly practiced management options against the insect pests of mango were spraying insecticides on the mango tree in the orchard followed by removal of unnecessary branches of the trees after harvesting of the fruits. Other important management options are the use of balanced fertilizer, use of pheromone traps for capturing and killing of the fruit flies, remomal of weeds from the mango orchards, application of insecticides with irrigation, application of granular insecticides at the base of the mango trees, use of tolerant variety, application of IPM, fumigation under the mango tree, leaving the birds from the orchards.

Management options for diseases: The most effective and commonly practiced management options against the disedases of mango were spraying of fungicide on the mango trees in the orchards, pruning of the diseased braches from the trees followed by removal of unnecessary branches of the trees after harvesting of the fruits. Other important management options for controlling mango diseases were the remomal of weeds from the mango orchards, application of pesticides at the base of the mango trees, use of tolerant variety, application of IPM, fumigation under the mango tree.

Management options for weeds: According to the responses by the stakeholders, the most effective and commonly practiced management options against the weeds of mango were weeding from the orchards particularly for parthenium, spraying herbicide.

2.8. Possible ways of entry of quarantine pests into Banlgadesh

Bangladesh usually imported most of the fresh mangoes mainly from India through landports and few amounts imported from Thailand and Pakistant. But no pests of mango had yet been intercepted in any of the consignment of mangoes imported as reported by the PQW-DAE. Besides, there is a possibility to enter mango pests through the fresh mango fruits consignment, if imported without considering the standard phytosanitary system of Internation Standard Phytosanitary Measures (ISPM).

2.9. Effective ways to prevent the entry of quarantine pests of mango into Bangladesh

The entry of quarantine pests of potato can be prevented by the following of phytosanitary measures as prescribed by the ISPM. Following steps can be followed as reported by the stakeholders participated in the study:

- Assurance of phytosanitary certificate during importation of fresh mango fruits,
- In case of high risk rating pests, pre-inspection of crop in the exporting countries should be ensured,
- Existing legislation method should be implemented by following quarantine rules and regulations,
- Standard phytosanitary activities should be followed during customs clearance of the products,
- Strengthening the laboratory capacity with modern equipment to inspect the imported product properly considering standard phytosanitary system,
- Strengthening the activities and monitoring system of quarantine centres under PQW, DAE in Bangladesh.
- Illegal entry of seed and ware fresh mango fruits and mango seedlings from neighboring countries especially India should be restricted applying legislation and awareness build up of the respective stakeholders,
- Intensify the co-operation with quarantine sectors of other countries.
- Action oriented training should be provided for skill development of the quarantine personnel of quarantine wing.

2.10. Options to prevent the spread of quarantine pests of mango within Bangladesh

The quarantine pests of mango, if already entered into Bangladesh, can be prevented their spread within the country considering the following steps as reported by the stakeholders participated in the study:

- Proper idenfication of the quarantine pests
- Awareness build up among the growers/farmers and other stakeholders about quarantine pests including their management,
- Restriction should be applied for the dessimination of infested mangoes from pest infested areas to pest free areas,
- Production of pest free mangoes by the application of proper management for pests,
- Intensive and frequent inspection of mango orchards by the experts,
- Follow the quarantine rules and regulation,
- Proper training of the quarantine personnel particularly on quarantine pests of respective crops along with their management options and phytosanitary measures.

Measures need to be taken by the exporters to export mangoes

- Pest free mangoes should be produced,
- Pre and post-harvest phytosanitary technique should be followed,
- Pest infested/infected mangoes should be discarded from the lots,
- Proper grading for the quality mango fruits should be ensured,
- Proper packing should be followed,
- Graded and packed mango fruits should be preserved in cold storage,
- Phytosanitary certificate must be ensured before emporting the mangoes.

CHAPTER 3

PRA STAGE 1: INITIATION

3.1. Initiating Pest Risk Analysis (PRA) by the identification of a pathway

Based on the Memo No. Phyto-34-2/2014/698 decision on 18 November 2014 by the Project Director of Strengthening Phytosanitary Capacity in Bangladesh under Plant Quarantine Wing (PQW) of Department of Agriculture Extension, Ministry of Agriculture, Bangladesh, the fresh mango (*Mangifera indica*) fruits which have highly introduction potential of associated pests must be analyzed for pest risk assessment to prevent introduction of the dangerous pests into Bangladesh. Thereafter, this "Pest Risk Analysis (PRA) of Mango in Bangladesh" had been initiated by the identification of a new pathway. The pathway is import of fresh mangoes from India, Pakistan and Thailand to Bangladesh. It is decided for this PRA to assess the pests likely to be associated with the pathway and represents potential hazard to the country of Bangladesh.

3.2. Commodity to be imported

The fresh mango (*Mangifera indica*) fruits belonging to the Order Sapindales and Family Anacardiaceae

3.3. Identification of PRA Area

The PRA areas are the 19 major mango growing districts of Bangladesh (From 20°34˝ North Latitude to 26°38˝ North Latitude. From 88°01˝ East Longitude to 92°41˝ East Longitude). The major mango growing districts where the PRA study had been done were the Chapainawabganj, Rajshahi, Natore, Dinajpur, Thakurgaon, Nilphamari, Rangpur, Pabna, Kustia, Chuadanga, Jhenaidah, Meherpur, Jessore, Satkhira, Mymensingh, Jamalpur, Khagrachori, Rangamati and Bandarban.

3.4. Information for PRA

Information sources utilized for this PRA are all published material available in international scientific journals, books, reports, websites of CABI, EPPO, personal communications, geographic data and unpublished results that have been made available to the risk assessors. Where these information sources have been used, this is indicated in the text by references enclosed in brackets. The primary data collected through field survey and Focus Group Discussion (FGD) of major mango growing districts (19) and Key Informant Interviews (KII) had also been utilized for this PRA.

3.5. Previous PRA, Current Status and Pest Interceptions

In the past, there was no previous pest risk assessment on fresh mango fruits from any of the exporting countries including India, Pakistan and Thailand. As reported by the Plant Quarantine Station located in Seaport Chittagong and other Landport such as Sonamasjid, Burimari and Hilly under Plant Quarantine Wing (PQW) of Department of Agriculture Extension (DAE), Bangladesh, during inspection in port of entry of fresh mango fruits from these exporting counties, not a pest had been detected yet today on the commodity imported into Bangladesh (DAE, 2015).

3.6. Initiation Conclusion

The initiation point for this PRA is the identification of a new potential pathway, the export of fresh mango fruits from any exporting countries viz. India, Pakistan and Thailand to Bangladesh, and the potential pest hazards, likely to be associated with the pathway.

CHAPTER 4

PRA STAGE 2: PEST RISK ASSESSMENT

The pest risk assessment was done with the aim to revise Bangladesh's phytosanitary measure regarding the fresh mango fruits imported from any mango exporting countries viz. India, Pakistan and Thailand into Bangladesh.

4.1. Pest Categorization: Identification of Quarantine Pests Likely to Follow the Pathway

The pests associated with fresh mango fruits have been categorized and listed below based on their scientific name, taxonomic position, common name, infective phase, plant parts affected, geographical distribution and their quarantine status.

Table 5 depicted the lists of pests associated with the fruits of *Mangiferae indica* that also occur in India, Pakistan, Thailand and Bangladesh and the absence or presence of these pests in Bangladesh. Based on Table 5, any pest that meets all above criteria will be selected for further assessment (Table 8).

Table-5: Pests Associated with fresh mango fruits *(Mangiferae indica)* in Bangldesh, India, Pakistan, Thailand and other mango producing countries

Pest	Common Name	Geographic Distribution	Infestation /Infective phase	Plant Part Affected	Presence in Banlgadesh	Quarantine Pest (Yes/No.)	Follow Pathway (Yes/No)	References
ARTHROPODS								
Order: Coleoptera Family: Curculionidae								
Sternochaetus frigidus	Mango pulp weevil	Burma, Thailand, India, the Philippines, Malaysia	Grub, adult	Fruit pulp	Yes	No	Yes	CABI, 2006 EPPO, 2006 Ahad, 2003
Sternochetus mangiferae (Fabricius)	Mango stone/ nut weevil	Australia, India, Thailand, Africa, Caribean	Grub, adult	Fruit, seed	Yes	No	Yes	NAPPO 2006; CABI/EPPO, 1991
Deporaus marginatus	Leaf cutting weevil	India, Thailand, China, Pakistan	Adult	Young leaf	Yes	No	Yes	www.plantwise.org
Family: Cerambycidae								
Batocera rubus (Linnaeus, 1758)	Mango stem borer	India, China, Malaysia, Philippines	Grub & Adult	Tree trunk, stem	Yes	No	Yes	en.wikipedia.org
Order: Diptera Family: Tephritidae								
Bactrocera dorsalis (Hendel)	Oriental fruit fly		Maggot	Fruits	Yes	No	Yes	CABI, 2006; EPPO, 2006
Bactrocera cucurbitae	Cucurbit fruit fly	India, Pakistan, Thailand, Sri Lanka	Maggot	Fruits	Yes	No	Yes	
Ceratitis cosyra (Walker)	Marula fruit fly	Sub-Saharan Africa	Maggot	Fruit	No	Yes	Yes	Javaid (1986); EPPO, 2014; CABI & EPPO, 1999
Ceratitis capitata (Wiedemann)	Mediterranean fruit	India (Absent, unreliable	Maggot	Fruit	No	Yes	Yes	CABI & EPPO, 1999; EPPO,

Pest	Common Name	Geographic Distribution	Infestation /Infective phase	Plant Part Affected	Presence in Banlgadesh	Quarantine Pest (Yes/No.)	Follow Pathway (Yes/No)	References
	fly	record, but formerly present in Bihar), KSA, Jordan, Syria, Yemen, Africa, Europe						2014; UFIFAA, 2015;
Bactrocera tryoni (Froggatt)	Queensland fruit	Australia	Maggot	Fruit	No	Yes	Yes	EPPO, 2014; CABI/EPPO, 1999
Bactrocera correcta (Bezzi)	Asian guava fruit fly	India, Pakistan, Thailand, Sri Lanka	Maggot	Fruit	No	Yes	Yes	EPPO, 2014; CABI/EPPO, 1999; CABI/EPPO, 2003; White & Elson-Harris, 1992
Bactrocera caryeae (Kapoor)	Member of oriental fruit fly	Oriental, India, Pakistan, Sri Lanka, Thailand	Maggot	Fruit	No	Yes	Yes	EPPO, 2014; Drew & Hancock, 1994
Bactrocera diversa (Coquillett)	Striped fruit fly	Oriental, India, Pakistan, Thailand Nepal, Sri Lanka	Maggot	Fruit	No	Yes	Yes	EPPO, 2014
Bactrocera tau (Walker 1849)	Fruit fly	India, Pakistan, Malyasia, Bhutan, Thailand, Vietnam	Maggot	Fruit	Yes	No	Yes	CABI (2003)
Bactrocera zonata (Saunders)	Peach fruit fly/ Guava fruit fly	India, Pakistan, Thailand, Nepal, Sri Lanka, KSA, Vietnam	Maggot	Fruit	Yes	No	Yes	CABI (2003)

Pest	Common Name	Geographic Distribution	Infestation /Infective phase	Plant Part Affected	Presence in Banlgadesh	Quarantine Pest (Yes/No.)	Follow Pathway (Yes/No)	References
Family: Cecidomyiidae								
Procontarinia matteiana	Mango leaf gall midge	India, Kenya	Maggot	Leaf	Yes	No	Yes	www.planthealthaustralia.com.au; en.wikipedia.org
Order: Homoptera **Family: Cicadellidae**								
Amritodus atkinsoni, Idioscopus clypealis	Mango hopper	India, Plakistan, Thailand	Nymph, adult	Leaves, stems, flowers, fruits at pea size	Yes	No	Yes	CABI, 2006; EPPO, 2006; Ahad, 2003
Family: Coccidae								
Coccus mangiferae (Green)	Mango common scale insect	India, China, Indonesia, Malaysia, Japan	Nymph and adult	Leaves, twigs	Yes	No	Yes	ScaleNet (2008); CABI Arthropod Name Index (1996)
Coccus viridis (Green)	Green scale	India, Pakistan, Malaysia, sub-Saharan Africa	Crawler, adult	Seedlings, leaf, plant	No	Yes	Yes	CABI, 2002; Dekle 1976b
Ceroplastes rubens Maskell	Red wax scale	East and South Asia including India, Pakistan; Australia	Crawler, adult	Leaves, fruits	No	Yes	Yes	CABI, 2005; CPC, 2005
Family: Diaspididae								
Aonidomytilus albus (Cockerell, 1893)	Tapioca scale insect	India, Thailand, Sri Lanka, Indonesia, Malaysia	Nymph and adult	Leaves, twigs, stems	No	Yes	Yes	Sankaran *et al.*, 1984; APPPC, 1987; EPPO, 2014; Nakahara, 1982; CABI

Pest	Common Name	Geographic Distribution	Infestation /Infective phase	Plant Part Affected	Presence in Banlgadesh	Quarantine Pest (Yes/No.)	Follow Pathway (Yes/No)	References
								(2015)
Aulacaspis tubercularis (Newstead)	White mango scale	India, Italy, South America, the Caribbean, Africa	Crawler, adult	Leaves, twigs, fruits	No	Yes	Yes	CPC, 2001; Joubert *et al.* 2000; Greathead, 1990
Parlatoria crypta McKenzie	Armored scale	India, Pakistan, Iran, Iraq, KSA, Africa	Crawler, adult	Leaves, twigs, fruits,	No	Yes	Yes	Dutta, 1996; CPC, 2003; Ghani and Muzaffar, 1974; Kozar *et al.* 1996
Pseudaonidia trilobitiformis (Green, 1896)	Gingging scale	Taiwan, Mexico, USA, Caribbean	Crawler, adult	Leaves, shoots, fruits	No	Yes	Yes	Anon. 1994; CABI, 2002; USDA 1979
Family: Psyllidae								
Apsylla cistellata (Buckton, 1896)	Mango shoot gall psyllid	India, Australia	Nymph, adult	Shoot, twig	Yes	No	Yes	Ahad, 2003; Ouvrard (2015)
Family: Monophlebidae								
Droshicha mangiferae Green	Mango mealy bug	India, Pakistan, Thailand	Nymph, adult	Inflorescence, leaf, shoot & fruit stalk	Yes (newly invaed)	Yes	Yes	en.wikipedia.org ; Ashfaq *et al.* (2011)
Order: Lepidoptera **Family: Saturniidae**								
Cricula trifenestrata (Helfer 1837)	Mango defoliator	India, Philippines, Java	Caterpillar	**Leaves,** twigs	Yes	No	Yes	en.wikipedia.org ; Ahad, 2003
Family: Pyralidae								
Citripestis eutraphera Meyrick	Mango fruit borer	India, Indonesia, Australia	Caterpillar	Fruits	Yes	No	Yes	Alam & Ahmad, 1969; planthealthaustr

Pest	Common Name	Geographic Distribution	Infestation /Infective phase	Plant Part Affected	Presence in Banlgadesh	Quarantine Pest (Yes/No.)	Follow Pathway (Yes/No)	References
								alia.com.au; en.wikipedia.org ;
Orthaga exvinacea Hampson	Mango leaf webber	India,	Caterpillar	Leaves, inflorescences	Yes	No	Yes	Singh and Verma (2013); Singh *et al.* (2006)
Family: Gracillariidae								
Acrocercops syngramma Meyrick	Mango leafminer	India, Pakistan	Caterpillar	Leaves	Yes	No	Yes	ICAR (2015)
Euthalia aconthea	Mango leaf caterpilla	India	Caterpillar	Leaves	Yes	No	Yes	Wikimediacommons (2015)
Family: Lymantriidae								
Lymantria mathura Moore 1865	Pink gypsy moth	India, China, Japan, Nepal	Caterpillar	Leaves	Yes	No	Yes	Dey & Tiwari, 1997; Browne, 1968; EPPO, 2014; CABI (2015)
Order: Acarina **Family: Eriophyidae**								
Aceria mangiferae Sayed	Mango eriophyid mite	India, Indonesia, Philippines, Srilanka, Burma, Pakistan and Malaysia.	Nymph and adult	Leaves, fruits	Yes	No	Yes	www.agridr.in
FUNGI								
Order: Glomerellales **Family: Glomerellaceae**								
Colletotrichum gloeosporioides	Mango anthracnose	Cosmopolitan	Spore (condia), mycelia	Panicles, leaves, branch terminals,	Yes	No	Yes	Nishijima, 1993; EPPO, 2006; Dickman, 1993

Pest	Common Name	Geographic Distribution	Infestation /Infective phase	Plant Part Affected	Presence in Banlgadesh	Quarantine Pest (Yes/No.)	Follow Pathway (Yes/No)	References
				fruits				
Order: Erysiphales **Family: Erysiphaceae**								
Oidium mangiferae	Powdery mildew	India, Pakistan, Thailand, the Philippines	Conidia	Leaves, inflorescences, fruits	Yes	No	Yes	CABI, 2012; Akhter *et al.*, 2000; Nelson, 2008; Verma and Sharma, 1999; Rawal, 1997
Order: Hypocreales **Family: Nectriaceae**								
Fusarium moniliforme	Mango malformation	India, Pakistan, Myanmar	Conidia, spodochia, mycelia, chlamydospore	Inflorescences, twigs, seedlings,	Yes	No	Yes	Kumar *et al.*, 2011; Khan and Khan, 1960; Meah and Khan, 1992
Order: Pleosporales **Family: Pleosporaceae**								
Alternaria alternate (Fr.) Keissl. (1912)	Alternaria leaf spot	India, Pakistan, Thailand	Condia, mycelia	Leaves	Yes	No	Yes	Ashrafuzzaman, 1991;http://en.wikipedia.org/
Order: Pleosporales **Family: Incertae sedis**								
Hendersonia creberrima Syd., Syd. & Butler	Mango fruit rot	India	Spores, Pycnidia	Fruit	No	Yes	Yes	Farr *et al.*, 2006; Cline, 2006
Order: Helotiales **Family: Sclerotiniaceae**								
Botrytis cinerea Pers.1794	Blossom blight/ grey mould	India, Pakistan, Thailand	Conidia, sclerotia, mycelia	Flowers and fruits	Yes	No	Yes	EPPO, 2006; Asharafuzzaman, 1991 http://en.wikiped

Pest	Common Name	Geographic Distribution	Infestation /Infective phase	Plant Part Affected	Presence in Banlgadesh	Quarantine Pest (Yes/No.)	Follow Pathway (Yes/No)	References
								ia.org/
Order: Botryosphaeriales **Family: Botryosphaeriaceae**								
Botryosphaeria theobromae	Die back	India, Pakistan, Thailand	Conidia	Shoots, leaves, twigs	Yes	No	Yes	Ashrafuzzaman, 1991; Khanzada *et al.*, 2005; ttp://en.wikipedia.org/
Macrophoma mangiferae Hing. & Sharma	Leaf and stem blight	India, Nigeria	Spores, picnidia	Leaves, stems, fruits	No	Yes	No	Hingorani, *et al.*, 1960; Farr *et al.*, 2006
Order: Myriangiales **Family: Elsinoaceae**								
Elsinoë mangiferae	Mango scab	India, Pakistan, Thailand	Spores	Leaves, fruits	Yes	No	Yes	CABI, 2012; Ashrafuzzaman, 1991
Order: Diaporthales **Family: Diaporthaceae**								
Phomopsis mangiferae S. Ahmad 1954	Stem-end-rot of mango	India, Pakistan, Australia	Spores, mycelia	Fruits	No	Yes	Yes	ARS, 2001; Laxinarayana and Reddy, 1975
Phylum: Ascomycota **Order: Incertae sedis and Family: Incertae sedis**								
Cytosphaera mangiferae Died. 1916	Twig canker/stem-end rot	India, Pakistan, Malaysia, Papua New Guinea	Conidia	Stem, leaf, twig, fruit	No	Yes	Yes	Farr *et al.*, 2006; http://eol.org/pages/295159/names
Actinodochium jenkinsii	Mango	India	Spores	Fruits	No	Yes	Yes	Uppal *et al.*,

Pest	Common Name	Geographic Distribution	Infestation /Infective phase	Plant Part Affected	Presence in Banlgadesh	Quarantine Pest (Yes/No.)	Follow Pathway (Yes/No)	References
Uppal, Patel & Kamat	black spot							1953
ALGAE								
Order: Trentepohliales **Family: Trentepohliaceae**								
Cephaleuros virescens Kunze 1827	Leaf red rust	India, Pakistan, Thailand	Zoospores	Leaves, petioles, twigs	Yes	No	Yes	Ashrafuzzaman, 1991; http://en.wikipedia.org/;
BACTERIA								
Order: Xanthomonadales **Family: Xanthomonadaceae**								
Xanthomonas campestris pv. *mangiferaeindicae*	Bacterial black spot	India, Thailand, Pakistan,Malaysia, the Philippines, Australia	Bacterial cell	Leaves, twig/stems, fruits	No	Yes	Yes	CABI, 2012; Gagnevin & Pruvost, 2001
WEED								
Order: Asterales **Family: Asteraceae**								
Parthenium hysterophorus L.	Parthenium weed	India, Australia	Seed	Annual herb aggressively disturb sites	Yes (limited areas)	Yes	Yes	Dale, 1981; Navie *et al*., 1996; EPPO, 2014; Holm *et al.*, 1991
Order: Santalales **Family: Loranthaceae**								
Dendrophthae falcate	Loranthus / Indian Mistletoe	India, Pakistan, Thailand	Seed, fruits	Stem, twigs, tree	Yes	No	Yes	Singh, 2015

4.2. Quarantine Pests Likely to be Associated with Fresh Mangoes imported from India, Thailand, Pakistan

Based on the Table 5, Quarantine pests that are reasonably likely to follow the pathway on commercial shipments of fresh mangoes (*Mangiferae indica*) from other countries including India, Pakistan, Thailand included 20 species and were further analyzed in this risk assessment and are summarized in **Table 6.** All of these pests are needed to applied phytosanitary measures to each pest based on risk ratings.

Table-6: Quarantine pests likely to be associated with *Mangigerae indica* imported from India, Pakistan and Thailand selected for further analysis

Sl.	Pest species	Common name	Order	Family	Category
1	*Ceratitis capitata* (Wiedemann)	Mediterranean fruit fly	Diptera	Tephritidae	Insect
2	*Bactrocera tryoni* (Froggatt)	Queensland fruit fly	Diptera	Tephritidae	Insect
3	*Ceratitis cosyra* (Walker)	Marula fruit fly	Diptera	Tephritidae	Insect
4	*Bactrocera caryeae* (Kapoor)	Member of oriental fruit fly	Diptera	Tephritidae	Insect
5	*Bactrocera correcta* (Bezzi)	Asian guava fruit fly	Diptera	Tephritidae	Insect
6	*Bactrocera diversa* (Coquillett)	Three striped fruit fly	Diptera	Tephritidae	Insect
7	*Coccus viridis* (Green)	Green scale insect	Homoptera	Coccidae	Insect
8	*Ceroplastes rubens* Maskell	Red wax scale	Homoptera	Coccidae	Insect
9	*Aonidomytilus albus* (Cockerell, 1893)	Tapioca scale insect	Homoptera	Diaspididae	Insect
10	*Aulacaspis tubercularis* (Newstead)	White mango scale	Homoptera	Diaspididae	Insect
11	*Parlatoria crypta* McKenzie	Armored scale	Homoptera	Diaspididae	Insect
12	*Pseudaonidia trilobitiformis* (Green, 1896)	Gingging scale	Homoptera	Diaspididae	Insect
13	*Droshicha mangiferae* Green	Mango mealy bug	Homoptera	Monophlebidae	Insect
14	*Phomopsis mangiferae* S. Ahmad 1954	Stem-end-rot of mango	Diaporthales	Diaporthaceae	Fungi
15	*Cytosphaera mangiferae* Died. 1916	Twig canker	Incertae sedis	Incertae sedis	Fungi
16	*Actinodochium jenkinsii* Uppal, Patel & Kamat	Mango black spot	Incertae sedis	Incertae sedis	Fungi
17	*Hendersonia creberrima* Syd., Syd. & Butler	Mango fruit rot	Pleosporales	Incertae sedis	Fungi
18	*Macrophoma mangiferae*	Leaf and stem blight	Botryosphaeriales	Botryosphaeriaceae	Fungi
19	*Xanthomonas campestris* pv. *mangiferae indica*	Bacterial black spot of mango	Xanthomonadales	Xanthomonadaceae	Bacteria
20	*Parthenium hysterophorus* L.	Parthenium weed	Asterales	Asteraceae	Weed

4.3. Risk Assessment (Analysis of Quarantine Pests Likely to Follow the Pathway)

The risk assessment was done in accordance with International Plant Protection Convention (IPPC) and the International Standards for Phytosanitary Measures (ISPMs) including ISPM 2 and ISPM 11. The import risk assessment consists of two main components, the Consequence of the Introduction and the Introduction Potential of pests to the importing country. The consequences of introduction evaluate the contains five risk elements such as Climate-Host Interaction, Host Range, Dispersal Potential, Economic Impact and Environmental Impact.

The Likelihood of Introduction is divided into six sub-elements such as (i) Quantity of commodity imported annually, (ii) Survive post harvest treatment, (iii) Survival potential during shipment, (iv) Not are detected at the port of entry suitable for survival, (v) Imported or moved subsequently to an area with an environment suitable for survival, (vi) Come into contact with host material suitable for reproduction. Together, the Consequences of Introduction and the Likelihood of Introduction estimate the Baseline Pest Risk Potential, which is the overall risk in the absence of specific mitigation measures beyond standard post-harvest treatment. Each risk is then assigned a qualitative value and a risk rating value (Table 7). The risk values are combined for both the Consequences of Introduction and the Likelihood of Introduction to give an overall estimate of the risk.

Table-7: Risk rating and corresponding risk value for risk assessment of quarantine pests

Risk rating	Rating value
High	3
Medium	2
Low	1

4.3.1. Assess Consequences of Introduction of Pests (Table 5 & 6)

The undesirable outcomes being considered are the negative impacts resulting from the introduction of quarantine pests. After identifying the quarantine pests that could reasonably be expected to follow the pathway, the assessment of risk continues by considering the consequences of introduction. For each of these quarantine pests, the potential consequences of introduction are rated using five **Risk Elements**. These elements reflect the Climate-Host Interaction, Host Range, Dispersal Potential, Economic Impact and Environmental Impact of the pests. For each Risk Element, pests are assigned a rating of **low** (1 point), **medium** (2 points) or **high** (3 points). A Cumulative Risk Rating is then calculated by summing all Risk Element values.

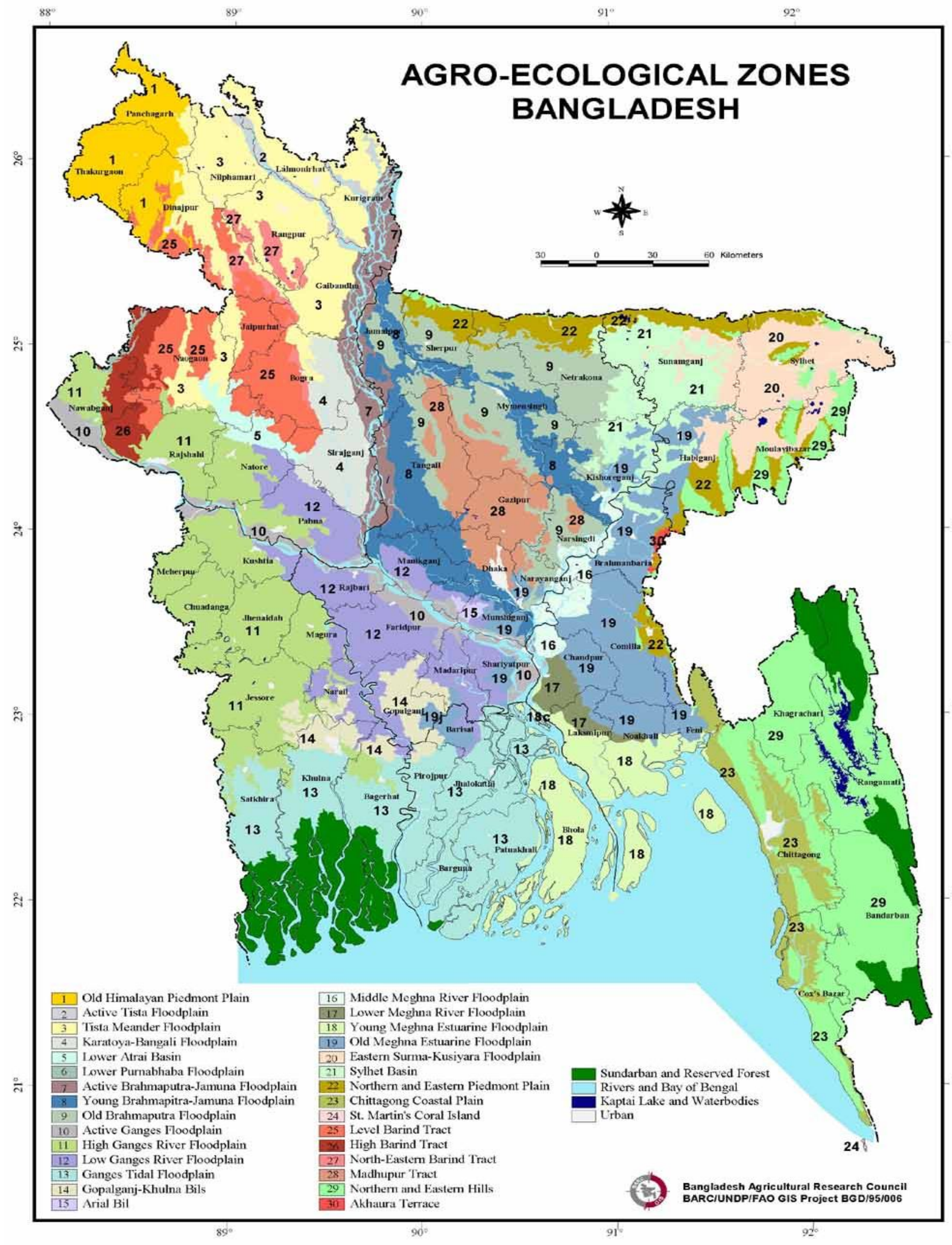
Risk Element 1: Climate-Host Interaction

When introduced to new areas, pests can be expected to behave as they do in their native areas if host plants and climates are similar. Ecological zonation and the interactions of the pests and their biotic and abiotic environments are considered in the element. Estimates are based on availability of both host material and suitable climate conditions. To rate this Risk Element, the 30 defined agriculture ecological zones[1] of Bangladesh are used. Due to the availability of both suitable host plants and suitable climate, the pest has potential to establish a breeding colony:

Rating scores are as follows:

Low **:** In a single ecological zone…………….........……. **1 point.**
Medium **:** In two or three ecological zones……..........………**2 points**.
High **:** In four or more ecological zones…..........……..... **3 points**

Figure-9: Agro-ecological zone (AEZ) map of Bangladesh[1]



Source: http://www.barcapps.gov.bd/barc_english/index.php/2013-05-16-10-30-07/spatial-database

Risk Element 2: Host Range

The risk posed by a plant pest depends on both its ability to establish a viable, reproductive population and its potential for causing plant damage. For arthropods, risk is assumed to be correlated positively with host range. For pathogens, risk is more complex and is assumed to depend on host range, aggressiveness, virulence and pathogenicity; for simplicity, risk is rated as a function of host range.

Rating scores are as follows:

Low : Pest attacks a single species or multiple species within a single genus……. **1 point**
Medium : Pest attacks multiple species within a single plant family…………………….. **2 points**
High : Pest attacks multiple species among multiple plant families……................... **3 points**

Risk Element 3: Dispersal Potential and Pathway

A pest may disperse after introduction to a new area. The following items are considered:

- Reproductive patterns of the pest
- Inherent powers of movement

Rating scores are as follows:

Low : Pest has neither high reproductive potential nor rapid dispersal capability.......**1 point**
Medium : Pest has either high reproductive potential or the species is capable of rapid dispersal……………………………………………………………………………. **2 points**
High : Pest has high biotic potential, *e.g.*, many generations per year, many offspring per reproduction ("r-selected" species), and evidence exists that the pest is capable of rapid dispersal, *e.g.*, over 10 km/year under its own power; via natural forces, wind, water, vectors, *etc*., or human assistance………………………..……………**3 points**

Risk Element 4: Economic Impact

Introduced pests are capable of causing a variety of direct and indirect economic impacts. These are divided into three primary categories (other types of impacts may occur):

- Lower yield of the host crop, *e.g.*, by causing plant mortality, or by acting as a disease vector.
- Lower value of the commodity, *e.g*., by increasing costs of production, lowering market price, or a combination.
- Loss of foreign or domestic markets due to presence of new quarantine pest.

Rating scores are as follows:

Low : Pest causes any one or none of the above impacts …......................**1 point**
Medium : Pest causes any two of the above impacts ………………..................**2 points**
High : Pest causes all three of the above impacts ………………..................**3 points**

Risk Element 5: Environmental Impact

The assessment of the potential of each pest to cause environmental damage proceeds by considering the following factors:

- Introduction of the pest is expected to cause significant, direct environmental impacts, *e.g.*, ecological disruptions, reduced biodiversity.

- Pest is expected to have direct impacts on plant species as endangered or threatened in Bangladesh[1].
- Pest is expected to have indirect impacts on plant species as endangered or threatened by disrupting sensitive, critical habitat.
- Introduction of the pest would stimulate chemical or biological control programs.

Rating scores are as follows:

Low : None of the above would occur…................**1 point**
Medium : One of the above would occur….................**2 points**
High : Two or more of the above would occur…....**3 points**

4.3.1.1. Assessment of Risk Rating of Consequences of Introduction of Quarantine Pests

1. Consequences of Introduction of Tephritidae (Diptera): ***Ceratitis capitata*** (Wiedemann), ***Bactrocera tryoni*** (Froggatt), ***Ceratitis cosyra*** (Walker), ***Bactrocera caryeae*** (Kapoor), ***Bactrocera correcta*** (Bezzi), ***Bactrocera diversa*** (Coquillett)	Risk Rating
Climate-Host Interaction The distribution of fruit flies infesting mangoes are distributed in South and South East Asia, the Meditarranean and Africa. The species wise distribution of mango fruit flies are as follows: ***Ceratitis capitata* (Wiedemann):** *C. capitata* is widespread in Africa and is endemic to most sub-Saharan countries. It was recorded from western Zambia by Munro (1953) and Namibia by Hancock *et al.* (2001). The lack of records or reports of 'restricted distributions' in many African countries is likely to reflect the lack of observations rather than absence. The spread to Europe, Egypt, the Middle East, the Malagasy subregion, Australia and the Americas is likely to be a result of accidental transportation during trade. Jafari and Sabzewari (1982) recorded *C. capitata* from the Mazandaran Province of Iran, where it was first detected in 1977. The first records from the Amazon area of Brazil were in 1996 for Rondonia (Ronchi-Teles *et al.*, 1996) and in 1997 for Para (GomesSilva *et al.*, 1998). Reports of *C. capitata* from Suriname (e.g. Gasparich *et al.*, 1997) refer to mislabelled specimens originally from California. It has been recorded intermittently in the Ukraine between 1937 and 1966 (FischerColbrie and BuschPetersen, 1989), in California since 1975, in Florida since 1929 and in Texas since 1966 (Gasparich *et al.*, 1997). In Chile it was present from 1963 to 1995 (Diaz *et al.*, 1999). In New South Wales, Australia, it was first recorded in 1898 and had disappeared by 1948 (Orian and Moutia, 1960; Permkam and Hancock, 1995). In Queensland, Australia it was formerly present in the southeast and first recorded in 1909. It disappeared during the 1930s (Permkam and Hancock, 1995). Occasional outbreaks occur in South Australia. In Victoria, Australia it was first recorded in 1909 and had disappeared by the 1940s (Permkam and Hancock, 1995). It has been eradicated in New Zealand, but an outbreak occurred in 1996 (Holder *et al.*, 1977). Eggs of *C. capitata* are laid below the skin of the host fruit. They hatch within 2-4 days (up to 16-18 days in cool weather) and the larvae feed for another 6-11 days (at 13-28°C). Pupariation is in the soil under the host plant and adults emerge after 6-11 days (24-26°C; longer in cool conditions) and adults live for up to 2 months (field-caged) (Christenson & Foote, 1960).	**High (3)**

[1]Irfanullah, H.M. 2011. Conserving threatened plants of Bangladesh: miles to go before we start? Bangladesh Association of Plant Taxonomists, *Bangladesh J. Plant Taxon.* **18**(1): 81-91.

***Bactrocera tryoni* (Froggatt): EPPO region**: Absent. **North America**: USA (found but not established in California). **South America**: Chile (twice adventive in Easter Island, but eradicated; Bateman, 1982). **Oceania**: Australia (throughout eastern half of Queensland, eastern New South Wales, and extreme east of Victoria; recently found in Tasmania, where it is now under eradication; outbreaks repeatedly occur in South Australia, but are regularly eradicated (Maelzer, 1990); established in the Perth area of Western Australia in 1989 but now believed eradicated). A few males have been trapped in Papua New Guinea but *B. tryoni* is unlikely to be established there (Drew, 1989). New Zealand (intercepted only). **EU**: Absent. Eggs are laid below the skin of the host fruit. These hatch within 1-3 days and the larvae feed for 10-31 days. Pupariation is in the soil under the host plant and adults emerge after 1-2 weeks (longer in cool conditions) and adults occur throughout the year (Christenson & Foote, 1960). *B. tryoni* would be unable to survive the winter. The adults are best able to survive low temperatures, *Bactrocera* spp. generally having a normal torpor threshold of 7°C, dropping as low as 2°C in winter. ***Ceratitis cosyra* (Walker): EPPO region:** Absent. **Africa:** Cameroon, Comoros, Côte d'Ivoire, Kenya, Madagascar, Malawi, Mozambique, Seychelles, South Africa, Sudan, Tanzania, Togo, Zaire, Zambia, Zimbabwe. **EU:** Absent. ***Bactrocera caryeae*:** India (Karnataka, Tamil Nadu (IIE, 1994a), Maharashtra (Carroll *et al*., 2002)); Sri Lanka (IIE, 1994a). ***Bactrocera correcta*:** India (Bihar, Gujarat, Haryana, Himachal Pradesh, Karnataka, Punjab, Tamil Nadu), Japan, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand, United States (CAB International, 2003). In India, this potential pest often occurs with serious pest species such as *B. dorsalis* and *B. zonata* (Kapoor, 1989). ***Bactrocera diversa*:** China, Sri Lanka, Thailand (CAB International, 2003); India (DPP, 2001). ***Bactrocera dorsalis*:** True *B. dorsalis* is restricted to mainland Asia (except the peninsula of southern Thailand and West Malaysia), as well as Taiwan and its adventive population in Hawaii (Drew and Hancock, 1994). CAB International (2003) also includes California and Florida, USA, in the distribution because the fly is repeatedly trapped there in small numbers. This species is a serious pest of a wide range of fruit crops in Taiwan, southern Japan, China and in the northern areas of the Indian subcontinent (CAB International, 2003). In Asia, *B. dorsalis* is recorded from Bangladesh (IIE, 1994b); Bhutan, Cambodia, China (Drew and Hancock, 1994); Guam (Waterhouse, 1993); Laos, Myanmar (Drew and Hancock, 1994); Nauru (Waterhouse, 1993); Nepal, Pakistan, Sri Lanka, Thailand, United States (Hawaii) and Vietnam (Drew and Hancock, 1994). ***Bactrocera cucurbitae*:** *B. cucurbitae* is widely distributed in Asia, but also occurs in Africa, North America and Oceania regions (CAB International, 2003). In Asia, *B. cucurbitae* is recorded from Afghanistan (IIE, 1995a); Bangladesh (CABI, 2003); Brunei Darussalam (Waterhouse, 1993); Cambodia (IIE, 1995a); China (CAB, 2003); India (CAB International, 2003; IIE, 1995a); Indonesia, Iran, Laos, Malaysia, Myanmar, Nepal, Oman, Pakistan, Philippines, Saudi Arabia (CABI, 2003); Singapore (IIE, 1995a); Sri Lanka, Thailand, United Arab Emirates and Vietnam (CAB International, 2003). For a full distribution listing, refer to CAB International (2003). ***Bactrocera tau*:** Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China (Fujian, Guangdong, Guangxi, Guizhou, Hainan, Hubei, Hong Kong, Sichuan, Taiwan, Yunnan, Zhejiang), India (Uttar Pradesh), Indonesia (Sumatra), Laos, Malaysia (Peninsular Malaysia, Sabah, Sarawak), Myanmar, Singapore, Thailand, Vietnam (CAB International, 2003).	

Bactrocera zonata: Bangladesh, Egypt, India (Andhra Pradesh, Assam, Bihar, Delhi, Gujarat, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Punjab, Tamil Nadu, Uttar Pradesh, West Bengal), Iran, Laos, Mauritius, Myanmar, Oman, Pakistan, Réunion, Saudi Arabia, Sri Lanka, Thailand, United Arab Emirates, Vietnam (CAB International, 2003). Fruit flies in the genus *Bactrocera* infest fruit of numerous hosts in tropical and semitropical areas (CPC, 2005) including India, Pakistan, Thailand, Vietnam, the Philippines corresponding to almost all of 30 Agro-Ecological Zones (AEZ) of Bangladesh. Based on this distribution, we estimate that different species of mango fruit flies could become established into different agro-ecological zones in Bangladesh, so the Climate-Host Interaction risk rating is **High (3).**	
Host Range ***Ceratitis capitata* (Wiedemann):** *C. capitata* is a highly polyphagous species and its pattern of host relationships from region to region appears to relate largely to what fruits are available; examples were given by White and ElsonHarris (1994). *Coffea* spp. are especially heavily attacked, although the attack on coffee does not impact on this crop as only the fleshy part of the fruit, which is discarded, is utilised by the larvae. However, the quality may be affected and in many areas coffee crops appear to act as an important reservoir from which other crops may be attacked. In some areas wild hosts are of importance, for example, box thorn, *Lycium europaeum*, is an important overwintering host in North Africa (Cayol, 1996). Several wild hosts in Zimbabwe were recorded by Hancock (1987) and Copeland *et al.* (2002) recorded 51 wild host species in Kenya. Lists of wild and cultivated hosts were provided by Liquido *et al.* (1991), Hancock *et al.* (2000) and De Meyer *et al.* (2002). In addition to the hosts listed, *C. capitata* has also been found on *Artabotrys monteiroae, Berberis holstii, Bourreria petiolaris, Carissa longiflora, Carissa tetramera, Chrysophyllum carpussum, Coccinia microphylla, Corallocarpus ellipticus, Diospyros pubescens, Drypetes gerrardii, Elaeodendron schweinfurthianum, Grewia trichocarpa, Harrisonoia abyssinica, Lamprothamnus zanguebaricus, Ludia mauritiana, Lycium campanulatum, Manilkara sulcata, Mimusops kirkii, Minusops kummel, Mimusops zeheri, Peponium mackenii, Pentarhopalopilia umbellulata, Polysphaeria parvifolia, Richardella campechiana, Salacia elegans, Santalum freyinetianum, Vepris nobilis, V. simplicifolia* and *V. trichocarpa*. ***Bactroceral tryoni:*** As shown by Fitt (1986), adults of *B. tryoni* exhibit no particular preference in the species of fruits on which they will lay. The main hosts are in practice mostly tree fruits: *Annona*, *Averrhoa carambola*, avocados (*Persea americana*), *Citrus*, *Fortunella*, guavas (*Psidium guajava*), *Malus*, mangoes (*Mangifera indica*), passion fruits (*Passiflora edulis*), pawpaws (*Carica papaya*), peaches (*Prunus persica*), plums (*Prunus domestica*) and *Pyrus*. However, vegetables such as tomatoes (*Lycopersicon esculentum*) are also infested. Many tree fruit crops of the EPPO region are potential hosts. ***Bactrocera caryeae***: *Mangifera indica* (mango) (Peña and Mohyuddin, 1997). ***Bactrocera correcta***: Primary hosts are: *Anacardium occidentale* (cashew), *Mangifera indica* (mango), *Manilkara zapota* (sapodilla), *Mimusops elengi* (Asian bulletwood), *Muntingia calabura* (Jamaica cherry), *Psidium guajava* (guava), *Syzygium samarangense* (Java apple), *Terminalia catappa* (Indian almond), *Ziziphus jujube* (jujube) (CAB International, 2003). ***Bactrocera diversa***: *Cucurbita maxima* (giant pumpkin), *Cucurbita pepo* (pumpkin, squash), *Lagenaria siceraria* (bottle gourd), *Luffa acutangula* (angled luffa), *Luffa*	**High (3)**

aegyptiaca (smooth loofah), *Ziziphus jujuba* (jujube) (CAB International, 2003); *Mangifera indica* (mango) (Srivastava, 1997). ***Bactrocera dorsalis*****:** *B. dorsalis* is a very serious pest of a wide variety of fruits and vegetables (CAB International, 2003). Due to the confusion between *B. dorsalis* and related species in the Oriental fruit fly species complex (some 52 species that are found in the Oriental region, and a further 16 species native to Australasia), there are very few published host records which definitely refer to true *B. dorsalis* (CAB International, 2003). No host plant survey has yet been carried out to show which hosts are of particular importance within the Asian range of true *B. dorsalis*. Recorded commercial hosts are: *Aegle marmelos* (bael fruit), *Anacardium occidentale* (cashew), *Annona reticulata* (bullock's heart), *Annona squamosa* (sugar apple), *Areca catechu* (betelnut palm), *Artocarpus altilis* (breadfruit), *Artocarpus heterophyllus* (jackfruit), *Capsicum annuum* (bell pepper), *Chrysophyllum cainito* (caimito), *Citrus maxima* (pummelo), *Citrus reticulata* (mandarin orange), *Coffea arabica* (arabica coffee), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Dimocarpus longan* (longan), *Ficus racemosa* (cluster fig), *Litchi chinensis* (lychee), *Malus pumila* (apple), *Mangifera foetida* (bachang mango), *Mangifera indica* (mango), *Manilkara zapota* (sapodilla), *Mimusops elengi* (Asian bulletwood), *Momordica charantia* (bitter gourd), *Muntingia calabura* (Jamaica cherry), *Musa* sp. (banana), *Nephelium lappaceum* (rambutan), *Persea Americana* (avocado), *Prunus armeniaca* (apricot), *Prunus avium* (gean), *Prunus cerasus* (sour cherry), *Prunus domestica* (plum, prune), *Prunus mume* (Japanese apricot), *Prunus persicae* (peach), *Psidium guajava* (guava), *Punica granatum* (pomegranate), *Pyrus communis* (pear), *Syzygium aqueum* (water apple), *Syzygium aromaticum* (clove), *Syzygium cumini* (jambolan), *Syzygium jambos* (rose apple), *Syzygium malaccense* (Malay apple), *Syzygium samarangense* (wax apple), *Terminalia catappa* (Indian almond), *Ziziphus jujuba* (jujube); *Ziziphus mauritiana* (Chinese date) (Allwood *et al*., 1999; Tsuruta *et al*., 1997). A numerous species under various plant families are attacked by the above mentioned species of fruit flies. Thus we estimate that the different species of fruit flies can establish in Bangladesh. Therefore, the Host Range risk rating is **High (3).**	
Dispersal Potential and Pathway In India, *Bactrocera* spp*.* adults can remain active throughout the year, but the population declines during the winter months (Mann 1996). In India, the wide host range of *Bactrocera* spp. allows it to breed actively in the field from February to November and go through nine to ten generations a year (Lall and Singh 1969). These pests fly away from their host field within one hour after emergence from the pupal stage (Kazi 1976), and may disperse to nearby fields. The main means of natural spread of the fruit flies over large areas is by rapid dispersal ability and wind-borne migration, particularly of the spring generation. Adults can also be carried over long distances. Transport of infested fruits, either through trade or by travellers, is the main means of movement. Adult flight will also spread the pest. The maggots can easily be transported on fresh mango fruits, and in all forms of packaging and transport. Fresh mango fruits grown on land harbouring overwintered larvae are common means of transport in international trade (Bartlett, 1980). Based on these informations, the fruit flies are all rated **High (3)** for Dispersal Potential because of their high reproductive ability and their ability to disperse rapidly.	**High (3)**
Economic Impact *C. capitata* (Mediterranean fruit fly) is an important pest in Africa and has spread to	**High (3)**

almost every other continent to become the single most important pest species in its family. It is highly polyphagous and causes damage to a very wide range of unrelated fruit crops. In Mediterranean countries, it is particularly damaging to citrus and peach. It may also transmit fruitrotting fungi (Cayol et al., 1994). Damage to fruit crops is frequently high and may reach 100% (Fimiani, 1989; FischerColbrie and BuschPetersen, 1989). In Central America, losses to coffee crops were estimated at 515% and the berries matured earlier and fell to the ground with reduced quality (Enkerlin et al., 1989). As in areas where the fly is endemic, in outbreak conditions the economic impacts include reduced production, increased control costs and lost markets. In India, *B. dorsalis* is the most destructive fruit fly of mango, followed by *B. zonatus* and *B. correctus* (Abbas *et al.* 2000). Females oviposit inside the mesocarp of mature fruits, and larvae feed on the pulp, causing the fruit to rot before ripening and finally drop (Abbas *et al.* 2000). The injury by *B. dorsalis* reduces yield and quality of mango fruits (Mann 1996). In some years *B. cucurbitae* partially or totally destroys 50% of vegetable crops it attacks (Lall and Singh, 1969). In India, B. correcta is one of the important fruit borers of guava and can cause 80% damage. Reductions in the total phenolic content in fruits of susceptible cultivars also causes damage (Manoukas, 1993; Mohamed Jalaluddin and Sadakathulla, 1999). Adult fruit fly (*Bactrocera* spp.) can be controlled with methyl eugenol traps (Lakshmanan *et al.* 1973), bait sprays, pheromone mating disruption, and pesticide applications to fruit (Abbas *et al.* 2000). Larvae inside mango fruit can be killed by hot water treatment of mature fruit (Wadhi and Sharma, 1972), cold treatments (Burikam *et al.* 1992), vapor heat treatment (Heard *et al.* 1992, Heather *et al.* 1992), and gamma irradiation (Heather *et al.* 1991). The expense required to control fruit flies and the loss of export potential due to the presence of fruit flies would have a **High (3)** Economic Impact.	
Environmental Impact Adult fruit fly (*Bactrocera* spp.) can be controlled with methyl eugenol traps (Lakshmanan *et al.* 1973), bait sprays, pheromone mating disruption, and pesticide applications to fruit (Abbas *et al.* 2000). Larvae inside mango fruit can be killed by gamma irradiation (Heather *et al.* 1991). The residual toxicity of the applied chemical insecticides on fruits and irradiated mango would have a **High (3)** Environmental Impact.	**High (3)**
2. Consequences of Introduction of Coccidae (Homoptera): *Coccus viridis* (Green) (Green scale)	**Risk Rating**
Climate-Host Interaction ***Coccus viridis* (Green)** is pantropical in distribution. It has been reported from India through Indo-China, Malaysia to the Philippines and Indonesia, throughout much of Oceania and sub-Saharan Africa south to South Africa (CABI, 2002). In the New World, it is present in Florida, and ranges from Central America to the northern part of South America and throughout the Caribbean. Its reported distribution corresponds to Agro Ecological Zones (AEZ) of Bangladesh. It is estimated that this species could become established in areas of Bangladesh. Survival outside of these areas would be limited to greenhouse or other artificial situations. Consequently, the Climate-Host Interaction risk element was rated **High (3)** for *C. viridis*.	**High (3)**
Host range ***Coccus viridis* (Green)** has a broad host range (CABI, 2002). Primary hosts are *Citrus* spp. (Rutaceae), *Coffea arabica* (Rubiaceae), *Artocarpus* sp. (Moraceae),	**High (3)**

Camellia sinensis (Theaceae), *Manihot esculenta* (Euphorbiaceae), *Mangifera indica* (Anacardiaceae), *Psidium guajava* (Myrtaceae), and *Theobroma cacao* (Sterculiaceae) (CABI, 2002). Other hosts include *Alpinia purpurata* (Zingiberaceae), *Chrysanthemum* sp. (Asteraceae), *Manilkara zapota* (Sapotaceae), *Nerium oleander* (Apocynaceae) (CABI, 2002), and *Dimocarpus longan* (Sapindaceae) (ScaleNet, 2004). Therefore, the Host Range risk element was rated **High (3)** for this organism.	
Dispersal Potential and Pathway *Coccus viridis* is parthenogenetic and oviparous (Dekle 1976b). Females may deposit up to 500 eggs (CABI 2002). There may be several generations per year (Kosztarab 1997). The rate of natural dispersal is inherently low (Tandon and Veeresh 1988); however, since 1985, *C. viridis* has been intercepted 10,658 times by agricultural specialists at U.S. ports of entry (PIN309 query September 30, 2004), which is strong evidence that this species can, and has, spread quickly and widely via the transport of infested plant materials. In light of this evidence, this organism was rated **High (3)** for the Dispersal Potential risk element.	**High (3)**
Economic Impact Although its economic impact is usually minor, it can be extremely devastating depending on location and crop (CABI 2002). *Coccus viridis* is a pest of coffee, citrus and other crops in several regions in the tropics, and it is reported as a major pest of citrus in Bolivia (Ben-Dov 1993). *Coccus viridis* is a major pest of coffee in Haiti (Aitken Soux 1985) and India (Narasimham 1987). In Brazil, infestations of 50 scales per plant caused significant damage to coffee seedlings, reducing leaf area and plant growth rate (Silva and Parra 1982). Of all the scale insects known on coffee in Papua New Guinea, *C. viridis* and one other scale species cause most of the yield loss Williams 1986). In India, citrus fruit quality was significantly lower on trees following *C. viridis* infestation and the sooty mold (*Capnodium citri*) contamination that accompanied it (Haleem 1984). Based on this evidence, the wider establishment in the Bangladesh of *C. viridis* would likely lead to lower yield of host crops, lower value of host crop commodities, and loss of foreign or domestic markets. Consequently, *C. viridis* was rated High (3) for the Economic Impact risk element.	**High (3)**
Environmental Impact The extreme polyphagy of *C. viridis* predisposes it to attack vulnerable native plants in the Bangladesh. The wider establishment of this species could have a negative impact on the citrus industry in all over areas of Bangladesh, and stimulate the initiation of chemical control programs. Therefore, the Environmental Impact risk element was rated **High (3).**	**High (3)**
3. Consequences of Introduction of Coccidae (Homoptera): *Ceroplastes rubens* Maskell (Red wax scale)	**Risk Rating**
Host-Climate Interaction *Ceroplastes rubens*' distribution extends from warm temperate zones to the tropics. It is found in East and South Asia, throughout Oceania, Australia, East Africa, and the West Indies (CABI, 2005). It is estimated that it could survive in the Climatic Conditions of different Agro Ecological Zones of Bangladesh. Because one or more of its potential hosts occurs in these zones, this risk element was rated **High (3)**.	**High (3)**
Host Range *C. rubens* has been recorded on numerous wild and cultivated hosts, including *Citrus* spp. (Rutaceae), *Mangifera indica* (Anacardiaceae), *Artocarpus altilis* (Moraceae), *Cinnamomum verum* (Lauraceae), *Camellia sinensis* (Theaceae), *Litchi chinensis* (Sapindaceae), *Psidium guajava* (Myrtaceae), *Coffea* sp. (Rubiaceae),	**High (3)**

Alpinia purpurata (Zingiberaceae), *Myristica fragrans* (Myristicaceae), *Annona* sp. (Annonaceae), *Artemisia* sp. (Asteraceae), *Prunus* spp. (Rosaceae), *Pinus* spp. (Pinaceae), *Cocos nucifera* (Arecaceae) (CPC, 2005), and *Dimocarpus longan* (Sapindaceae) (Li-zhong, 2000; Ben-Dov *et al*., 2003). This risk element was rated **High (3).**	
Dispersal Potential and Pathway Females of this scale may deposit over 1000 eggs, but mean fecundity is just below 300 (CPC, 2001). There are two generations per year (CPC, 2005). As with other scales, the species exhibits limited mobility under its own power. The main means of long-distance dispersal is on infested plant materials (CPC, 2002). The dispersal potential of *C. rubens* risk element was rated **High (3)**.	**High (3)**
Economic Impact *Ceroplastes rubens* is a widespread pest of *Citrus*, coffee, tea, *Cinnamomum*, mango, avocado and litchi (CPC, 2001). It is considered a major pest of citrus in Australia, Hawaii, Korea, China and Japan (CPC, 2002). Economic damage is caused directly through phloem feeding and indirectly through the promotion of sooty mold growth, which lowers the market value of fresh fruit and can reduce photosynthetic efficiency, causing reduced growth (CPC, 2002). Based on this evidence, if *C. rubens* should become more widely established in the United States, there would likely be a lower yield of host crops, lower value of host crop commodities, and loss of foreign or domestic markets. Thus, its potential economic impact was rated **High (3).**	**High (3)**
Environmental Impact The extreme polyphagy of this species increases the probability of it attacking plants in the Bangladesh. As this species is a pest of citrus, the wider establishment of this pest in Bangladesh would likely result in the initiation of chemical control programs. This risk element was, therefore, rated **High (3)**.	**High (3)**
4. Consequences of Introduction of Diaspididae (Homoptera): *Aonidomytilus albus* (Cockerell, 1893) (Tapioca scale)	**Risk Rating**
Climate-Host Intraction *Aonidomytilus albus* is a tropical species of New World origin. It has not been recorded from Australia or the Pacific islands. It is distributed in China (Tao, 1999), India (Sankaran *et al*., 1984; APPPC, 1987; EPPO, 2014), Sri Lanka (Williams & Williams, 1988; EPPO, 2014), Thailand (Wongkobrat, 1988; Waterhouse, 1993; APPPC, 1987), Africa (Nakahara, 1982; EPPO, 2014), USA (Nakahara, 1983), Brazil (Nakahara, 1982; Kondo, 2001; EPPO, 2014). The climate of these regions particularly for India, Thailand, Sri Lanka is correspond to different AEZ of Bangladesh. Therefore, the risk Climate-Host Interacton was rated **High (3)**.	**High (3)**
Host Range The preferred hosts of *A. albus* are species of *Manihot esculenta* (cassava), but this insect has been recorded feeding on a variety of hosts, including several species of Solanum. Host include: *Carica papaya* (papaw), Chrysanthemum (daisy), *Croton bonplandianus*, *Jatropha gossypiifolia* (bellyache bush), *Malvastrum americanum* (spiked malvastrum (Australia)), *Mangifera indica* (mango), *Rosa chinensis* (roses), *Salvia* sp. (sage), Solanum (nightshade), *Turnera ulmifolia* (west Indian holly) (CABI, 2015).	**High (3)**
Dispersal Potential and Pathway The first-instar crawlers are the dispersal stage and move across quite short distances to new parts of the host-plant or to adjacent plants. Dispersal over longer	**Medium (2)**

distances is only possible with the assistance of wind or animals/humans. Mortality due to abiotic factors is high during dispersal (CABI, 2015). Dispersal of the sessile adults and immature stages between countries occurs through human transport of infested plant material, mainly on planting sticks rather than on stored tubers (CABI, 2015). Transport of infested planting sticks of cassava, and stored cassava, is the main risk of transporting A. albus to new territory. Transport of infested material through fields planted with cassava also risks spread of the infestation, as crawlers may drop (or be blown) off the harvested material onto uninfested plants still in the field (CABI, 2015). Thus, the risk for Dispersal Potential and Pathway was rated **Medium (2).**	
Economic Impact *A. albus* is only an occasional problem in the field; most often, it is a pest of cassava stems stored for later planting. Infested cuttings often do not root, and use of infested cuttings at planting can result in rooting failure of up to 80% (Lal and Pillai, 1981). Heavy infestation causes desiccation of the stems; in the field, this causes them to become thin and weak, and to break in the wind; death of the plant may result. Breakage of stems leads to profuse branching, and infested plants often appear bushy. The severity of attack becomes worse in drought conditions, aggravating drought stress (Lal and Pillai, 1981). The socio-economic impact of this can be considerable, as cassava is an important staple crop during drought, e.g. in Africa. A. albus is a more or less serious pest of cassava in East and West Africa, Argentina, Brazil, Colombia, India, Madagascar, Mexico, Taiwan, Thailand, West Indies and USA (Florida) (Simmonds, 1960; Subramaniam *et al.*, 1977; Vargas *et al.*, 1978; Lal and Pillai, 1981; Wongkobrat, 1988). In Brazil, this species is a pest on Manihot and Solanum spp. (Foldi, 1988), and was regarded with potential pest status on Manihot spp. (source of Ceara rubber) by Bastos *et al*. (1979). It can cause serious damage locally in Kenya (Bruijn and Guthrie, 1982). Severe attacks on cassava cuttings kept for planting can lead to losses (Lal and Pillai, 1981; Chua and Wood, 1990); it is a field pest less often (Lal and Pillai, 1981). The severity of attack by *A. albus* becomes worse in drought conditions, aggravating drought stress (Lal and Pillai, 1981). The socio-economic impact of this can be considerable, as cassava is an important staple crop during drought in Africa. Based on the information, therefore, the risk of Economic Impact was rated **Medium (2)**, because *A. albus* reduce the revenue by reducing the yield of affected crops.	**Medium (2)**
Environmental Impact Lozano *et al.* (1977) recommended a 5-minute dip of planting sticks in 200 ppm malathion or diazinin to kill any infestation. Lal and Pillai (1981) found that vertical storage of stems reduced infestation, and spraying of infested stems with 0.1% malathion or methyl demeton before planting minimised subsequent infestation problems in the field. Pillai *et al.* (1993) recommended the use of dimethoate and methyl demeton for control of *A. albus*. Therefore, the Environmental Impact Risk was rated **Low (1)**.	**Low (1)**
5. Consequences of Introduction of Diaspididae (Homoptera): *Aulacaspis tubercularis* (Newstead) (White mango scale)	**Risk Rating**
Climate-Host interaction The mango scale, *Aulacaspis tubercularis*, is found throughout the world where mango is cultivated, including the northern part of South America, the Caribbean, the east and west coasts of Africa, and India, and Italy (CPC, 2001). The regions occupied by *A. tubercularis* correspond to Agro Ecological Zones of Bangladesh, so	**High (3)**

the Climate-Host Interaction rating is **High (3)**.	
Host range *Aulacaspis tubercularis* attacks hosts in at least seven plant families (Hamon, 2002), so Host Range is rated **High (3)**.	**High (3)**
Dispersal potential and Pathway In South Africa, *A. tubercularis* was first recorded on one cultivar of mango in 1947 and has since become a pest throughout all mango producing areas of South Africa (Joubert *et al.*, 2000). Only the crawler stage can move to a new host (adult males can fly but cannot establish a colony), but scale insects can move to new hosts as a result of wind, birds, and insects. Crawlers are capable of moving distances of tens of kilometers on wind currents to infect clean crops (Greathead, 1990). Because of the proven ability of *A. tubercularis* to spread through mango producing regions, Dispersal Potential is rated **High (3)**.	**High (3)**
Economic Impact *Aulacaspis tubercularis* attacks mango leaves, branches and fruit, where it causes superficial pink or yellow blemishes to develop, making the fruit unmarketable (Joubert *et al.*, 2000), although precise economical figures are lacking. In the absence of evidence, Economic Impact is rated **Medium (2).**	**Medium (2)**
Environmental Impact The genus *Cucurbita* is a reported host of this scale species, *A. tubercularis* (CPC, 2003). The introduction of *A. tubercularis* into the United States could stimulate chemical or biological control programs. Consequently, the Environmental Impact was rated **High (3)** for *A. tubercularis*.	**High (3)**
6. Consequences of Introduction of Diaspididae (Homoptera): *Parlatoria crypta* McKenzie (Armored scale)	**Risk Rating**
Climate-Host Intraction *Parlatoria crypta* has been reported in Africa (Comoros, Sudan) (Ben-Dov *et al.*, 2004), India (Dutta, 1996; CPC, 2003; Ben-Dov *et al.*, 2004), Afghanistan (CPC, 2003; Fowjhan and Kozar, 1994; Ben-Dov *et al.*, 2004), Pakistan (Ghani and Muzaffar, 1974; Ben-Dov *et al.*, 2004), Iran (Kozar *et al*, 1996; Ben-Dov *et al.*, 2004), Iraq (Ben-Dov *et al.*, 2004; CPC, 2003), and Saudi Arabia (Ben-Dov *et al.*, 2004). Based on this distribution and availability of potential hosts, it is estimated that suitable climatic conditions for this species should be available in different AEZ of Bangladesh. One or more of its potential hosts occurs in these zones. Therefore, this species was rated **High (3)** for the Climate-Host Interaction.	**High (3)**
Host Range *Parlatoria crypta* has as a very wide host range, which includes plants from multiple families (Ben-Dov *et al.*, 2004). In light of this wide host range, *P. crypta* was rated **High (3)** for the Host Range risk element.	**High (3)**
Dispersal Potential and Pathway No information was found on the biology of *P. crypta*; however, related species exhibit multivoltinism and high fecundity. For instance, *Parlatoria ziziphi* may produce two to seven generations per year, depending on the geographical location, and fecundity varies from 8 to 34 eggs per female (CPC, 2002; Blackburn and Miller, 1984). The crawler stage of armored scales can be dispersed by natural means (several meters), on other organisms (*e.g.*, the feet of birds), or by wind (Miller *et al.* 1985). As with other scale insects, long-distance dispersal of *P. crypta* can likely be accomplished by transport on infested plant material. Consequently, the dispersal potential of *P. crypta* was rated **High (3)** for the Dispersal Potential risk element.	**High (3)**

Economic Impact Little information could be found on the economic impact of *P. crypta* other than it is listed as an insect pest by Miller and Davidson (1990), and it is reported to cause very serious damage (on leaves, buds, stems and the top part of trees) on olive trees in Iran (Najafinia, *et al*., 2002). The related species *P. ziziphi* is reported as an important citrus pest in various parts of the world: China, Egypt, Iran, Italy, Libya, Nigeria, Tunisia, Algeria, Morocco, and Southeast Asia, and is reported to cause some damage in Greece, Italy, Spain, Israel, Egypt, and South Africa (Blackburn and Miller, 1984). It has become the most important citrus pest in Upper Egypt (Coll and Abd Rabou, 1998). However, there is little information on the specific economic losses caused by this scale (CPC, 2002). This insect is mainly a problem as a contaminant on fruit, which can cause rejection in most fresh fruit markets (Blackburn and Miller, 1984). It also causes dieback of twigs, premature drop of fruit and leaves, and deformation of fruit (Blackburn and Miller, 1984). Large populations cause chlorosis and premature drop of leaves, dieback of twigs and branches, stunting and distortion of the fruit, and premature fruit drop (Blackburn and Miller, 1984). Based on the fact that there is little information available on the economic impact of *P. crypta* but that it is reported to cause serious damage to olives, that this species has a wide host range that includes some economically important hosts lide olive in Bangladesh, and that the related species *P. ziziphi* is an important economic pest, *P. crypta* was given a **Medium (2)** rating for the Economic Impact risk element.	**Medium (2)**
Environmental Impact *Agave arizonica* (Agavaceae) is the only potential host for *P. crypta* present in the continental United States (USFWS (2004). This plant species is reported as present in *P. crypta*'s predicted climatic range within the United States. *Cordia bellonis* (Boraginaceae), which is reported as potential host in Puerto Rico (USFWS (2004). Control measures against armored scales (Diaspididae) are often necessary to produce a marketable crop (Miller, 1985). In Florida, scale insects, including *P. ziziphi*, are often managed by natural as well as released parasites, predators, and pathogens; and scale populations may require treatment if biological control has been disrupted (Mossler and Nesheim, 2003). In China, the following pesticides have been used to effectively control *P. ziziphi*: omethoate, chlorpyrifos, methidathion, quinalphos, lambda-cyhalothrin, fenvalerate or cypermethrin (CPC, 2002). Based on this information, *P. crypta* was given a **High (3)** rating for the Environmental Impact risk element.	**High (3)**
7. Consequences of Introduction of Diaspididae (Homoptera): *Pseudaonidia trilobitiformis* (Green, 1896) (Gingging scale)	**Risk Rating**
Climate-Host Intraction *Pseudaonidia trilobitiformis* has been reported in Taiwan (Anonymous 1994), Mexico, Venezuela, the Caribbean (CABI 2002), East Africa, New Caledonia in the South Pacific (Fabres 1974), and Florida (Coile and Dixon 2000; USDA 1979). Suitable climatic conditions for this species should be available in the some Agro Ecological Zones (AEZ) of Bangladesh. One or more of its potential hosts occurs in these zones. It is, therefore, rated **Medium (2)** for the Climate-Host risk element.	**Medium (2)**
Host Range Hosts recorded for *Pseudaonidia trilobitiformis* include *Mangifera indica* and *Anacardium occidentale* (Anacardiaceae), *Citrus* spp. (Rutaceae), *Anthurium andreanum* (Araceae), *Persea americana* (Lauraceae), *Zingiber officinale* (Zingiberaceae), *Theobroma cacao* (Sterculiaceae), *Coffea* spp. (Rubiaceae), *Cocos nucifera* (Arecaceae) (CABI 2002), *Passiflora* spp. (Passifloraceae) (Hill 1983), and	**High (3)**

Dimocarpus longan (Sapindaceae) (Anonymous 1994). *Pseudaonidia trilobitiformis* is, therefore, rated **High (3)** for the Host Range risk element.	
Dispersal Potential and Pathway No information is available on the biology of *Pseudaonidia trilobitiformis*, but two related species that occur in the southern U.S. exhibit multivoltinism and high fecundity. *Pseudaonidia duplex* (Cockerell) has three generations per year in Louisiana, and *P. paeoniae* (Cockerell) produces 30-50 eggs per female (Kosztarab 1996). Long-distance dispersal of *P. trilobitiformis* is likely accomplished by transport on infested plant material. Based on this evidence, this scale species was rated **High (3)** for the Dispersal Potential risk element.	**High (3)**
Economic Impact *Pseudaonidia trilobitiformis* is regarded as a minor pest of avocado, cacao, citrus, coconut, coffee, mango, and passion fruit (Hill 1983). In Brazil, however, it is a pest of cashew that requires chemical control (Silva *et al.* 1977). Wider establishment of this insect in Bangladesh could stimulate chemical control programs and cause a loss of domestic and foreign markets for commodities, such as citrus. Based on this evidence, *P. trilobitiformis* was rated **Medium (2)** for the Economic Impact risk element.	**Medium (2)**
Environmental Impact Because *P. trilobitiformis* represents a potential threat to citrus and possibly other economically important crops, wider establishment of this species in Bangladesh could stimulate chemical control programs. Based on this evidence, *P. trilobitiformis* was rated **High (3)** for the Environmental Impact risk element.	**High (3)**
8. Consequences of Introduction of Fungus: *Phomopsis mangiferae* S. Ahmad (Stem-end rot of mango)	**Risk Rating**
Climate-Host Interaction The fungus, *Phomopsis mangiferae*, causes a postharvest rot of mango (Johnson *et al*., 1994). It occurs in India, Pakistan and Australia in mango producing areas (ARS, 2001; Laxinarayana and Reddy, 1975) that correspond to Climatic conditions of different AEZ of Bangladesh, so this pest is rated **High (3)** for Climate-Host Interaction.	**High (3)**
Host range The host range appears to be limited to mango (ARS, 2001; Johnson *et al*., 1994) so it is also rated **Low (1)** for Host Range.	**Low (1)**
Dispersal Potential and Pathway The disease infects mango fruit endophytically, that is, from within the plant (Johnson *et al*., 1994; Sangchote *et al.,* 1992) and infected fruit can become mummified. Infected seeds germinate to produce infected plants, perpetuating the fungus within the plant (Johnson *et al*., 1994). The Dispersal Potential is rated **Low (1)**, because dispersal assumes that the infected seed subseqently is used in mango production. If infected fruit is consumed and seeds are discarded, infected fruit are unlikely to come into contact with susceptible mango plants.	**Low (1)**
Economic Impact The pest also causes a stem-end rot of harvested fruits (Johnson *et al.*, 1994), which is likely to impact grower revenue by ruducing market quality of fruits. For these reasons, the Economic Impact is rated **Medium (2)**.	**Medium (2)**
Environmental Impact The Environmental Impact is rated **Low (1)** because *P. mangiferae* is host specific for mango (ARS, 2001), and mango is not an Endangered or Threatened species in Bangladesh.	**Low (1)**

9. Consequences of Introduction of Pathogens (Fungi): *Cytosphaera mangiferae* Died. 1916 (Twig canker)	Risk Rating
Climate-Host Interaction *Cytosphaera mangiferae* is found primarily in tropical regions in Australia and sub-tropical regions in Asia (Malaysia, Pakistan, India, and Papua New Guinea) (Farr *et al.*, 2006). These regions roughly correspond to the climate of different AEZ of Bangladesh. *Cytosphaera mangiferae* was, therefore, rated **Low (1)** for Climate-Host Interaction.	**Low (1)**
Host range In addition to mango, the host range of *C. mangiferae* includes agarwood (*Aquilaria agallocha* Roxb.), *Artocarpus frengenifolia*, *Macadamia integrifolia* and *Sabal palmetto* (Johnson & Hyde, 1992). Of these species, there is limited production of *Aquilaria* spp., *Artocarpus* spp. or *Macadamia* spp. in Bangladesh. However, the agarwood (*Aquilaria agallocha* Roxb.) is a native plant throughout the Hilly Areas like Sylhet, and Hill tracts of Bangladesh. *Cytosphaera mangiferae* was, therefore, rated **High (3)** for Host Range, since it attacks multiple species from multiple plant families.	**High (3)**
Dispersal Potential and Pathway The fungus is thought to grow endophytically leading to stem cankers and fruit infections (Johnson & Hyde, 1992). Dispersal has not been extensively studied, however discarded, infected fruit may be a source of conidia produced on the surface (Johnson & Hyde, 1992). These conidia may disperse via wind or water to infect mango nearby. *Cytosphaera mangiferae* was assigned a **Medium (2)** risk rating because of uncertainty in Dispersal Potential.	**Medium (2)**
Economic Impact *Cytosphaera mangiferae* causes stem-end rot (Peterson, 1986), a zonate leaf spot, twig canker, and a post-harvest fruit rot (MAF, 2003) It is more prevalent as orchards age and when anthracnose is controlled (MAF, 2003). *Cytosphaera mangiferae* was, therefore, rated **Medium (2)** for Economic Impact.	**Medium (2)**
Environmental Impact *Cytosphaera mangiferae* is the pest of limited host including mango. However these plants do not inhabit the zones where the pathogen is estimated to become established. Based on this evidence, the Environmental Impact is rated **Low (1)**.	**Low (1)**
10. Consequences of Introduction of Pathogens (Fungi): *Actinodochium jenkinsii* Uppal, Patel & Kamat	**Risk Rating**
Climate-Host Interaction Mango black spot caused by *Actinodochium jenkinsii* has only been recorded in India (Uppal *et al.*, 1953). Uppal *et al.* (1953) described this disease as strictly a wound parasite, with ripe fruits being more susceptible than green ones. It occurs in coastal areas of Bombay State (geographic division in 1937) (Uppal *et al.*, 1953), and because this region corresponds to Coastal Zone of Bangladesh, the Climate-Host Interaction rating is **Low (1)**.	**Low (1)**
Host range The Host Range is rated **Low (1)** because this disease is known to attack only Alfonso and Piari varieties of mango (Uppal *et al.*, 1953).	**Low (1)**
Dispersal Potential and Pathway Affected fruits show only a few dusky brown to blackish brown, round, small necrotic spots. This pest is rated **Medium (2)** for Dispersal Potential because disease spread through an orchard could be rapid, but long range disease spread is likely to be slower, as evidenced by the fact that it does not occur outside of India.	**Medium (2)**

Economic Impact The Government of India has also indicated that this disease is of no economic significance in India (Seshadri, 2004); therefore, the Economic Impact rating is **Low (1)**.	**Low (1)**
Environmental Impact The Environmental Impact is rated **Low (1)** because *A. jenkinsii* is host specific for mango (Uppal *et al.*, 1953), and mango is not an Endangered or Threatened species.	**Low (1)**
11. Consequences of Introduction of Pathogens (Fungi): *Hendersonia creberrima* Syd., Syd. & Butler (Mango fruit rot)	**Risk Rating**
Climate-Host Interaction The fungus, *Hendersonia creberrima*, causes a ripe fruit rot of mango, with large, irregular, black spots developing all over the fruit's surface and not exclusively at the stem end (Sydow, *et al.*, 1916). It is reported only from India in mango producing areas (Farr *et al.*, 2006; Cline, 2006). Areas where it is found correspond to Agro Ecological Zones of Bangladesh, so this pest is rated **High (3)** for Climate-Host Interaction.	**High (3)**
Host range The only reported host is mango, so the pathogen is rated **Low (1)** for Host Range.	**Low (1)**
Dispersal Potential and Pathway *H. creberrima* causes a storage rot of mango fruit and reproductive structures form typically when the rot is advanced, producing masses of spores from pycnidia (Sydow *et al.*, 1916). The Dispersal Potential is rated **Medium (2)**, because spores are produced in abundance and released from pycnidia in wet tendrils or droplets likely dispersed by rain or heavy dew.	**Medium (2)**
Economic Impact *H. creberrima* causes a storage rot of harvested fruits (Sydow, *et al.*, 1916), which may impact grower revenue by reducing quality of marketed fruit. For these reasons, the Economic Impact is rated **Medium (2)**.	**Medium (2)**
Environmental Impact The Environmental Impact is rated **Low (1)** because *H. creberrima* infects only mango, although other hosts have not been studied to date (USFWS, 2002).	**Low (1)**
12. Consequences of Introduction of Pathogens (Fungi): *Macrophoma mangiferae* Hing. & Sharma (Leaf and stem blight)	**Risk Rating**
Climate-Host Interaction The fungus, *Macrophoma mangiferae*, causes a leaf and stem blight and postharvest rot of mango (Hingorani, *et al.*, 1960). It occurs in India and Nigeria in mango producing areas and has been intercepted from Mexico (Farr *et al.*, 2006; Okigbo & Osuinde, 2003; Hingorani, *et al.*, 1960). Areas where it is found correspond to the Climate of Bangladesh, so this pest is rated **High (3)** for Climate-Host Interaction.	**High (3)**
Host range The primary host is mango (Hingorani, *et al.*, 1960), although it also weakly infects *Ficus carica*, *Eryobotrya japonica*, *Eugenia jambolina*, and *Vitis vinifera*, so the pathogen is rated **High (3)** for Host Range.	**High (3)**
Dispersal Potential and Pathway *M. mangiferae* infects leaves, stems and causes a storage rot of mango fruit (Hingorani, *et al.*, 1960). The Dispersal Potential is rated **Medium (2)**, because dispersal occurs when fruiting structures (pycnidia) form on colonized mango tissue. Spores produced in abundance are dispersed by rain or heavy dew (Hingorani, *et*	**Medium (2)**

al., 1960).	
Economic Impact This fungus causes a leaf and stem blight and storage rot of harvested fruits (Hingorani, *et al.*, 1960; Okigbo & Osuinde, 2003), which may impact grower revenue by reducing tree productivity (reduced leaf area) or quality of marketed fruit. For these reasons, the Economic Impact is rated **Medium (2)**.	**Medium (2)**
Environmental Impact The Environmental Impact is rated **Medium (2)** because *M. mangiferae* has a somewhat limited host range.	**Medium (2)**
13. Consequences of Introduction of Bacterium: *Xanthomonas campestris* pv. *mangiferaeindicae* (Patel *et al*.) Robbs *et al*.	**Risk Rating**
Climate-Host Interaction Mango bacterial black spot, caused by *Xanthomonas campestris* pv. *angiferaeindicae*, is found in India, Australia, the Comoros Islands, Japan, Kenya, Malaysia, Mauritius, New Caledonia, Pakistan, the Philippines, Réunion, Taiwan, Thailand and the United Arab Emirates (Gagnevin & Pruvost, 2001). *Xanthomonas campestris* pv. *mangiferaeindicae* infects not only mango (*Mangifera indica*), but also cashew (*Anacardium occidentale*), Brazilian pepper (*Schinus terebinthefolius*), ambarella (*Spondias cytherea* or *S. dulcis*), and other members of the plant family Anacardiaceae, growing in the regions listed above (Gagnevin & Pruvost, 2001). These regions correspond to the Climatic conditions of different AEZ of Bangladesh, so the Climate-Host Interaction rating is **High (3).**	**High (3)**
Host range *Xanthomonas campestris* pv. *mangiferaeindicae* infects not only mango (*Mangifera indica*), but also cashew (*Anacardium occidentale*), Brazilian pepper (*Schinus terebinthefolius*), ambarella (*Spondias cytherea* or *S. dulcis*), and other members of the plant family Anacardiaceae (Gagnevin & Pruvost, 2001). The Host Range is rated **Medium (2)** because this pathogen attacks multiple species in the family Anacardiaceae (CPC, 2005).	**Medium (2)**
Dispersal Potential and Pathway Bacterial pathogens in the genus *Xanthomonas* penetrate their hosts through natural openings and wounds (Agrios, 1997). The bacteria overwinter on infected or healthy plant parts, on or in seeds, on infected plant debris, on contaminated containers or tools and in the soil (Agrios, 1997). Rain plays an important role in pathogen dispersal (Agrios, 1997; Pruvost *et al.*, 1990). This pest is rated **Medium (2)** for Dispersal Potential because disease spread through an orchard could be rapid, but long range disease spread is likely to be slower.	**Medium (2)**
Economic Impact organization Pruvost *et al*., (1990) described bacterial black spot of mango as one of the principle diseases in mango producing countries, so the Economic Impact rating is **High (3)**.	**High (3)**
Environmental Impact *Xanthomonas campestris* pv. *mangiferaeindicae* has a somewhat limited host range only few species under the family Anacardiaceae. Based on this evidence, the environmental Impact is rated **Low (1)**.	**Low (1)**
14. Consequences of Introduction of Weed: *Parthenium hysterophorus* L. (Parthenium weed)	**Risk Rating**
Climate-Host Interaction The genus *Parthenium* contains 15 species, all native to North and South America. *P. hysterophorus* has a native range in the subtropical regions of North to South America. It is thought that the species originated in the region surrounding the Gulf	**High (3)**

of Mexico, including southern USA, or in central South America (Dale, 1981; Navie *et al.,* 1996), but is now widespread in North and South America and the Caribbean. Since its accidental introduction into Australia and India in the 1950s, probably as a contaminant of grain or pasture seeds, it has achieved major weed status in those countries. It was first recorded in southern Africa in 1880 but was not reported as a common weed in parts of that region until the mid-1980s following extensive flooding on the east coast (McConnachie *et al.*, 2011). Recent reports of the weed from other countries indicate that its geographic range continues to increase including Pakistan. Parthenium weed is an aggressive colonizer of disturbed ground, able to germinate, grow and flower over a wide range of temperatures and photoperiods. It occurs in the humid and sub-humid tropics, showing a marked preference for black, alkaline, cracking, clay soils of high fertility, but is able to grow on wide variety of soil types from sea level up to 1800 m (Evans, 1987a). In Ethiopia, it grows from low to high-mid-altitude areas at 900-2500 m asl (Taye, 2002). High clay content in soils prolonged the rosette stage, enhanced relative growth rates in height and diameter, and hampered root growth, but promoted biomass allocation to shoots (Annapurna and Singh, 2003). Mahadevappa (1997) noted that parthenium weed has several built-in properties and efficient behavioural mechanisms that enable it to overcome many ecological adversities and thus continue to survive under stress. The weed finds access to any type of land but it is especially prolific in disturbed habitats, for example, roadsides and railway tracks, stock yards, around buildings and on waste land, from where it spreads and invades agricultural systems. Seed germination of this weed occurred at the mean minimum (10°C) and maximum (25°C) temperatures of the collection site, as well as over a wide range of fluctuating temperatures (12/2°C - 35/25°C) in light (Tamado *et al.,* 2002). Seed germination can occur over a wide range of soil pH (2.5-10), with an optimum of 5.5-7.0 (Parsons and Cuthbertson, 1992). Germination may be increased after cold stratification, and with exposure to light (Karlsson *et al*., 2008). Based on the geographical distribution pattern and climatic conditions, we can estimate that this weed could become established in most of the agro-ecological zones of Bangladesh.	
Hosts/Species Affected In Australia, the main impact of *P. hysterophorus* has been in the pastoral region of Queensland, where it replaces forage plants, thereby reducing the carrying capacity for grazing animals (Haseler, 1976; Chippendale and Panetta, 1994). Serious encroachment and replacement of pasture grasses has also been reported in India (Jayachandra, 1971) and in Ethiopia (Tamado, 2001; Taye, 2002). *P. hysterophorus* is now being reported from India as a serious problem in cotton, groundnuts, potatoes and sorghum, as well as in more traditional crops such as okra (*Abelmoschus esculentus*), brinjal (*Solanum melongena*), chickpea and sesame (Kohli and Rani, 1994), and is also proving to be problematic in a range of orchard crops, including cashew, coconut, guava, mango and papaya (Tripathi *et al.*, 1991; Mahadevappa, 1997). Similar infestations of sugarcane and sunflower plantations have recently been noted in Australia (Parsons and Cuthbertson, 1992; Navie *et al.*, 1996). In Ethiopia, parthenium weed was observed to grow in maize, sorghum, cotton, finger millet (*Eleusine coracana*), haricot bean (*Phaseolus vulgaris*), tef (*Eragrostis tef*), vegetables (potato, tomato, onion, carrot) and fruit orchards (citrus, mango, papaya and banana) (Taye, 2002). In Pakistan, the weed has been reported from number of crops, including wheat, rice, sugarcane, sorghum, maize, squash, gourd and water melon (Shabbir 2006; Shabbir *et al.* 2011).	**High (3)**

Dispersal Potential and Pathway Parthenium weed seed can be moved and spread via water, farm machinery, industrial machinery, feral animals, humans, vehicles, stock fodder, movement of stock, grain and seed (PAG, 2000). It can also be spread by the wind because its seeds are small (1-2 mm diameter) and light (50 µg) and able to travel long distances (Navie *et al.*, 1996; Taye, 2002). The transportation of soil, sand and gravel from *Parthenium*-infested areas to non-infested areas for construction purposes may be the reason for the high infestation along the roadsides and around buildings (Taye, 2002). Continental and inter-continental dispersal may occur when seeds contaminate commercial seed stocks or farm machinery. It can be spread via flowing water or can be blown by wind, making prevention of spread difficult. Once introduced it can be spread by vehicles and farm machinery, and the transport of goods, sand, soil and compost from infested areas to uninfested areas. Long distance and local dispersion of parthenium weeds mainly caused by agricultural activities, animal production, flooding or other natural disaster, foraging and seed trading (PAG, 2000).	**High (3)**
Economic Impact It is only in the past 20-30 years that parthenium weed has come to the fore as a weed of major economic importance, based mainly on its rapid spread in Australia and India (McFadyen, 1992; Navie *et al.*, 1996; Evans, 1997a and Mahadevappa, 1997). Since its impact is multi-faceted, affecting crop production, animal husbandry, human health and biodiversity, its overall economic impact is difficult to quantify. The main impact of parthenium weed on crops relates to its allelopathic properties. The water soluble phenolics; caffeic acid, ferulic acid, vanicillic acid, anisic acid and fumaric acid; and sesquiterpene lactones, mainly parthenin and/or hymenin, occur in all parts of the plant and significantly inhibit the germination and subsequent growth of a wide variety of crops including pasture grasses, cereals, vegetables, other weeds and tree species (Navie *et al.*, 1996; Evans, 1997a). Few critical assessments of yield losses have been made, although it has been determined that almost 30% grain loss can occur in irrigated sorghum in India (Channappagoudar *et al.*, 1990). As *Parthenium* pollen is also allelopathic (Kanchan and Jayachandra, 1980), heavy deposits on nearby crop plants may result in failure of seed set, and losses of up to 40% have been reported in maize yield in India (Towers *et al*., 1977). In eastern Ethiopia, parthenium weed is the second most frequent weed (54%) after *Digitaria abyssinica* (63%) (Tamado and Milberg, 2000) and sorghum grain yield was reduced from 40 to 97% depending on the year and location (Tamado, 2001). Also, Chippendale and Panetta (1994) estimate that cultivation costs may be doubled since the prepared ground has to be re-worked to eliminate the emergent parthenium weed seedlings. The growth and nodulation of legumes were inhabited by parthenium weed because of the effect of allelochemicals on nitrogen fixing and nitrifying bacteria (Kanchan and Jayachandra, 1981; Dayama, 1986). Another, indirect effect of parthenium weed on crop production is its role as an alternate host for crop pests. A wide range of crop insects and diseases has been reported from parthenium weed both in the neotropics and in its exotic range (McClay *et al.*, 1995; Evans, 1997a; Singh, 1997). For example, it appears to be an important secondary host of a beetle pest (*Pseudoheteronyx* sp.) of sunflower in Australia, of plant parasitic nematodes in the USA (Navie *et al.*, 1996), as well as of a major polyphagous lepidopteran pest (*Diacrisia obliqua* [*Spilartica obliqua*]) in India (Evans, 1997a). Similarly, it has been reported as a reservoir of *Xanthomonas campestris* pv. *phaseoli* [*X. axonopodis* pv. *phaseoli*], *Pseudomonas solancearum* [*Burkholderia solanacearum*], Tomato yellow leaf curl virus, Potato X virus and	**High (3)**

Potato Y virus in both Cuba and India (Evans, 1997a). I Parthenium weed also significantly impacts on livestock production by affecting grazing land, animal health, milk and meat quality and the marketing of pasture seeds and feed grain. It can reduce the percentage cover of palatable species of grasslands in India by up to 90% (Jayachandra, 1971). The most comprehensive economic analysis has been made in Australia, where *Parthenium* weed monocultures in grazing land in Queensland were estimated to cover more than 17,000 km², reducing cattle stocking rates by as much as 80% (McFadyen, 1992), with a net annual loss of revenue calculated at up to AU$17 million (Chippendale and Panetta, 1994). Further losses result if farms also supply harvesting machinery, fodder or grain, since there is now legislation to prevent their movement from infested properties because of contamination by weed seed. An additional, non-quantifiable side effect of parthenium weed is on animal health, as the sesquiterpene lactone, parthenin, has been shown to cause severe dermatitis, anorexia and intestinal damage, which can lead to death of buffalo, cattle and sheep (Towers and Subba Rao, 1992), and 10-50% of the weed in the diet can kill these animals within 30 days (Naarasimhan *et al.*, 1977a, b, 1980; More *et al.*, 1982). Taints of meat have been detected from sheep given a diet of 30% parthenium weed (Tudor *et al.*, 1982) and tainting of milk, meat and honey have also been reported (Towers and Subba Rao, 1992; Taye, 2002).	
Environmental Impact Parthenium weed lacks predators, and cattle and livestock usually do not feed on it. As a result, the food chain is disturbed and the trophic structure changes, leading to an ecological imbalance in the invaded area. The importance value index (IVI) of parthenium weed remained at a maximum in both cropped and non-cropped areas across the seasons (Tiwari and Bisen, 1984). It causes a prolonged toxic effect to the soil environment-for instance, Kanchan and Jayachandra (1981) reported that the leachates from parthenium weed have an inhibitory effect on nitrogen fixing and nitrifying bacteria. Parthenium weed is also an environmental weed that can cause irreversible habitat changes in native grasslands, woodlands, river banks and floodplains in both India and Australia (Jayachandra 1971; McFadyen, 1992; Evans, 1997a; Kumar and Rohatgi, 1999). Parthenium weed, due to its allelopathic potential, replaces dominant flora and suppresses natural vegetation in a wide range of habitats and thus becomes a big threat to biodiversity. Wherever it invades, it forms a territory of its own, replacing indigenous grasses and weeds which are supposedly useful for the grazing animals (De and Mukhopadhyay, 1983). Parthenium weed has an adverse effect on a variety of natural herbs which are the basis of traditional systems of medicines for the treatment of several diseases in various parts of the world (Mahadevappa *et al.*, 2001; Shabbir and Bajwa, 2006).	**High (3)**

4.3.1.2. Cumulative Risk Rating for Consequences of Introduction

The assessment of the Consequences of Introduction of Quarantine Pests has been summarized for each pest by summing the five Risk Elements to produce a Cumulative Risk Rating. This Cumulative Risk Rating is considered to be a biological indicator of the potential of the pest to establish, spread, and cause economic and environmental impacts. The cumulative Risk Rating should be interpreted as follows:

- **Low** : 5 - 8 points
- **Medium** : 9 - 12 points
- **High** : 13 - 15 points

A cumulative Risk Rating is then calculated by summing all risk element values. The values determined for the Consequences of Introduction for each pest are summarized in Table 8.

Table-8: Summary of Consequences of Introduction

Pests	Risk Element 1	Risk Element 2	Risk Element 3	Risk Element 4	Risk Element 5	Cumulative Risk Rating
Ceratitis capitata (Wiedemann) Order: Diptera Family: Tephritidae	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Bactrocera tryoni (Froggatt) Order: Diptera Family: Tephritidae	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Ceratitis cosyra (Walker) Order: Diptera Family: Tephritidae	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Bactrocera caryeae (Kapoor) Order: Diptera Family: Tephritidae	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Bactrocera correcta (Bezzi) Order: Diptera Family: Tephritidae	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Bactrocera diversa (Coquillett) Order: Diptera Family: Tephritidae	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Coccus viridis (Green) Order: Homoptera Family: Coccidae	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Ceroplastes rubens Maskell Order: Homoptera Family: Coccidae	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Aonidomytilus albus (Cockerell) Order: Homoptera Family: Diaspididae	High (3)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Aulacaspis tubercularis Order: Homoptera Family: Diaspididae	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (14)
Parlatoria crypta McKenzie Order: Homoptera Family: Diaspididae	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (14)
Pseudaonidia trilobitiformis (Green, 1896) Order: Homoptera Family: Diaspididae	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (14)
Phomopsis mangiferae S. Ahmad Order: Diaporthales Family: Diaporthaceae	High (3)	Low (1)	Low (1)	Medium (2)	Low (1)	Low (8)
Cytosphaera mangiferae Died Order: Intertae sedis	Low (1)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (9)

Pests	Risk Element 1	Risk Element 2	Risk Element 3	Risk Element 4	Risk Element 5	Cumulative Risk Rating
Family: Intertae sedis						
Actinodochium jenkinsii Uppal, Patel & Kamat Order: Intertae sedis Family: Intertae sedis	Low (1)	Low (1)	Medium (2)	Low (1)	Low (1)	Low (6)
Hendersonia creberrima Syd., Syd. & Butler Order: Pleosporales Family: Intertae sedis	High (3)	Low (1)	Medium (2)	Medium (2)	Low (1)	Medium (9)
Macrophoma mangiferae Order: Botryosphaeriales Family: Botryosphaeriaceae	High (3)	High (3)	Medium (2)	Medium (2)	Medium (2)	Medium (12)
Xanthomonas campestris pv. *mangiferaeindicae* (Patel *et al.*) Robbs *et al.* Order: Xanthomonadales Family: Xanthomonadaceae	High (3)	Medium (2)	Medium (2)	High (3)	Low (1)	Medium (11)
Parthenium hysterophorus L. Order: Asterales Family: Asteraceae	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)

4.3.2. Assess Introduction Potential of Quarantine Pests

The potential of introduction is a function of the quantity of the commodity to be imported as well as the opportunity provided for the quarantine pests to survive pre and post harvest handling. The pest's opportunity is defined by six criteria that consider the potential for the pest survival along the pathway. These include the pest's opportunity to survive pre- and postharvest treatment and shipment, the possibility of avoiding detection at port of entry and the potential to find suitable host.

Sub-element 1- Quantity of commodity imported annually

The rating for the quantity imported annually is based on the amount of commodity expected to be imported. For qualitative import risk assessments, the amount of the commodity imported is estimated in units of standard 40-foot long shipping containers. The rating assigned is as follows:

Table-9: Showing the risk rating and value assigned to quantity of shipping containers imported annually

Quantity (containers/year)	Rating	Rating value
<10	Low	1
10-100	Medium	2
>100	High	3

According to the West-Bengal Exporters Coordination Committee (2014), it is reported that Bangladesh imported annually 300,000 metric tonnes of mangoes from India over the last four years, which accounts to 12000 forty-foot shipping containers annually, considering 25 tons capacity for each container. The probability of all pests entering as a direct result of the quantity of the commodity being imported is therefore high from India across the land port as well from

Thailand into Bangladesh. Therefore, we can estimate that the quarantine pests could be entered into Bangladesh. Thus, the risk is rated **high (3)** in this sub-element.

Sub-element 2- Survive post harvest treatment

This risk sub-element was estimated based on the fruit being cleaned and washed as part of standard post-harvest practices in Indian mango production as explained by Seshadri (2004). As internal pests, all of the **fruit flies** are highly likely to survive postharvest treatment and have been rated **High (3)** risk for this sub-element.

As external pests, the Homopteran pests would have less of a probability of surviving post-harvest treatments than internal feeders. Consequently, the Homopteran pests are rated **Medium (2)** risk for this sub-element.

All six pathogens (fungi and bacteria) would be highly likely to survive postharvest treatment and, therefore, are rated **High (3)** risk for this sub-element.

A range of herbicides including atrazine, dicamba, 2,4-D, picloram and glyphosate, all applied at high volume, have been employed successfully in Queensland, Australia (Haseler, 1976). However, chemical control over the enormous areas infested by parthenium weed (*Parthenium hysterophorus* L.) in Queensland is economically unviable and non-sustainable (Parsons and Cuthbertson, 1992), as well as environmentally undesirable (Navie *et al.*, 1996). In India, the economics of spraying are even more untenable. Nevertheless, in Australia, spot spraying with atrazine plus a non-ionic surfactant is recommended as a pre-emergence treatment. Post-emergence control has been achieved with 2,4-D, often in combination with picloram (Navie *et al.*, 1996), whilst low rates of glyphosate have proven to be effective in coffee plantations in Kenya (Njoroge, 1989). Based on above mentioned information, they are rated **High (3)** for this risk element.

Sub-element 3- Survival potential during shipment

Most fresh mangoes are transported from India to Bangladesh through landport. Therefore, the period of time taken for shipment through landport India to Sonamasjid Landport, Hilly Landport of Bangladesh is maximum 2-5 days. While other mangoes are transported from Thailand to Bangladesh by Seaway. Therefore, the period of time taken for shipment through seaway from Thailand to Chittagong Seaport of Bangladesh is maximum 20-25 days. Secondly, it is packed in wrapping (wooden/plastic boxes) and stored in normal conditions. So the pests could survive during transporting process. Based on this analysis, all of the insect pests are highly likely to survive shipment and have been rated **High (3)** for this sub-element.

The stem end rot diseases (*Phompsis mangiferae* and *Actinodochium jenkinsii*) and fruit rotters (*Macrophoma mangiferae*, *Hendersonia creberrima* and *Cytosphaera mangiferae*) are highly likely to survive shipping conditions (AFFA, 2001) because most control measures are not curative and do not eradicate the pathogens (Coates *et al.*, 1997; Coates *et al.*, 1993; Johnson *et al.*, 1993; Johnson *et al.*, 1990; Johnson and Highley, 1994). Additionally, controlled atmospheric conditions may only slow stem end rot or fruit rot symptom expression (Johnson *et al.*, 1993), leading to longer latent periods. For these reasons, the rating was **High (3)** for *Phomopsis mangiferae*, *Actinodochium jenkinsii*, *Macrophoma mangiferae*, *Cytosphaera mangiferae* and *Hendersonia creberrima*.

The bacteria *Xanthomonas campestris* pv. *mangiferaeindicae* survive epiphytically on fruit, leaves and soil (Pruvost *et al.*, 1990; Pruvost and Luisetti, 1991); epiphytic populations are not detected on symptomless mature fruit (Pruvost and Luisetti, 1991). The number of bacterial spots occurring on mature fruits is directly related to epiphytic populations, suggesting that the resident populations are an important source of inoculum for fruit infection (Pruvost and Luisetti, 1991) so the rating was **High (3)**.

The weed, *Parthenium hysterophorus* L. cab easily be entered from India into Bangladesh during trading of agricultural produces and machineries through cross boundary transportation. Therefore, this pest weed is rated **High (3)** for this risk sub-element.

Sub-element 4- Not Detected at Port of Entry

As external feeders, the Homopteran insect pests have a high probability of being detected at the port-of-entry because they will be visible on the outside of the fruit, so they are rated **Low (1)** for Not Detected at the Port-of-Entry.

Inspectors cutting mango failed to detect larvae of *Anastrepha supensa*, a fruit fly in the same family as *Bactrocera* spp. and *Ceratitis* spp., 71.6% of the time (Gould, 1995). These findings underscore the high likelihood of fruit flies crossing borders undetected in fruit and supports a rating of **High (3)** for Not Detected at Port-of-Entry for all the *Bactrocera* species and *Ceratitis* species.

Obvious advanced post harvest rot caused by the fungi: *Actinodochium jenkinsii, Cytosphaera mangiferae, Phomopsis mangiferae, Macrophoma mangiferae* and *Hendersonia creberrima* would likely be detected at ports of entry when there are obvious external symptoms, although they may not be clearly attributable to a single pathogen (Johnson *et al*., 1989; Lim *et al*., 1991; MAF 2003). Latent fungal infections, however, are likely to evade detection. For these reasons, *Actinodochium jenkinsii*, *Cytosphaera mangiferae*, *Phomopsis mangifera*, *Macrophoma mangiferae* and *Hendersonia creberrima* are rated **Medium (2)** for this risk element.

Advanced symptoms of bacterial black spot, caused by *Xanthomonas campestris* pv. *mangiferaeindicae* are likely to be detected at ports of entry when there are obvious external symptoms, although symptoms may vary depending on the susceptibility of the host and on environment and may not be clearly attributable to a single pathogen (Shekhawat & Patel, 1974). The role of latent infections in mango bacterial black spot is uncertain. Limited research into mango bacterial black spot indicates that *Xanthomonas campestris* pv. *mangiferaeindicae* causes latent infections, which would also be likely to evade detection, although presence of the bacterium strictly as an epiphyte has not be conclusively ruled out (Gagnevin & Pruvost, 2001). For this reason, *Xanthomonas campestris* pv. *mangiferaeindicae* is rated **Medium (2)** for this risk element.

Parthenium hysterophorus is presumed to have entered India along with food grains imported from the USA (Vartak, 1968) and it has since spread to most of the sub-continent (Nath, 1988). It is thought to have entered Pakistan, Nepal and Bangladesh via road connections, where thousands of vehicles cross between India and these countries every day at several places. From the experience in India, Australia and Africa, it is clear that there is considerable risk of accidental introduction via crop or pasture seed and other possibilities. Hence, this pest is rated **High (3)** for this risk sub-element.

Sub-element 5- Imported or Moved to an Area Suitable for Survival

The climate-host range for the majority of the pests examined here is limited to warm areas in Bangladesh. Mango will presumably be shipped all over the country, so a portion of the pests that enter the country are likely to reach areas of host abundance should those hosts exist in Bangladesh. Consequently, risk ratings for this sub-element were based on the climatic regions of Bangladesh suitable for each pest and the hosts available in those areas. Although *Macrophoma mangiferae*, may infect hosts other than mango, which inhabit a wide range of Agro Ecological Zones of Bangladesh. Based on the evidence provided above for each pest in regard to the Climate-Host Interaction risk element, *Parlatoria crypta* and *Ceroplastes rubens* are rated **High (3)**, *Ceratitis capitata, Ceratitis cosyra, Bactrocera tryoni, Bactrocera caryeae*, *Bactrocera correcta*, *Bactrocera diversa*, *Bactrocera dorsalis*, *Pseudaonidia trilobitiformis*, *Coccus viridis*, and *Xanthomonas campestris* pv. *mangiferaeindicae* are rated **Medium (2)**, and *Actinodochium jenkinsii*, *Cytosphaera mangiferae*, *Aonidomytilus albus, Aulacaspis tubercularis*, *Hendersonia creberrima, Macrophoma mangiferae*, and *Phomopsis mangiferae* are rated **Low (1)** for the Imported or Moved to an Area Suitable for Survival sub-element.

Parthenium hysterophorus L. weed is an aggressive colonizer of disturbed ground, able to germinate, grow and flower over a wide range of temperatures and photoperiods. It occurs in the humid and sub-humid tropics, showing a marked preference for black, alkaline, cracking, clay soils of high fertility, but is able to grow on wide variety of soil types from sea level up to 1800 m (Evans, 1987a). Mahadevappa (1997) noted that parthenium weed has several built-in properties and efficient behavioural mechanisms that enable it to overcome many ecological adversities and thus continue to survive under stress. Areas receiving less than 500 mm of rainfall are probably unsuitable, although the weed has strong adaptive methods to tolerate both moisture stress (Kohli and Rani, 1994) and saline conditions (Hegde and Patil, 1982). The weed finds access to any type of land but it is especially prolific in disturbed habitats, for example, roadsides and railway tracks, stock yards, around buildings and on waste land, from where it spreads and invades agricultural systems. Therefore, most of the agro-ecological zones are the places have sub-tropical climate conditions suitable for survival of this weed species. They are rated **High (3)** for this risk element.

Sub-element 6- Come into Contact with Host Material Suitable for Reproduction

Even if the final destination of infested commodities is suitable for pest survival, suitable hosts must be available in order for the pest to survive. This sub-element considers the likelihood that the pest species can come in contact with host material for reproduction. The complete host range of the pest was considered. According to the IPPC standard for pest risk analysis (IPPC, 2003), other factors that may be considered are:

- Dispersal mechanisms, including vectors to allow movement from the pathway to a suitable host
- Whether the imported commodity is to be sent to a few or many destinations in the PRA area
- Proximity of entry, transit and destination points to suitable hosts
- Time of year at which import takes place
- Intended use of the commodity (*e.g.*, for planting, processing or consumption)
- Risks from by-products and waste

The fruit flies develop quickly and, have a wide range of hosts (Fletcher, 1989a). Also, *Bactrocera* spp. and *Ceratitis* spp. have excellent dispersal capabilities, and many of them can fly 50-100km during their life (Fletcher 1989b). Therefore, it is possible that they could escape from houses, compost piles or garbage to find nearby hosts. Additionally, fruit infested with fruit flies often contain multiple larvae, making the chance that adults could mate higher. For these reasons the fruit flies are rated **High (3)** for this risk sub-element.

Sessile Homopterans (mealybugs, scale insects, *etc*.) may disperse great distances by wind (Greathead, 1997) but do not have the capability for directed dispersal in this way. Long range dispersal strategies depend on large numbers of insects being dispersed so that some may find suitable hosts. Insects arriving with fruit represent such small populations that dispersal by air to a host would be very unlikely. Furthermore, successful establishment of these insects in a new environment can occur only when mobile forms (*i.e.,* crawlers) are present on the imported fruit and these fruit are placed in close proximity to a susceptible host. As these circumstances are highly unlikely to co-occur (Miller, 1985), scale insects have a low probability of establishment. For these reasons, the homopteran pests are rated **Low (1)** for this risk sub-element.

For the pathogens, only discarded fruit or unused portions of fruit (peel, seed, etc.) are likely to be sources of inoculum. Bacteria or spores of fungi must then be dispersed from discarded fruit into mango orchards at a time when susceptible tissue is available (Johnson *et al.*, 1993; Johnson *et al.*, 1989; Kishun and Chand, 1989; Pruvost *et al.*, 1990; Pruvost and Luisetti, 1991). The likelihood of discarded fruit being in close proximity to cultivated mango is small. For these reasons, four of the pathogens (one bacterium such as *Xanthomonas campestris* pv. *mangiferaeindicae*, and three fungi such as *Actinodochium jenkinsii*, *Hendersonia creberrima,* and *Phomopsis mangiferae*) are rated **Low (1)**. Other two fungi such as *Macrophoma mangiferae* and *Cytosphaera mangiferae* may infect a broader range of hosts, yet temperatures required for survival may limit their ranges, so they are rated **Medium (2)**.

In Australia, *Parthenium hysterophorus* weed germinates mainly in spring and early summer. It produces flowers and seeds throughout its life and dies in late autumn (Navie *et al.*, 1996). It is a prolific seed producer (15,000-25,000 achenes per plant) (Haseler, 1976; Navie *et al*., 1996; Mahadevappa, 1997), and can grow at any time of the year as long as there is moisture (Tamado, 2001; Taye, 2002) and continues to flower and fruit until senescence. The longevity of surface-lying seeds seems to be short with little or no dormancy, but there is evidence that buried achenes can remain viable for at least 4-6 years (Navie *et al*., 1996), and Navie *et al.*, (1998) estimated the half-life of buried seed to be about 6 years. Whereas Tamado *et al.* (2002) reported that the viability of the seeds was greater than 50% after 26 months of burial in the soil, indicating the potential build-up of a substantial and persistent soil seed bank. Therefore, this weed pest is rated to be **High (3)** for this risk sub-element.

Summary of Cumulative Risk Rating for Potential of Introduction

The assessment of the Potential of Introduction of Quarantine Pests has been summarized for each pest by summing the six Sub-elements to produce a Cumulative Risk Rating for Potential of Introduction. The cumulative Risk Rating should be interpreted as follows:

- **Low :** 6 - 9 points
- **Medium :** 10 - 14 points
- **High :** 15 - 18 points

A cumulative Risk Rating for Potential of Introduction is then calculated by summing all risk Sub-element values. The values determined for the Potential of Introduction for each pest are summarized in Table 10.

Table-10: Risk Rating for Potential of Introduction of Quarantine Pests

Pests	Sub-Element 1	Sub-Element 2	Sub-Element 3	Sub-Element 4	Sub-Element 5	Sub-Element 6	Cumulative Risk Rating
Ceratitis capitata (Wiedemann) Order: Diptera Family: Tephritidae	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (17)
Bactrocera tryoni (Froggatt) Order: Diptera Family: Tephritidae	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (17)
Ceratitis cosyra (Walker) Order: Diptera Family: Tephritidae	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (17)
Bactrocera caryeae (Kapoor) Order: Diptera Family: Tephritidae	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (17)
Bactrocera correcta (Bezzi) Order: Diptera Family: Tephritidae	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (17)
Bactrocera diversa (Coquillett) Order: Diptera Family: Tephritidae	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (17)
Coccus viridis (Green) Order: Homoptera Family: Coccidae	High (3)	Medium (2)	High (3)	Low (1)	Medium (2)	Low (1)	Medium (12)
Ceroplastes rubens Maskell Order: Homoptera Family: Coccidae	High (3)	Medium (2)	High (3)	Low (1)	High (3)	Low (1)	Medium (13)
Aonidomytilus albus (Cockerell) Order: Homoptera Family: Diaspididae	High (3)	Medium (2)	High (3)	Low (1)	Low (1)	Low (1)	Medium (11)
Aulacaspis tubercularis Order: Homoptera Family: Diaspididae	High (3)	Medium (2)	High (3)	Low (1)	Low (1)	Low (1)	Medium (11)
Parlatoria crypta McKenzie	High	Medium	High	Low	High	Low	Medium

Pests	Sub-Element 1	Sub-Element 2	Sub-Element 3	Sub-Element 4	Sub-Element 5	Sub-Element 6	Cumulative Risk Rating
Order: Homoptera Family: Diaspididae	(3)	(2)	(3)	(1)	(3)	(1)	(13)
Pseudaonidia trilobitiformis (Green, 1896) Order: Homoptera Family: Diaspididae	High (3)	Medium (2)	High (3)	Low (1)	Medium (2)	Low (1)	Medium (12)
Phomopsis mangiferae S. Ahmad Order: Diaporthales Family: Diaporthaceae	High (3)	High (3)	High (3)	Medium (2)	Low (1)	Low (1)	Medium (13)
Cytosphaera mangiferae Died Order: Intertae sedis Family: Intertae sedis	High (3)	High (3)	High (3)	Medium (2)	Low (1)	Medium (2)	Medium (14)
Actinodochium jenkinsii Uppal, Patel & Kamat Order: Intertae sedis Family: Intertae sedis	High (3)	High (3)	High (3)	Medium (2)	Low (1)	Low (1)	Medium (13)
Hendersonia creberrima Syd, Syd. & Butler Order: Pleosporales Family: Intertae sedis	High (3)	High (3)	High (3)	Medium (2)	Low (1)	Low (1)	Medium (13)
Macrophoma mangiferae Order: Botryosphaeriales Family: Botryosphaeriaceae	High (3)	High (3)	High (3)	Medium (2)	Low (1)	Medium (2)	Medium (14)
Xanthomonas campestris pv. *mangiferaeindicae* (Patel *et al.*) Robbs *et al.* Order: Xanthomonadales Family: Xanthomonadaceae	High (3)	High (3)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (14)
Parthenium hysterophorus L. Order: Asterales Family: Asteraceae	High (3)	High (3)	High (3)	High (3)	High (3)	High (3)	High (18)

4.4. Conclusion: Pest Risk Potential and Pests Requiring Phytosanitary Measures

The Pest Risk Assessment (PRA) is based on the International Standard for Phytosanitary Measures No 11 (2004) and the PRA scheme developed by EPPO (European and Mediterranean Plant Protection Organization) (1997).

To estimate the pest risk potential for each pest, the cumulative risk rating for the Consequences of Introduction and Potential of Introduction is summed. The risk potential ratings are assigned as follows:

Low : 11-18 points
Medium : 19-26 points
High : 27-33 points

Table 11: The Overall Pest Risk Potential Rating

Pests	Consequences of Introduction	Potential of Introduction	Pest Risk Potential
Ceratitis capitata (Wiedemann) Order: Diptera Family: Tephritidae	High (15)	High (17)	High (32)
Bactrocera tryoni (Froggatt) Order: Diptera Family: Tephritidae	High (15)	High (17)	High (32)
Ceratitis cosyra (Walker) Order: Diptera Family: Tephritidae	High (15)	High (17)	High (32)
Bactrocera caryeae (Kapoor) Order: Diptera Family: Tephritidae	High (15)	High (17)	High (32)
Bactrocera correcta (Bezzi) Order: Diptera Family: Tephritidae	High (15)	High (17)	High (32)
Bactrocera diversa (Coquillett) Order: Diptera Family: Tephritidae	High (15)	High (17)	High (32)
Coccus viridis (Green) Order: Homoptera Family: Coccidae	High (15)	Medium (12)	High (27)
Ceroplastes rubens Maskell Order: Homoptera Family: Coccidae	High (15)	Medium (13)	High (28)
Aonidomytilus albus (Cockerell, 1893) Order: Homoptera Family: Diaspididae	Medium (11)	Medium (11)	Medium (22)
Aulacaspis tubercularis (Newstead) Order: Homoptera Family: Diaspididae	High (14)	Medium (11)	Medium (25)
Parlatoria crypta McKenzie Order: Homoptera Family: Diaspididae	High (14)	Medium (13)	High (27)
Pseudaonidia trilobitiformis (Green, 1896) Order: Homoptera Family: Diaspididae	High (14)	Medium (12)	Medium (26)
Phomopsis mangiferae S. Ahmad 1954 Order: Diaporthales Family: Diaporthaceae	Low (8)	Medium (13)	Medium (21)

Pests	Consequences of Introduction	Potential of Introduction	Pest Risk Potential
Cytosphaera mangiferae Died. 1916 Order: Intertae sedis Family: Intertae sedis	Medium (9)	Medium (14)	Medium (23)
Actinodochium jenkinsii Uppal, Patel & Kamat Order: Intertae sedis Family: Intertae sedis	Low (6)	Medium (13)	Medium (19)
Hendersonia creberrima Syd, Syd. & Butler Order: Pleosporales Family: Intertae sedis	Medium (9)	Medium (13)	Medium (22)
Macrophoma mangiferae Order: Botryosphaeriales Family: Botryosphaeriaceae	Medium (12)	Medium (14)	Medium (26)
Xanthomonas campestris pv. *mangiferaeindicae* (Patel *et al.*) Robbs *et al.* Order: Xanthomonadales Family: Xanthomonadaceae	Medium (11)	Medium (14)	Medium (25)
Parthenium hysterophorus L. Order: Asterales Family: Asteraceae	High (15)	High (18)	High (33)

Potential ratings:

Low : Pest will typically not require specific mitigations measures;
Medium : Specific phytosanitary measure may be necessary.
High : Specific phytosanitary measures are strongly recommended. Port-of-entry inspection is not considered sufficient to provide phytosanitary security.

Identification and selection of appropriate sanitary and phytosanitary measures to mitigate risk for pests with particular Pest Risk Potential ratings is undertaken as part of the risk management phase.

From the quantitatively risk analysts of quarantine pests likely to be associated and follow the fresh mango fruits pathway to Bangladesh from India, Pakistan, Thailand and other exporting countries, the following 10 pests were identified as having high (14) and other 10 pests as medium (1) unmitigated risk potential:

There are 10 pests with **High** risk rate:

Arthropods

Ceratitis capitata (Wiedemann) [Order: Diptera, Family: Tephritidae]
Bactrocera tryoni (Froggatt) [Order: Diptera, Family: Tephritidae]
Ceratitis cosyra (Walker) [Order: Diptera, Family: Tephritidae]
Bactrocera caryeae (Kapoor) [Order: Diptera, Family: Tephritidae]
Bactrocera correcta (Bezzi) [Order: Diptera, Family: Tephritidae]
Bactrocera diversa (Coquillett) [Order: Diptera, Family: Tephritidae]
Coccus viridis (Green) [Order: Homoptera, Family: Coccidae]
Ceroplastes rubens Maskell [Order: Homoptera, Family: Coccidae]
Parlatoria crypta McKenzie [Order: Homoptera, Family: Diaspididae]

Weed
Parthenium hysterophorus L. [Order: Asterales, Family: Asteraceae]

There are 10 pests with **Medium** risk rate:
Arthropods

Aonidomytilus albus (Cockerell, 1893) [Order: Homoptera, Family: Diaspididae]
Aulacaspis tubercularis (Newstead) [Order: Homoptera, Family: Diaspididae]
Pseudaonidia trilobitiformis (Green, 1896) [Order: Homoptera, Family: Diaspididae]

Fungi
Phomopsis mangiferae S. Ahmad 1954 [Order: Diaporthales, Family: Diaporthaceae]
Cytosphaera mangiferae Died. 1916 [Order: Intertae sedis, Family: Intertae sedis]
Actinodochium jenkinsii [Order: Intertae sedis, Family: Intertae sedis]
Hendersonia creberrima [Order: Pleosporales, Family: Intertae sedis]
Macrophoma mangiferae [Order: Botryosphaeriales, Family: Botryosphaeriaceae

Bacteria
Xanthomonas campestris pv. *mangiferaeindicae* (Patel *et al.*) Robbs *et al*

[Order: Xanthomonadales, Family: Xanthomonadaceae]

4.5. Uncertainty

The purpose of this section is to summarise the uncertainties and assumptions identified during the preceding hazard identification and risk assessment stages. An analysis of these uncertainties and assumptions can then be completed to identify which are critical to the outcomes of the risk analysis. Critical uncertainties or assumptions are considered for further research with the aim of reducing uncertainty or removing the assumption. Where there is significant uncertainty in the estimated risk, a precautionary approach to managing risk may be adopted. In these circumstances the measures should be consistent with other measures where equivalent uncertainties exist and be reviewed as soon as additional information becomes available.

There is a major uncertainty concern regarding the prevalence of above mentioned high and medium risk rated insect pests, diseases and weed of mangoes in India, Pakistan, Thailand and other countries of mango export.

The assessment should have included information on export volumes and frequency to other countries, the average size of export lots, the number of lots found infested with pests of mango in the importing countries, and preferably, any information on incidence level in pests infested mango consignments or lots would be valuable.

Thus, the assessment of uncertainties and assumptions for each organism often covers similar areas of information or lack of information, with key factors or variables being relevant across different organism groups. The following sections outline these considerations. The uncertainties and assumptions are covered in these sections rather than individually in each pest risk assessment.

4.5.1. Uncertainties and assumptions around hazard biology

- The *Ceratitis capitata* (Mediterranean fruit fly), *Bactrocera tryoni* (Queensland fruit fly) and *Ceratitis cosyra* (Marula fruit fly), *Bactrocera correcta* (Asian guava fruit fly), *Bactrocera diversa* (Three stripped fruit fly), *Aonidomytilus albus* (Tapioca scale) are the well known hitch-hiker species, and has been associated with *Mangifera indica* in India, Thailand, Pakistan. Currently there are no data demonstrating this association between this hitch-hiker pest and the pathway imported from India, Pakistan and Thailand into

Bangladesh. Interception data rather than biological information would be required to clarify this issue.

- The biology of insects that have been reared in the laboratory for several generations is often different to wild counterparts established in greenhouses or in field conditions (Mangan & Hallman 1998). Aspects such as life cycle, preovipositional period, fecundity and flight ability (Chambers 1977), as well as cold or heat tolerance can be influenced by the highly controlled laboratory environment. Laboratory reared insects may differ in their responses to environmental stress and exhibit tolerances that are exaggerated or reduced when compared with wild relatives.
- If a pest species occurs in Bangladesh often its full host range, or behaviour in the colonised environment remains patchy. It is difficult to predict how a species will behave in a new environment, particularly if it has not become established as a pest elsewhere outside its natural range. Therefore there will be considerable uncertainty around the likelihood of an organism colonising new hosts or the consequences of its establishment and spread on the natural environment. Where indigenous plants are discussed as potential hosts this is extrapolated from the host range (at genus and family level) overseas and is not intended as a definitive list.

4.5.2. Uncertainty and assumptions around ecological races of the pests

- There are distinct temperature requirements for optimum development and reproduction for the different species of pests like *Ceratitis capitata* (Mediterranean fruit fly), *Bactrocera tryoni* (Queensland fruit fly) and *Ceratitis cosyra* (Marula fruit fly). Therefore, the molecular data on race detection of the insect pests rather than occurrence of biological information would be required to clarify this issue.

4.5.3 Assumption around transit time of mangoo on the Landport and or Sea Pathway

- An assumption is made around the time the fresh mango fruits take to get from the field in India, Thailand and Pakistan to Bangladesh ready for wholesale if it is transported by Landport or Sea shipment. It is assumed that harvesting and packing of mango fruits will take up to two days that transport of the commodity to the seaport could take up to one day, and then transit to Bangladesh could take up to 5 to 25 days and into distribution areas could also take up to two days. In total it is assumed that transport of seed potatoes from India, Thailand and Pakistan by landport or sea will take at least 10 to 30 days to reach Bangladesh.

4.5.4. Further work that would reduce uncertainties

Section of PRA	Uncertainties	Further work that would reduce uncertainties
Taxonomy	None	-
Pathway	Presence of a pathway from imported produce to suitable protected environments, such as botanical gardens.	• Monitor all suitable protected environments which are near points of entry of infested produce. • Check reports of finds by other mango exporting countries
Distribution	None	-
Hosts	None	-
Establishment	Establishment potential under glasshouse in the PRA area.	Continue to monitor the literature for reports of establishment in protected environments.
Spread	Rate of potential spread in areas at risk within the PRA area	Continue to monitor the literature for reports on ability to spread.
Impact	Potential to cause damage in protected environments	Continue to monitor the literature for reports on damage caused in protected environments
Management	None	-

CHPTER 5

PRA STAGE 3: PEST RISK MANAGEMENT

5.1. Risk Management Options and Phytosanitary Procedures

Pest risk management evaluates and selects options for measures to reduce the risk of entry, establishment or spread of quarantine pests assessed to pose an unacceptable level of risk to Bangladesh via the importation of commercially produced mangoes from India, Pakistan, Thailand or any other countries of mango export (i.e. produced under standard cultivation, harvesting and packing activities). Plant Quarantine of Bangladesh should considers that the risk management measures proposed below is commensurate with the identified risks.

The measures described below will form the basis of the import conditions for fresh mango fruit from India and other country of export.

There are 4 categories of measures proposed to mitigate the risks identified in the pest risk assessment:

1. Pre-export vapour heat treatment (VHT) or hot water treatment (HWT) for the management of fruit fly species;
2. Designated pest free places of production or production sites for the management of *Sternochetus frigidus* (mango pulp weevil) and *S. mangiferae* (mango seed weevil);
3. Inspection and remedial action for other identified quarantine pests; and
4. Supporting operational systems to maintain and verify phytosanitary status.

5.1.1. Pre-export vapour heat treatment (VHT) or hot water treatment (HWT) for the management of fruit fly species

Fruit flies, *Ceratitis capitata, Ceratitis cosyra, Bactrocera tryoni, Bactrocera caryeae*, *B. correcta* and *B. diversa* have been assessed as quarantine pests of high risk for mangoes from India and therefore require measures to mitigate that risk.

Visual inspection alone is not considered to be an appropriate risk management option in view of the level of risk identified and because clear visual signs of infestation (particularly in recently infested fruit) may not be present. If infested fruit was not detected at inspection, fruit flies may enter, establish and spread. Other measures that might be applied to mitigate risks associated with fruit flies are either the use of disinfestations treatments or by sourcing fruit from pest free areas.

The PQW-DAE of Bangladesh therefore can propose the following phytosanitary risk management options to mitigate the risk posed by fruit flies of quarantine concern associated with mangoes from India: (1a) vapour heat treatment (VHT) or (1b) hot water treatment (HWT).

1a. Vapour heat treatment (VHT)

VHT efficacy trial data for fruit flies in mangoes should be provided by the exporting countries like India, Pakistan, Thailand etc to Bangladesh. Eggs and larvae of *Bactrocera dorsalis* and *B. cucurbitae* (the two most heat tolerant species) are killed when the mango fruit pulp temperature is maintained at 47.5°C for 20 minutes. Therefore, VHT should be used to mitigate the risk of fruit fly species of quarantine concern associated with imported mango fruit from exporting countries. Treatment time will be for a minimum time of two hours, including the warming and cooling periods to bring the fruit pulp to temperature. Treatment commences when the pulp core temperature of all monitored fruit reaches, or is above, the required temperature and this temperature is maintained for the required period.

The phytosanitary security of the product must be maintained after the vapour heat treatment to prevent re-infestation by fruit flies. Phytosanitary inspection of the treated fruit would be conducted by Qurantine Authority of exporting country and the details of the treatment will be included on the Phytosanitary Certificate.

1b. Hot water treatment (HWT)

The alternative heat disinfestations treatment for fruit fly in mango fruit should be considered using hot water and should be provided relevant efficacy data to PQW-DAE of Bangladesh by exporting country. Eggs and larvae are killed when mango fruit are submerged in hot water at 48°C for 20 minutes. Hot water is used as an effective disinfestations treatment for certain fruit fly species in certain fruits in international trade. The literature indicates that the efficacy of the treatment is dependent upon the size and shape of the mango fruit. This treatment is in commercial use in India and is the protocol required for the export of Indian mangoes to China since 2003.

Therefore, the PQW-DAE of Bangladesh needs to propose an option of a pre-export hot water treatment of 48°C or above for 20 minutes. Mangoes would be treated with a hot water submersion treatment in accordance with the following schedule:

1. Fruit pulp temperature would be 21°C or above prior to commencing treatment.
2. Fruit would be submerged at least 10 cm below the water surface.
3. Water would circulate constantly and be kept at 48°C throughout the treatment period, with the following tolerances:
   a) During the first five minutes of the treatment – temperatures may fall as low as 47.4°C provided the temperature is at least 48°C at the end of the five minute period.
   b) Temperatures may fall as low as 47.4°C for no more than 10 minutes.
4. The dip time must be extended for an additional 10 minutes if hydrocooling starts immediately after the hot water immersion treatment.

5.1.2. Designated pest free places of production or pest free production sites

Sternochetus frigidus (mango pulp weevil, MPW) and *S. mangiferae* (mango seed weevil, MSW) have been assessed to have an unrestricted risk estimate of low and therefore measures are required to mitigate the risk.

The mango pulp and mango seed weevil enter the developing mango and feed internally on the seed and/or pulp. As there are no clear visual signs of infestation, visual inspection alone is not considered to be an appropriate risk management option. If infested fruit are not detected at inspection, these weevils may enter, establish and spread in Bangladesh.

The pest free places of production or pest free production sites should be designated as a risk management measure for these internal feeding weevils and should send survey data on pest free places of production or pest free production sites to the importing country.

The Plant Qurantine Authority would be responsible for the establishment of production area pest freedom by verification of pest free places of production or pest free production sites by official surveys and monitoring. Monitoring would involve field inspections and fruit cutting done at least once during the growing season and before harvest. These monitoring surveys would be conducted during each year of mango production for each pest free area before consignments would be permitted for export.

For example, based on the survey data provided by the Indian Minintry of Agriculture (IMOA), for the 2004 season, designated pest free areas have been established for the production areas of Barabanki, Malihabad, Saharanpur in the Lucknow region, Uttar Pradesh, the areas of Navsari and Valsad in Gujarat and the areas of Devgad, Kudal, Malvan, Sawantwadi and Vengurla in Maharashtra.

5.1.3. Inspection and remedial action for other identified quarantine pests such as mealybugs and scale insects

Mealybugs (*Ferrisia virgata*, *Nipaecoccus nipae*, *Planococcus ficus*, *P. lilacinus*, *P. minor*, *Rastrococcus iceryoides*, *R. invadens*, *Rastrococcus spinosus*) and **scale insects** (*Abgrallaspis cyanophylli*, *Aspidiotus nerii*, *Ceroplastes actiniformis*, *Coccus longulus*, *Hemiberlesia rapax*, *Lepidosaphes beckii*, *L. gloverii*, *Milviscutulus mangiferae*) are assessed to have an unrestricted risk estimate of low, and measures are therefore required to mitigate that risk.

Visual inspection for freedom from mealybugs and scale insects is considered to be an appropriate risk management option for these pests because they can easily be detected on the surface of mango fruit. Therefore, PQW-DAE of Bangladesh can consider this measure to reduce the risk associated mealybugs and scale insects to very low.

5.1.4. Supporting operational systems to maintain and verify phytosanitary status

It is necessary to have a system of operational procedures in place to ensure that the phytosanitary status of fresh mangoes from exporting country is maintained and verified during the process of production and export to importing country. This is to ensure that the objectives of the risk mitigation measures previously identified have been met and are being maintained.

Details of this system, or of an equivalent one, will be determined by agreement with the Plant Quarantine Authority of exporting country. This is to ensure that requirements are appropriate to the circumstances of exporting country for fresh mango production and export.

The proposed system of operational procedures for the production and export of fresh mangoes to importing country from exporting country consists of:

- 4a. Registration of export orchards;
- 4b. Registration of packinghouses and auditing of procedures;
- 4c. Pre-export inspection and remedial action by Plant Quarantine Authority of exporting country;
- 4d. Packaging and labeling;
- 4e. Phytosanitary certification by Plant Quarantine Authority of exporting country;
- 4f. Specific conditions for storage and movement; and
- 4g. On-arrival phytosanitary inspection and clearance to be provided by the Plant Quarantine Authority of importing country

4a. Registration of export orchards

All mango fruit for export to other country must be sourced from export orchards and growers registered with Plant Quarantine Authority of exporting country. Copies of the registration records must be made available to Plant Quarantine Authority of importing country, if requested. The Plant Quarantine Authority of exporting country is required to register all export orchards prior to commencement of exports. All export orchards are expected to produce mango fruit under standard commercial cultivation, harvesting and packing activities.

The objective of this procedure is to ensure that orchards from which mangoes are sourced can be identified. This is to allow trace back to individual orchards and growers in the event of non-compliance. For example, if live pests are intercepted, the ability to identify a specific orchard/grower allows the investigation and corrective action to be targeted rather than applying to all possible orchards/growers.

4b. Registration of packinghouses and auditing of procedures

All packinghouses intending to export mango fruit to importing country need to be registered with the Plant Quarantine Authority of exporting country. Vapour heat treatment (VHT)/ hot water treatment (HWT) for pre-export disinfestation of fruit flies should be done within the registered packinghouses/treatment facilities in exporting country. Plant Quarantine Authority of importing country will only approve the designated and identified VHT/HWT facilities that are registered by the Plant Quarantine Authority of exporting country.

The targeted inspection for freedom from mealybugs and scale insects would be carried out within the registered packinghouses. Packinghouses would be required to identify the individual orchard with a numbering system and identify fruit from individual orchards by marking boxes or pallets (i.e. one orchard per pallet) with the unique orchard number. The list of registered packinghouses must be kept by Plant Quarantine Authority of exporting country and provided to Plant Quarantine Authority of importing country, if requested, with updates provided if packinghouses are added or removed from the list.

The objective of this procedure is to ensure that packinghouses at which the VHT/HWT and inspections are conducted can be identified. This is to allow trace back to individual packinghouses and orchards/growers in the event of non-compliance.

4c. Pre-export inspection and remedial action by the authority of exporting country

The Plant Quarantine Authority of exporting country would inspect all consignments in accordance with official procedures for all visually detectable quarantine pests and trash using sampling rates developed by the Plant Quarantine Authority of exporting country in consultation with importing country.

If actionable mealybugs, scale insects are found during these inspections, then remedial action must be taken.

Records of interceptions to be made during these inspections (live or dead quarantine pests, and trash) would be maintained by Plant Quarantine Authority of exporting country and made available importing country as requested. This information will assist in future reviews of this import pathway and consideration of the appropriateness of the phytosanitary measures that have been applied.

4d. Packing and labeling

All packages of mangoes for export would be free from contaminated plant material including trash and weed seeds and would meet Bangladesh's general import conditions for fresh fruits and vegetables. Trash refers to soil, splinters, twigs, leaves and other plant materials but excludes the mango calyx.

Inspected and treated fruits would be required to be packed in new boxes. The fruit should be packed in boxes that have had any openings either screened with mesh or covered with tape. Packing material would be synthetic or highly processed if of plant origin. No unprocessed packing material of plant origin, such as straw, will be allowed. All wood material used in packaging of mango fruit must comply with the condition of importing country.

All boxes would be labelled with the orchard registration number and packinghouse registration number for the purposes of trace back in the event that this is necessary. The pallets should be securely strapped only after phytosanitary inspection has been carried out following mandatory post-harvest treatments. Palletised product should be identified by attaching a uniquely numbered pallet card to each pallet or part pallet to enable trace back to registered orchards.

4e. Phytosanitary certification by the authority of exporting country

The Plant Quarantine Authority of exporting country would be required to issue a Phytosanitary Certificate for each consignment upon completion of pre-export treatment and inspection. The objective of this procedure is to provide formal documentation to Plant

Quarantine Authority of importing country verifying that the relevant measures have been undertaken offshore. Each Phytosanitary Certificate would contain the following information:

A consignment is the quantity of mango fruit covered by one Phytosanitary Certificate that arrives at one port in one shipment. Consignments need to be shipped directly from one port or city in exporting country to a designated port or city in importing country.

4f. Specific conditions for storage and movement

Packed product and packaging must be protected from pest contamination during and after packing, during storage and during movement between locations (e.g. packinghouse to cool storage/depot, to inspection point, to export point).

Product for export to importing country that has been inspected and certified by the Plant Quarantine Authority of exporting country would be maintained in secure conditions that will prevent mixing with fruit for export to other destinations. Security of the consignment is to be maintained until release from quarantine in importing country.

The objective of this procedure is to ensure that the phytosanitary status of the product is maintained during storage and movement.

4g. On-arrival phytosanitary inspection and clearance by importing country

On arrival in importing country, each consignment would be inspected by Plant Quarantine Authority of importing country. The Plant Qurantine Authority would undertake a documentation compliance examination for consignment verification purposes at the port of entry in importing country prior to release from quarantine. Fruit from each consignment would be randomly sampled for inspection. Such sampling methodology would provide 95% confidence that there is not more than 0.5% infestation in a consignment. The objective of this procedure is to verify that the required measures have been undertaken.

Action for non-complying lots: Where consignments are found to be non-compliant with import requirements at Plant Quarantine Authority of importing country, on-arrival inspection due to the presence of live quarantine pests or trash, the importer will be given the option to treat (if suitable treatments for the pests detected can be applied), re-export or destroy the consignment.

Uncategorized pests: If an organism that is detected on mango from exporting country into importing country that has not been categorized, it will require assessment to determine its quarantine status and if phytosanitary action is required. The detection of any significant pests of quarantine concern not already identified in the analysis may result in the suspension of the trade while a review is conducted to ensure that the existing measures continue to provide the appropriate level of phytosanitary protection for importing country.

5.2. SUMMARY OF IMPORT CONDITIONS

Plant Qurantine Wing of Department of Agriculture Extension, Bangladesh should consider that the risk management measures identified in the previous section, upon which these import conditions are based, are commensurate with the identified risks.

- Import Condition 1. Registration of export orchards
- Import Condition 2. Packinghouse registration and auditing of procedures
- Import Condition 3. Pre-export vapour heat treatment for fruit flies
- Import Condition 4. Pre-export hot water treatment for fruit flies
- Import Condition 5. Pest free places of production or pest free production sites for mango pulp and seed weevils
- Import Condition 6. Targeted pre-export inspection by the Plant Quarantine Authority of exporting country
- Import Condition 7. Packing and labelling

- Import Condition 8. Phytosanitary certification by Plant Quarantine Authority of exporting country
- Import Condition 9. Storage and movement
- Import Condition 10. Targeted on-arrival quarantine inspection and clearance by Plant Quarantine Authority of importing country
- Import Condition 11. Audit and review of policy.

IMPORT CONDITION-1: REGISTRATION OF EXPORT ORCHARDS

All mango fruit for export to exporting country must be sourced from export orchards and growers registered with Plant Quarantine Authority of exporting country. Copies of the registration records must be made available to Plant Quarantine Authority of importing country, if requested. The Plant Quarantine Authority of exporting country is required to register all export orchards prior to commencement of exports.

IMPORT CONDITION-2: PACKINGHOUSE REGISTRATION AND AUDITING OF PROCEDURES

- All packinghouses intending to export mango fruit to importing country must be registered with the Plant Quarantine Authority of exporting country.
- Vapour heat treatment (VHT)/hot water treatment (HWT) for pre-export disinfestations should be conducted within the registered packinghouses/treatment facilities in country of export.
- Plant Quarantine Authority of importing country will have to approve designated and identified VHT/HWT facilities that are registered by Plant Quarantine Authority of exporting country. These facilities must be designed to prevent the entry of fruit flies into areas where unpacked treated fruit is held. This will include a provision for treated fruit to be discharged directly into insect proof and secure packing rooms.
- The management of the treatment facility will be required to provide details of systems that are in place to ensure isolation and segregation from other fruit throughout the treatment, packing, storage and transport stages before exports commence. This will be audited for compliance with Plant Quarantine Authority of importing country requirements in the initial export season by Plant Quarantine Authority of exporting country before exports will be permitted.
- After the initial season approval of the registered treatment centres, importing country will require Plant Quarantine Authority of exporting country to audit the facilities at the beginning of each season to ensure that they comply with Plant Quarantine Authority of importing country's requirements before registration is renewed. Plant Quarantine Authority of exporting country would then monitor the treatment centres on an ongoing basis during their operational season to ensure continued compliance with imporing country's requirements. Reports of audits noting any non-conformity together with appropriate corrective action will be submitted to importing country.

- Plant Quarantine Authority of exporting country will ensure the following:
  - registered treatment facilities are maintained in a condition that will provide efficacy in treatment programs
  - all areas are hygienically maintained (cleaned daily of damaged, blemished, infested fruit) the premises are maintained to exclude the entry of pests from outside and between treated and untreated fruit
  - all measurement instruments are regularly calibrated and records retained for verification
  - the movement of fruit from the time of arrival at the registered treatment centre through to the time of export are recorded and
  - the security of fruit is maintained at all times that fruit is on the premises.

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- The targeted inspection for freedom from mealybugs and scale insects is to be carried out within the registered packinghouses. Packinghouses will be required to identify the individual orchard with a numbering system and identify fruit from individual orchards by marking boxes or pallets (i.e. one orchard per pallet) with the unique orchard number. The list of registered packinghouses must be kept by Plant Quarantine Authority of exporting country and provided to country of import if requested, with updates provided if packinghouses are added or removed from the list.

- Registration of orchards and packinghouses is to include an audit program conducted by the Plant Quarantine Authority of exporting country to ensure that orchards and packinghouses are suitably equipped to carry out the specified control measures and phytosanitary treatments. An audit is to be conducted prior to registration and then conducted at least annually.

IMPORT CONDITION-3: PRE-EXPORT VAPOUR HEAT TREATMENT

If vapor heat treatment is adopted by the Plant Quarantine Authority of exporting country for fruit fly disinfestations, the following procedures must be followed:

- Vapour heat treatment must be conducted in exporting country in VHT facilities registered with, and audited by Plant Quarantine Authority of exporting country, to ensure that they are suitably equipped to carry out the requirements for VHT stipulated in this document. Mango fruit must be be treated at 47.5°C (pulp core temperature) for 20 minutes.
- Treatment time will be for a minimum of two hours, including the warming and cooling periods to bring the fruit pulp to temperature. Treatment commences when the pulp core temperature of all probe-monitored fruit reaches, or is above, the required temperature. This temperature must be maintained for the required period.
- Temperature values need to be recorded to a standard agreed between Plant Quarantine Authority of exporting country and country of import and monitored by Plant Quarantine Authority of exporting country.
- The phytosanitary security of the product must be maintained after the vapour heat treatment to prevent reinfestation by fruit flies. Phytosanitary inspection of the treated fruit must be conducted by Plant Quarantine Authority of exporting country and the details of the treatment included on the Phytosanitary Certificate.

IMPORT CONDITION-4: PRE-EXPORT HOT WATER TREATMENT

If hot water treatment is adopted by the Plant Quarantine Authority of exporting country for fruit fly disinfestation, the following procedures must be followed:

- Mangoes must be treated with a hot water submersion treatment of 48°C or above for 20 minutes in accordance with the following schedule:
  1. Fruit pulp temperature must be 21°C or above prior to commencing treatment.
  2. Fruit must be submerged at least 10 cm below the water surface.
  3. Water must circulate constantly and be kept at 48°C throughout the treatment period, with the following tolerances:
     a. During the first five minutes of the treatment – temperatures may fall as low as 45.4°C provided the temperature is at least 46°C at the end of the five minute period.
     b. The temperatures may fall as low as 45.4°C for no more than 10 minutes.
  4. The dip time must be extended for an additional 10 minutes if hydrocooling starts immediately after the hot water immersion treatment.
- Hot water treatment must be conducted in exporting country in packinghouse facilities registered with, and audited by Plant Quarantine Authority of exporting country.

Temperature values need to be recorded to a standard agreed between Plant Quarantine Authority of exporting country and importing country and monitored by Plant Quarantine Authority of exporting country.

- The phytosanitary security of the product must be maintained after the hot water treatment to prevent reinfestation by fruit flies. Phytosanitary inspection of the treated fruit must be conducted by Plant Quarantine Authority of exporting country and the details of the treatment included on the Phytosanitary Certificate.

IMPORT CONDITION-5: PEST FREE PLACES OF PRODUCTION OR PEST FREE PRODUCTION SITES FOR MANGO PULP AND SEED WEEVILS

- The Plant Quarantine Authority of exporting country is responsible for establishing, maintaining and verifying pest freedom for MPW and MSW in "Pest free places of production and pest free production sites", as defined by the International Standards for Phytosanitary Measures (ISPM), Food and Agriculture Organization (FAO), Publication No. 10 *Requirements for the establishment of pest free places of production and pest free production sites*.

- The Plant Quarantine Authority of exporting country is responsible for the establishment of production area pest freedom by verification of pest free places of production or pest free production sites by official surveys and monitoring. Monitoring must involve field inspections and fruit cutting done at least once during the growing season and before harvest. These monitoring surveys must be conducted during each year of mango production for each pest free area before consignments will be permitted for export to Australia. The results must be submitted to Plant Quarantine Authority of importing country before access can be considered.

- The Plant Quarantine Authority of exporting country must maintain production area pest freedom and specify the measures in place to prevent the introduction of the pest into the place of production or production site or to destroy previously undetected infestations. The Plant Quarantine Authority of exporting country must advise importing country of the nominated orchards within the designated pest free places of production/pest free production sites. The Plant Quarantine Authority of exporting country must notify importing country of any pest detected during routine monitoring and surveys conducted during the production season. For example, India designated pest free areas during 2004 season for the production areas of Barabanki, Malihabad, Saharanpur in the Lucknow region, in the State of Uttar Pradesh.

- A Phytosanitary Certificate confirming that the specific pests like MPW and MSW are not known to occur in the designated places of production or pest free production sites and that the product is free from this pest would be issued by the Plant Quarantine Authority of exporting country.

IMPORT CONDITION-6: TARGETED PRE-EXPORT INSPECTION BY IMOA

- The Plant Quarantine Authority of exporting country will inspect all consignments in accordance with official procedures for all visually detectable quarantine pests and trash using sampling rates developed by the Plant Quarantine Authority of exporting country in consultation with imporing country.

- The inspection procedures will ensure that fresh mango fruit are free from all pests of quarantine concern to importing country and are free from any contaminant plant material (leaves, twigs, seed, etc.) and soil. The targeted inspection will ensure freedom from actionable mealybugs, and scale insects. Inspection must be completed in packinghouses that are registered with, and audited by, Plant Quarantine Authority of exporting country. Consignments that do not comply with the above requirements will be rejected for export to importing country.

- During inspection, the produce should be examined directly with a lens or binocular microscope. Any pests or debris may be brushed onto a white sheet of paper for inspection under a lens or microscope.
- Records of interceptions made during these inspections (live or dead quarantine pests, and trash) are to be maintained by the Plant Quarantine Authority of exporting country and made available to importing country as requested. This information will assist in future reviews of this import pathway and consideration of the appropriateness of the phytosanitary measures that have been applied.

IMPORT CONDITION-7: PACKING AND LABELLING

- All packages of mangoes for export must be free from contaminated plant materials including trash and weed seeds and must meet importing country's general import conditions for fresh fruits and vegetables. Trash refers to soil, splinters, twigs, leaves and other plant materials but excludes the mango calyx.
- Inspected and treated fruits will be required to be packed in new boxes. The fruit must be packed in boxes that have had any openings either screened with mesh or covered with tape. Packing material would be synthetic or highly processed if of plant origin. No unprocessed packing material of plant origin, such as straw, will be allowed. All wood material used in packaging of mango fruit must comply with the importing country's conditions.
- All boxes will be labelled with the orchard registration number and packinghouse registration number for the purposes of trace back in the event that this is necessary. The pallets should be securely strapped only after phytosanitary inspection has been carried out following mandatory post-harvest treatments. Palletised product is to be identified by attaching a uniquely numbered pallet card to each pallet or part pallet to enable trace back to registered orchards.

IMPORT CONDITION-8: PHYTOSANITARY CERTIFICATION BY IMOA

The Plant Quarantine Authority of exporting country is required to issue a Phytosanitary Certificate for each consignment upon completion of pre-export treatment and inspection. Each Phytosanitary Certificate is to contain the following information:

Additional declarations: "*The mangoes in this consignment have been produced in [name of exporting country] in accordance with the conditions governing entry of fresh mangoes to [name of importing country] and inspected and found to be free of quarantine pests*".

AND

"Mangoes have been produced in [name of area, region and State] which is free of mango pulp weevil (Sternochetus frigidus) and mango seed weevil (S. mangiferae)."

Distinguishing marks: The orchard registration number, packinghouse registration number, number of boxes per consignment, and container and seal numbers (as appropriate); to ensure trace back to the orchard in the event that this is necessary.

A consignment is the quantity of mango fruit covered by one Phytosanitary Certificate that arrives at one port in one shipment. Consignments need to be either shipped directly from one port or city in [*name of exporting country*] to a designated port or city in [*name of importing country*], or if transhipped, sealing of containers must be maintained.

Treatments: Details of vapour heat treatment or hot water treatment (i.e. temperature, duration and packing house/facility number), where relevant, must be included in the treatment section on the Phytosanitary Certificate.

IMPORT CONDITION-9: STORAGE AND MOVEMENT

Packed product and packaging is to be protected from pest contamination during and after packing, during storage and during movement between locations (e.g., packing house to cool storage/depot, to inspection point, to export point).

Product for export to importing country that has been inspected and certified by the Plant Quarantine Authority of exporting country must be maintained in secure conditions that will prevent mixing with fruit for export to other destinations. This can be achieved through segregation of fruit for export to country of import in separate storage facilities, netting or shrink-wrapping pallets in plastic, or by placing sealed cartons in the low temperature cold storage before loading into a shipping container.

Alternatively, packed fruit can be directly transferred at the packinghouse into a shipping container, which is to be sealed and not opened until the container reaches to imporing country.

Security of the consignment is to be maintained until release from quarantine in importing country.

IMPORT CONDITION-10: ON-ARRIVAL QUARANTINE CLEARANCE BY PQW

On-arrival, each consignment must be inspected by Plant Quarantine Authority of importing country and documentation examined for consignment verification purposes at the port of entry in importing country prior to release from quarantine. Sampling methodology would provide 95% confidence that there is not more than 0.5% infestation in a consignment.
Action for non-complying lots: Where consignments are found to be non-compliant with import requirements at country of import on arrival inspection, the importer will be given the option to treat (if suitable treatments for the pests detected can be applied), re-export or destroy the consignment.

If product continually fails inspection, importing country reserves the right to suspend the export program and conduct an audit of the fresh mango risk management systems that are in place. The program will continue only once country of import is satisfied that appropriate corrective action has been taken.

Uncategorized pests: If an organism that is detected on mango from exporting country has not been categorized, it will require assessment to determine its quarantine status and if phytosanitary action is required. The detection of any pests of quarantine concern not already identified in the analysis may result in the suspension of the trade while a review is conducted to ensure that the existing measures continue to provide the appropriate level of phytosanitary protection for importing country.

IMPORT CONDITION-11: AUDIT AND REVIEW OF POLICY

The importing country reserves the right to review the adopted policy at any time after significant trade has occurred or where there is reason to believe that the phytosanitary status of the exporting country has changed.

5.3. RISK MANAGEMENT CONCLUSIONS

All the pests assessed requires mitigative measures, however, due to the diverse nature of these pests, it is unlikely that a single mitigative measure will be adequate to reduce the risk to acceptable levels. Consequently, a combination of measures is being suggested as a feasible approach.

CHAPTER 6

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Kw…l.m¤cmviY Awa`ßi

evsjv‡`k dvB‡Uv‡m‡bUvix kw³kvjxKiY cÖKí

Dw™¢` msiÿY DBs, Lvgvievox, dvg©‡MU, XvKv|

‡dvbt 9103774|

Questionnaire for Farmers on Conducting Pest Risk Analysis (PRA) of Mango in Bangladesh under Strengthening Phytosanitary Capacity in Bangladesh

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‡mU-1: AvgPvlx‡`i R‡b¨ Rwic ckœvejx

‡KvW:					‡gvevBj ‡dvb											

A.0 AvgPvlxi e¨w³MZ Z_¨vw`t

A.1 DËi`vZvi bvg: ---

A.2 Mvg --

A.3 Kw…l.eK: ---

A.4 Dc‡Rjv: --

A.5 ‡Rjv: --

A.6 wk¶vMZ †hvM¨Zv: --------------------------------------

A.7 eqm: -- |

A.8 ‡ckvMZ: [‡KvW: 1=eo Pvlx, 2=ga¨g Pvlx, 3=ÿz`ª Pvlx, 4=cvšÍK Pvlx] [ ]

A.9 wj½: (‡KvW: 1=cyiæl, 2=gwnjv) [ ]

B.0 Av‡gi আবাদ ও পি.আর.এ সংক্রান্ত তথ্যাবলিt

B.1 DËi`vZvi e¨eüZ Rwgi aiY/ cKwZ:

AvgPv‡l e¨eüZ Rwgi aiY	Rwgi cwigvY (kZvsk)
1. G eQi Avg Pvl K‡i‡Qb Ggb Rwgi cwigvb ejyb?	
2. KZ ermi hver Avg Pvl K‡ib?	

B.2 Avcwb †Kvb ‡Kvb Rv‡Zi Avg Pvl K‡ib, `qv K‡i ej‡eb wK?

PvlKZ/e¨eüZ Av‡gi RvZ (bx‡Pi Lwj N‡i Av‡gi Rv‡Zi †KvW b¤i wjLyb)	wewfbœ Rv‡Zi Av‡gi PvlKZ Rwgi cwigvY (kZvsk)	Drcv`b (gY/kZK*)
1.		
2.		
3.		
4.		
5.		

[‡KvW: 1=ewwi Avg -1 (gnvb›`v), 2=ewwi Avg -2 (bxjg), 3=ewwi Avg-3 (Av¤cwj), 4=ewwi Avg -4 (nvBweªW Avg), 5=dRjx, 6=j¨vsov, 7=wLimvcvZ, 8=‡Mvcvj‡fvM, 9=jÿY‡fvM, 10=wngmvMi, 11=‡gvnb‡fvM, 12=Awkbv, 13=Kvjvcvnvox, 14=‡Pvlv Avg, 15=‡ev¤vB, 16=nwo fv½v, 17=¸wU Avg, 18=wgQwi †fvM, 19=mh©cyix, 20=jvj wm›`yi, 21=Ab¨vb¨ (hw` _v‡K)-------]

*1 gY=40 ‡KwR

B.3 Av‡gi wewfbœ Rv‡Zi cwZ ¶wZKi ‡cvKvgvKo, ‡ivM-evjvB এবং আগাছার সংবেদনশীল প্রতিক্রিয়া †Kgb?

Bs	¶wZKi †cvKv-gvKo, †ivM I AvMvQvi cwZ ms‡e`bkxjZv	Av‡gi Rv‡Zi bvg (`qv K‡i Lvjx N‡i ‡KvW b¤i wjLyb)
1.K.	‡cvKv-মাকড়ে বেশী আক্রান্ নq Ggb Av‡gi RvZ:	
L.	KxU-পতঙ্গ আক্রমন প্রতিরোধী আমের জাত:	
2.K.	‡ivM Øviv বেশী আক্রান্ত হয় এমন আমের জাত:	

L.	‡ivM cwZ‡iva¸ Av‡gi RvZ:	
3.K.	ciRxwe AvMvQv Øviv বেশী আক্রান্ত হয় এমন আমের জাতঃ	
L.	ciRxwe AvMvQv cwZ‡iva¸ Av‡gi RvZ:	

[‡KvW: 1=evwi Avg -1 (gnvb›`v), 2=evwi Avg -2 (bxjg), 3=evwi Avg-3 (Av¤ªcwj), 4=evwi Avg -4 (nvBweªW Avg), 5=dRjx, 6=j¨vsov, 7=wLimvcvZ, 8=‡Mvcvj‡fvM, 9=jÿY‡fvM, 10=wngmvMi, 11=‡gvnb‡fvM, 12=Awkbv, 13=Kvjvcvnvox, 14=‡PvIv Avg, 15=‡ev¤vB, 16=nvwofv½v, 17=¸wU Avg, 18=wgQwi †fvM, 19=mb-cyix, 20=jvj wm›`yi, 21=Ab¨vb¨ (hw` _v‡K)-------]

B.4 Av‡gi Pv‡li R‡b¨ mvavibZ: ‡Kvb ‡Kvb Drm ‡_‡K Av‡gi Pviv msMn/ক্রয় করেন?

[†KvW: 1=wb‡Ri Kjg KvUvi Pviv, 2=cwZ‡ekx KIK KvQ †_‡K, 3=weGwWwmÕi bvmvix †_‡K, 4=¯vbxq ‡Kvb bvmvix †_‡K, 5=cvkeZx †`k †_‡K Avg`vbxKZ Pviv, 6=wewfbœ M‡elbv cÖwZôvb, 7=GbwRI, 8=Ab¨vb¨ (hw` _v‡K)-----------]

B.5 Avcbvi GjvKvq Avg Mv‡Q ‡gi#`Üx cvbxi আক্রমনের aiY †Kgb? (`qv K‡i Lvjx N‡i msL¨v wjLyb)

bs	evjvB‡qi bvg	gi#`Üx cvbxর আক্রমনের অবস্থা: [‡KvW: gL¨ (‡ekx ÿwZKi) evjvB=1, ‡MŠY evjvB (A_©‰bwZK ÿwZKi bq)]	
1	cwL		
2	KvVweovj		
4	ev`yo		
5	Ab¨vb¨ (hw` _v‡K)		

B.6 Av‡gi ¶wZKi ‡cvKv-gvK‡oi Dcw¯wZ, ÿwZi aiY, Mv‡Qi Sзকিপূণ ধাপ, গাছের আক্রান্ত অংশ ও আক্রমনের তীব্রতা কেমন?

bs	ÿwZKi ‡cvKv-gvK‡oi bvg	ÿwZKi ‡cvKv দ্বারা আক্রান্ত হয় wKbv? [1=n¨vu 2=bv]	ÿwZi aiY [(‡KvW: 1=gL¨ †cvKv (‡ekx ÿwZKi), 2= ‡MŠY ‡cvKv (‡ekx ÿwZKi bq)]	Mv‡Qi SuywKc~Y© avc [†KvW: 1=Pviv, 2=evoš— MvQ, 3=cy®ú gÄyix, 4=d‡ji e„w×, 5=dj cvKvi mgq]	Mv‡Qi †Kvb অংশ আক্রান্ত হয় (‡KvW: 1=cvZv, 2=KvÛ, 3=cy®ú gÄyix, 4=Av‡gi ¸wU, 5=cvKv Avg, 6=Av‡gi AvwU)	আক্রমনের ZxeZv (‡KvW: 1=‡ekx, 2=ga¨g, 3=Kg)
1	Av‡gi dwos †cvKv (Mango hopper)					
2	d‡ji gvwQ (Mango fruit fly)					
3	d‡ji ‡fvgiv ‡cvKv (Fruit/pulp weevil)					
4	AvwUi ‡fvgiv †cvKv (Stone weevil)					
5	KvÛ wQ`Kvix †cvKv (Stem borer)					
6	weQv †cvKv (Mango defoliator)					
7	dj wQ`Kvix †cvKv (Mango fruit borer)					
8	cvZv †L‡Kv †cvKv (Leaf cutting weevil)					
9	WMvi Mj †cvKv (Mango shoot gall)					
10	cvZvi Mj †cvKv (Mango leaf gall)					
11	wgwj evM (Mango mealy bug)					
12	cvZv/ d‡ji Rvj m„óKvix †cvKv (Leaf/flower webber)					

13	cvZv myo½Kvix †cvKv (Leaf miner)					
14	cvZvi ‡j`v‡cvKv (Leaf caterpillar)					
15	Av‡gi †¯‹j Bb‡m± (Scale insect)					
16	WMv wQ`Kvix †cvKv (Shoot borer)					
17	‡Mvjvcx wRcwm g_ (Pink gypsy moth)					
18	cvZvi ÿỳ gvKo (Eriophyid mite)					
19	Ab¨vb¨ (hw` _v‡K)					

B.07 ***K. Avcbvi GjvKvq Avg Mv‡Q Av‡gi wgwj evM*** (mango mealy bug/giant mealy bug) ***-Gi Dcw¯wZ Av‡Q wK?*** *(‡KvW: n¨uv=1, bv=2)*|

L. hw` DËi n¨uv nq, Zvn‡j KZ ermi hver G‡cvKvi Dcw¯wZ †`Lv hv‡"Q e‡j g‡b K‡ib?
[‡KvW: 1= 1 ermi hver (2014-15), 2=MZ cvuP ermi hver (2010-15), 3=MZ 10 ermi hver (2005-15), 4=MZ 15 ermi hver (2000-2015), 5= MZ 15 erm‡ii AwaK mgq hver (2000 mv‡ji ce~©n‡Z), 6= Rvbv bvB]

গ. এই পোকায় গাছের কোন পর্যায় আক্রমন করে?
[†KvW: 1=Pviv, 2=evoš— MvQ, 3=Av‡gi d‡ji eo× chvq, 4= d‡ji eo× chvq, 5=Avg cvKvi chvq]|

ঘ. এই পোকায় গাছের কোন অংশে আক্রমন করে?
(‡KvW: 1=cvZv, 2=KvÛ, 3=cy®ú gÄyix, 4=Av‡gi ¸wU, 5=Av‡gi †evUv, 6=cvKv Avg, 7=mKj avc)|

ঙ.এই পোকার কারণে আক্রমনের তীব্রতা কেমন? *(‡KvW: 1=‡ekx, 2=ga¨g)*

B.08 ***K. Avcbvi GjvKvq Avg Mv‡Q eZ©gv‡b Ggb bZzb ‡Kvb ‡cvKv ‡`Lv hv‡"Q wK, hv ceeZx© mg‡q wQj bv?*** *(‡KvW: n¨uv=1, bv=2)*|

L. hw` DËi n¨uv nq, Zvn‡j ‡cvKv¸‡jvi wK wK? bvg D‡jL Ki‡b: [wb‡Pi Lvjx N‡i †KvW b¤i emvb]

[‡KvW: 1=Av‡gi ncvi, 2=d‡ji gwQ, 3=d‡ji ‡fvgiv †cvKv, 4=AwUi ‡fvgiv †cvKv, 5=KvÛ wQ`Kvix †cvKv, 6=wiQv †cvKv, 7=dj wQ`Kvix †cvKv, 8=cvZv †L‡Kv †cvKv, 9=WMvi Mj †cvKv, 10=cvZvi Mj †cvKv, 11=Av‡gi wgwj evM, 12=cvZv/d‡ji Rvj myóKvix †cvKv, 13=cvZv myo½Kvix †cvKv, 14=cvZvi ‡j`v‡cvKv, 15= Av‡gi †¯‹j Bb‡m±, 16=WMv wQ`Kvix †cvKv, 17=‡Mvjvcx wRcwm g_, 18=cvZvi ÿỳ gvKo, 19=Ab¨vb¨----------]

B.09 ***Avcbvi GjvKvq Avg Mv‡Q Av‡Mi Zzjbvq eZ©gv‡b AwaKi ÿwZ K‡i Ggb KZ¸‡jv AwbóKvix ‡cvKvi bvg ejyb?***

[‡KvW: 1=Av‡gi ncvi, 2=d‡ji gwQ, 3=d‡ji ‡fvgiv †cvKv, 4=AwUi ‡fvgiv †cvKv, 5=KvÛ wQ`Kvix †cvKv, 6=wiQv †cvKv, 7=dj wQ`Kvix †cvKv, 8=cvZv †L‡Kv †cvKv, 9=WMvi Mj †cvKv, 10=cvZvi Mj †cvKv, 11=Av‡gi wgwj evM, 12=cvZv/d‡ji Rvj myóKvix †cvKv, 13=cvZv myo½Kvix †cvKv, 14=cvZvi ‡j`v‡cvKv, 15= Av‡gi †¯‹j Bb‡m±, 16=WMv wQ`Kvix †cvKv, 17=‡Mvjvcx wRcwm g_, 18=cvZvi ÿỳ gvKo, 19=Ab¨vb¨----------]

B.10 ***Avcbvi Rvbvg‡Z Av‡gi Ggb ‡Kvb ÿwZKi ‡cvKv Av‡Q wK, ‡h¸‡jv cvkeZx©/Ab¨ †Kvb ‡`k/ ‡\_‡K Avgv‡`i ‡`‡k c‡ek K‡i‡Q, hv Avgv‡`i ‡`‡k c‡e© wQj bv?*** *(‡KvW: n¨uv=1, bv=2)*|

K. hw` DËi nüv nq, Zvn‡j ‡m me ‡cvKvi bvg ejyb?

[‡KvW: 1=Av‡gi ncvi, 2=d‡ji gwQ, 3=d‡ji ‡fvgiv †cvKv, 4=AwUi ‡fvgiv †cvKv, 5=KvÛ wQ`Kvix †cvKv, 6=wiQv †cvKv, 7=dj wQ`Kvix †cvKv, 8=cvZv †L‡Kv †cvKv, 9=WMvi Mj †cvKv, 10=cvZvi Mj †cvKv, 11=Av‡gi wgwj evM, 12=cvZv/d‡ji Rvj myóKvix †cvKv, 13=cvZv myo½Kvix †cvKv, 14=cvZvi ‡j`v‡cvKv, 15= Av‡gi †¯‹j Bb‡m±, 16=WMv wQ`Kvix †cvKv, 17=‡Mvjvcx wRcwm g_, 18=cvZvi ÿỳ gvKo, 19=Ab¨vb¨----------]

B.11 ***Avcwb mvaviYZ wKfv‡e Av‡gi*** **ক্ষতিকর পোকামাকড়ের আক্রমণ দমন করেন? নিচের খালিঘরে কোড নাম্বার লিখুনঃ**

(‡KvW t 1= Avg Mv‡Q KxUbvkK ‡¯cÖ K‡i, 2= Avg Mv‡Qi bx‡P †avuqv (wdDwg‡Mkb) w`‡q, 3=†d‡ivgb dv`u e¨envi করে, ৪=পোকায় আক্রান্ত ডালপালা ছেঁটে, *4= Av‡gi †gŠmyg †k‡l Ac‡qvRbxq Wvjcvjv †Q‡U w`‡q, 5=gwU‡Z Mv‡Qi †Mvovq `vbv`vi KxUbvkK e¨envi K‡i, 6=Mv‡Qi †Mvovi AveRbv/AvMvQv cwi¯‹vi K‡i, 7= ‡m‡Pi mv‡\_ KxUbvkK c‡qvM K‡i, 8=cwZ‡ivax RvZ e¨envi K‡i, 9= cwL Zvov‡bvi e¨e¯v K‡i, 10= mgwšZ evjvB c×wZ (AvB.wc.Gg.), 11= Mv‡Qi †Mvovq mÿg mvi e¨envi K‡i, 12= Ab¨vb¨ (`qv K‡i D‡jL Ki“b)]*

B.12 ***Av‡gi wewfbœ †iv‡Mi*** **আক্রমনের *Dcw¯wZ,* ক্ষতির ধরণ, গাছের ঝুঁকিপূণ ধাপ, গাছের আক্রান্ত অংশ ও আক্রমনের তীব্রতা কেমন?**

bs	***Av‡gi ‡ivM mg‡ni bvg***	*ÿwZKi ‡cvKv Øviv* আক্রান্ত হয় *wKbv? [1=n¨vu 2=bv]*	***ÿwZi aiY*** *[(‡KvW: 1=gL¨ †cvKv (‡ekx ÿwZKi), 2= ‡MŠY ‡cvKv (Aí ÿwZKi)]|*	***Mv‡Qi SuwKc~Y© avc*** *[†KvW: 1=Pviv, 2=evoš MvQ, 3=cÖ¯ú gÄix, 4=d‡ji ewØ×, 5=dj cvKvi mgq]|*	***Mv‡Qi*** **আক্রান্ত অংশ** *(‡KvW: 1=cvZv, 2=KvÛ, 3=cÖ¯ú gÄix, 4=Av‡gi ¸wU, 5=cvKv Avg, 6=Av‡gi AvwU)|*	**আক্রমনের *ZxeZv*** *(‡KvW: 1=‡ekx, 2=ga¨g, 3=Kg)*
1	*cvZvi G¨vbÎvK‡bvR †ivM*					
2	*d‡ji G¨vbÎvK‡bvR/ wUqvi †÷Bb*					
3	*gyKz‡ji cvDWvwi wgjwWD*					
4	*KvÛ/d‡ji g¨vjdi‡gkb*					
5	*KvÛ/dj cPv* (Stem/fruit end rot)					
6	*d‡ji myUx ‡gvì* (Shooty mold)					
7	*AvMv giv †ivM* (Dieback)					
8	*jvj iv÷ †ivM* (Red rust)					
9	*mv`v iv÷ †ivM* (White rust)					
10	*cvZvi ev`vgx `vM †ivM*					
11	*cvZvi AjUvi‡bwiqv `vM †ivM*					
12	*cvZvi e¨vK‡Uwiqvj evBU †ivM*					
13	*Av‡gi `vù †ivM* (Scab)					
14	*cvZvi †M¯úU (*Grey leaf spot*)*					
15	*Ab¨vb¨ (D‡jL Ki“b)---------*					

B.14 ***K. Avcbvi GjvKvq Avg Mv‡Q*** **বর্তমানে এমন কোন নতুন রোগের আক্রমন দেখা যাচ্ছে কি, যা পূর্ববর্তী সময়ে ছিল না?**
(‡KvW: n¨vu=1, bv=2)|

L. hw` DËi n¨vu nq, Zvn‡j ‡ivMmgn wK wK? bvg D‡jL Ki“b:

[‡KvW: 1=cvZvi G¨vbÎvK‡bvR †ivM, 2= d‡ji G¨vbÎvK‡bvR †ivM/wUqvi †÷Bb, 3=gyKz‡ji cvDWvwi wgjwWD, 4==cvZv/d‡ji g¨vjdi‡gkb, 5=Av‡gi KvÛ/dj cPv †ivM, 6=gyKz‡ji myUx ‡gvì †ivM, 7=AvMv giv †ivM, 8=jvj iv÷ †ivM, 9=mv`v iv÷ †ivM, 10=ev`vgx `vM †ivM, 11=cvZvi AjUvi‡bwiqv `vM †ivM, 12=e¨vK‡Uwiqvj wjdi evBU, 13=Av‡gi `vù †ivM, 14= cvZvi †M¯úU, 15=Ab¨vb¨ (hw` _v‡K)---------]

B.15 ***Avcbvi GjvKvq Av‡gi Av‡Mi Zzjbvq eZ©gv‡b ‡ekx ÿwZ K‡i Ggb KZ¸‡jv ‡iv‡Mi bvg ejyb?***

[‡KvW: 1=cvZvi G¨vbÎvK‡bvR †ivM, 2= d‡ji G¨vbÎvK‡bvR †ivM/wUqvi †÷Bb, 3=gyKz‡ji cvDWvwi wgjwWD, 4==cvZv/d‡ji g¨vjdi‡gkb, 5=Av‡gi KvÛ/dj cPv †ivM, 6=gyKz‡ji myUx ‡gvì †ivM, 7=AvMv giv †ivM, 8=jvj iv÷ †ivM, 9=mv`v iv÷ †ivM, 10=ev`vgx `vM †ivM, 11=cvZvi AjUvi‡bwiqv `vM †ivM, 12=e¨vK‡Uwiqvj wjdi evBU, 13=Av‡gi `vù †ivM, 14= cvZvi †M¯úU, 15=Ab¨vb¨ (hw` _v‡K)---------]

B.16 ***K. Avcbvi Rvbvg‡Z Av‡gi Ggb ‡Kvb ‡ivM Av‡Q wK, ‡h¸‡jv cvkeZx ‡`k/we‡`k ‡_‡K Avgv‡`i ‡`‡k c‡ek K‡i‡Q, hv Avgv‡`i ‡`‡k c‡e wQj bv? (‡KvW: n¨vu=1, bv=2)|***

L. hw` DËi nüvu nq, Zvn‡j G mKj †iv‡Mi bvg ejyb?

[‡KvW: 1=cvZvi G¨vbÎvK‡bvR †ivM, 2= d‡ji G¨vbÎvK‡bvR †ivM/wUqvi †÷Bb, 3=gK¨‡ji cvDWvwi wgjwWD, 4==cvZv/d‡ji g¨vjdi‡gkb, 5=Av‡gi KvÛ/dj cPv †ivM, 6=gK¨‡ji mU© ‡gvì †ivM, 7=AvMv giv †ivM, 8=jvj iv÷ †ivM, 9=mv`v iv÷ †ivM, 10=ev`vgx `vM †ivM, 11=cvZvi AjUvi‡bwiqv `vM †ivM, 12=e¨vK‡Uwiqvj wjdi evBU, 13=Av‡gi `vù †ivM, 14= cvZvi †M¯úU, 15=Ab¨vb¨ (hw` _v‡K)---------]

B.17 ***Avcwb wKfv‡e Av‡gi ‡ivM `gb K‡i _v‡Kb? wb‡Pi LwjN‡i ‡KvW bv¤^vi wjLyb:***

[‡KvWt 1= Avg Mv‡Q QÎvKbvkK ‡¯cª K‡i, 2=Avg Mv‡Qi bx‡P †avqv (wdDwg‡Mশন) দিয়ে, ৩=রোগে আক্রান্ত ডালপালা ছেঁটে ফেলে, 4= Av‡gi †g‡ŠmyB †k‡l Ac‡qvRbxq Wvjcvjv †Q‡U w`‡q, 5=gvwU‡Z Mv‡Qi †Mvovq evjvBbvkK e¨envi K‡i, 6=Mv‡Qi †Mvovi AveRbv/AvMvQv cwi¯‹vi K‡i, 7= †ivM cwZ‡ivax RvZ e¨envi K‡i, 8= Rwg‡Z ‰Re-mvi c‡qvM K‡i, 9=mgwšZ evjvB c×wZ (AvB.wc.Gg.), 10= Mv‡Qi †Mvovq mvg mvi e¨envi K‡i, 12= Ab¨vb¨ (D‡jL Kiæb)-------------------]

B.18 ***Avg Mv‡Qi ‡Kvb chvq/Ask*** **আগাছা দ্বারা বেশী আক্রান্ত হয় এবং ক্ষতির তীব্রতা কেমন? (খালী ঘরে সংখ্যা লিখুন)**

bs	***AvMvQvi bvg***	আক্রমনের অবস্থা *[‡KvW: gL¨ AvMvQv=1, ‡MŠY AvMvQv=2,* আক্রমন হয় *bv=3]*	***AvgMv‡Qi SzuwKc~Y© avcmgn*** *[‡KvW: 1=Pviv, 2=evoš MvQ, 3=d‡ji e„w× chvq, 4=d‡ji e„w× chvq]*	**আক্রমনের তীব্রতা** *[‡KvW: 1=‡ekx, 2=ga¨g, 3=Kg* আক্রমন হয়*]*
1	*‡jvivšvm ciRxwe MvQ* (Loranthus)			
2	*AwKW (*Orchid)			
3	*dvY (*Fern)			
4	*¯YjZv (*dodder plant)			
5	*cv‡_wbqvg (*Parthenium)			
6	*Ab¨vb¨*			

B.19 ***K. Avcbvi GjvKvq Avg Mv‡Q ev evMv‡b eZgv‡b bZzb Ggb ‡Kvb AvMvQv ‡`Lv hv‡”Q wK, hv ceeZx mg‡q wQj bv? (‡KvW: n¨vu=1, bv=2)|***

L. hw` DËi n¨vunq, Zvn‡j AvMvQvmgn wK wK? bvg D‡jL Kiæb:

[†KvW: 1=‡jvivšvm ciRxwe MvQ, 2=AwKW, 3=dvY, 4=¯YjZv, 5=cv‡_wbqvg, 6=Ab¨vb¨ (D‡jL Kiæb)---------]

B.20 ***Avcbvi GjvKvq Avg Mv‡Q ev evMv‡b ‡ÿ‡Z Av‡Mi Zzjbvq eZgv‡b ‡ekx ÿwZ K‡i Ggb KZ¸‡jv AvMvQvi bvg ejyb?***

[†KvW: 1=‡jvivšvm ciRxwe MvQ, 2=AwKW, 3=dvY, 4=¯YjZv, 5=cv‡_wbqvg, 6=Ab¨vb¨ (D‡jL Kiæb)---------]

B.21 ***K. Avcbvi Rvbvg‡Z Av‡gi Ggb ‡Kvb AvMvQv Av‡Q wK, ‡h¸‡jv cvkeZx ‡`k/ne‡`k ‡_‡K Avgv‡`i ‡`‡k c‡ek K‡i‡Q, hv Avgv‡`i ‡`‡k c‡e wQj bv? ([‡KvW: n¨vu=1, bv=2)|***

L. hw` DËi n¨vunq, Zvn‡j G mKj AvMvQv¸‡jvi bvg ejyb?

[†KvW: 1=‡jvivšvm ciRxwe MvQ, 2=AwKW, 3=dvY, 4=¯YjZv, 5=cv‡_wbqvg, 6=Ab¨vb¨ (D‡jL Kiæb)---------]

B.22 ***Av‡gi evMv‡b mvaviYZ: wKfv‡e AvMvQv `gb K‡i _v‡Kb? wb‡Pi LwjN‡i ‡KvW bv¤^vi wjLyb:***

[‡KvWt 1=Av‡gi evMvb ‡_‡K AvMvQv DwV‡q, 2=Avg MvQ †_‡K ciRxwe AvMvQv cwi®‹vi K‡i, 3=Av‡gi evMv‡b `vbv`vi AvMvQvbvkK wQwU‡q, 4=evMv‡b mvi/‡mP †`qvi mgq AvMvQv DwV‡q, 5=ciRxwe AvMvQv MvQ †_‡K cwi¯‹vi K‡i, 6=Avg Mv‡Qi †Mvovq gvwU DwV‡q, 7= ‡mP w`‡q, 8=Ab¨vb¨ (D‡jL Kiæb)]

Z_¨ msMnKvixi bvgt   *¯v¶i I ZvwiLt*

wdì mycvifvBRv‡ii bvgt   *¯v¶i I ZvwiLt*

MYcRvZš¿x evsjv‡`k miKvi

Kw…wl m¤úªmviY Awa`ßi

evsjv‡`k dvB‡Uv‡m‡bUvix ÿgZv kw³kvjxKiY cÖKí

Dw™¢` msiÿY DBs, Lvgvievox, dvg©‡MU, XvKv|

‡dvbt 9103774|

Questionnaire for Farmers on Conducting Pest Risk Analysis (PRA) of Mango in Bangladesh under Strengthening Phytosanitary Capacity in Bangladesh

Prepared by:

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‡mU-2: Gd.wR.wW. MvBWjvBbmg~n

‡KvW:				

A.0 **GdwRwW Gi ¯'vbt** ---

A.2 Mvg -- **A.3** Kw….eK: ---

A.4 Dc‡Rjv: -- **A.5** ‡Rjv: ---

B.1 ***Avcbv‡`i evMv‡b PvlK…Z Av‡gi RvZ¸‡jvi g‡a¨ me‡P‡q Rbwcq RvZ¸‡jv wK wK?***

B.2 ***Avcbviv ‡hmKj Av‡gi RvZ Pvl K‡ib, Gi Pvivi Drmmg~n wK wK?***

B.3 ***Avcbvi GjvKvq mvaviYZ Avg MvQ ‡Kvb ai‡bi ¶wZKi ‡পাকামাকড়ের আক্রমন ‡`Lv hvq? (bvg D‡jL Ki‡b)***

K. gyL¨ ¶wZKi ‡cvKvgvKo:

L. ‡MŠY ¶wZKi ‡cvKvgvKo:

B.4 ***Avcbv‡`i GjvKvq mvaviYZ Av‡gi evMv‡b/Av‡gi ‡Kvb ‡Kvb ‡ivM ¸‡jv ‡`Lv hvq? (‡iv‡Mi bvg D‡jL Ki‡b)***

K. gyL¨ ‡ivM:

L. ‡MŠY ‡ivM:

B.5 ***Avcbvi GjvKvq mvaviYZ Av‡gi evMv‡b/Mv‡Q ‡Kvb ‡কান আগাছাসমূহের আক্রমন ‡`Lv hvq? (bvg D‡jL Ki‡b))***

K. gyL¨ AvMvQv:

L. ‡MŠY AvMvQv:

B.6 ***K. Avcbv‡`i GjvKvq Av‡gi wgwj ev‡Mi Dcw¯'wZ Av‡Q wK?***

L. hw` †_‡K _v‡K Avcbv‡`i GjvKvq Gi Dcw¯'wZ K‡e †_‡K †`Lv hv‡"Q e‡j g‡b nq?

M. hw` Dcw¯'Z ‡_‡K _v‡K Zvn‡j Zv Avg Mv‡Q KLb (†gŠmyg) Ges wK cwigv‡b ÿwZ K‡i?

B.7 ***ÿwZKi ‡cvKv-gvKo, ‡ivM I AvMvQv Øviv Avg Mv‡Qi ‡Kvb ‡Kvb evMvb chvq/avcmg~n ‡বশী আক্রান্ত হয়?***

K. ÿwZKi ‡cvKvgvKo:

L. ‡ivM:

M. AvMvQv:

B.8 ***ÿwZKi ‡cvKv-gvKo I ‡ivM Øviv Avg Mv‡Qi ‡Kvb ‡Kvb Ask ‡*বশী আক্রান্ত হয়?**

K. ÿwZKi †cvKvgvKo:

L. ‡ivM evjvB:

B.9 ***ÿwZKi ‡cvKv-gvKo, ‡ivM-evjvB I AvMvQvi Avg MvQ/d‡ji ÿwZi ZxeZv ‡Kgb nq?***

K. ÿwZKi †cvKvgvKo:

L. ‡ivM:

M. AvMvQv:

B.10 ***Avcbvi GjvKvq Avg Mv‡Q ev evMv‡b eZgv‡b Ggb ‡Kvb bZzb ‡cvKv-gvKo, ‡ivM I AvMvQv ‡`Lv hv‡"Q wK, hv ceeZx mg‡q wQj bv? hw` ‡_‡K _v‡K, Zvn‡j ‡m¸‡jv wK wK? bvg D‡jL Ki‡b:***

K. ÿwZKi †cvKvgvKo:

L. ‡ivM:

M. AvMvQv:

B.11 ***Avcbvi GjvKvq Avg Mv‡Q ev evMv‡b Av‡Mi Zzjbvq eZgv‡b A‡bK †ekx ÿwZ K‡i Ggb KZ¸‡jv AwbóKvix ‡cvKv-gvKo, ‡ivM I AvMvQvi bvg ejyb?***

K. ÿwZKi ‡cvKvgvKo:

L. ‡ivM:

M. AvMvQv:

B.12 ***Avcbv‡`i*** **এলাকায় পার্থেনিয়াম আগাছার উপস্থিতি আছে কি? যদি থাকে তাহলে এর আক্রমনে ক্ষতির তীব্রতা কেমন?**

B.13 ***Avcbv‡`i GjvKvi Avg Mv‡Qi ÿwZKi ‡cvKv-gvKo, ‡ivM I AvMvQv `g‡b wK wK KvhKi e¨e¯v Mnb Kiv nq?***

K. ÿwZKi ‡cvKvgvKo `g‡b KvhKi e¨e¯v:

L. ‡ivM evjvB `g‡b KvhKi e¨e¯v:

M. AvMvQv `g‡b KvhKi e¨e¯v:

8

B.14 ***Avcbv‡`i Rvbvg‡Z Av‡gi Ggb ‡Kvb ÿwZKi ‡cvKv-gvKo, ‡ivM I AvMvQv Av‡Q wK, ‡h¸‡jv cvkeZx ‡`k/we‡`k ‡\_‡K Avgv‡`i ‡`‡k c‡ek K‡i‡Q g‡b nq, A\_P ‡m¸‡jv c‡e Avgv‡`i ‡`‡k wQj bv? hw` ‡_‡K _v‡K, Zvn‡j Zv‡`i bvg ejyb?***

K. ÿwZKi †cvKvgvKo:

L. ‡ivM:

M. AvMvQv:

‡dvKvm Mæc wWmKvkb (Gd.wR.wW.)-G AskMnbKvix‡`i ZvwjKv

bs	bvg	Mvg	‡ckv	‡gvevBj	¯vÿi
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

GdwRwW cwiPvjbvKvixi bvgt--- |

¯vÿi I ZvwiL: --|

‡gvevBj b¤i:---|

Government of the People's Republic of Bangladesh
Department of Agricultural Extension
Strengthening Phytosanitary Capacity in Bangladesh,
Khamarbari, Farmgate, Dhaka, Phone: 9103774

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Set-3a: KII Checklists for Additional DD (PP)/PPS at District Level-DAE Office

Name of the Key Informant... ………………………………. Designation ………………………..….

District: ……………………………………………………… Mobile:..…………………..……………

1.0 INFORMATION ABOUT INSECT PESTS OF MANGO

1.1 What are the major insect pests that cause potential damage to mango in your area?

1.2 What are the minor insect pests of mango?

1.3 What are the insect pests of mango, which incidences are being seen in recent years, but not seen earlier in your area?

1.4 What is the status of mango mealy bug in your area? Is it present or absent in your area?

1.5 Is there any presence of Mediterranean fruit fly [*Ceratitis capitata* (Weidemann)] and/or Queensland Fruit fly [*Bactrocera tryoni* (Froggatt)] of mango in your area/Bangladesh? If yes, how did you conform?

1.6 Is there any presence of Tapioca scale insect (*Aonidomytilus albus*) and white mango scale (*Aulacaspis tubercularis*) in your area? If yes, how did you conform and what is it's severity of damage to mango?

1.7 Is there any presence of pink gypsy moth (*Lymantria mathura* Moore) in the orchard of mango in your area/Bangladesh? If yes, how did you conform and what is it's severity of damage to mango?

1.8 Is there any presence of shoot borer of mango (*Chluonetia transsiersa*) in your area? If yes, how did you conform and what is it's severity of damage to mango?

1.9 What are the quarantine insect pests of mango that might already be entered into Bangladesh through importation of mango/seedlings/planting materials/seeds from other countries or through cross boundary from neighboring countries that were not seen earlier?

1.10 What are the possible ways of entry of newly introduced insect pests of mango that were not seen earlier in your area?

1.11 What are the options to prevent the entry and spread of potential insect pests of mango within Bangladesh?

1.12 What are the effective options to control the quarantine insect pests of mango that are found in your area?

1.13 What are the effective ways to prevent the entry of quarantine insect pests of mango into Bangladesh from the countries of mango export?

1.14 What steps are being taken by the PQW of DAE to prevent the entry of quarantine insect pests of mango through imported mango?

1.15 Give your suggestions for the better management of the insect pests of mango in Bangladesh.

2.0 INFORMATION ABOUT DISEASES OF MANGO

2.1 What are the major diseases that cause potential damage to mango in your area?

2.2 What are the minor diseases of mango?

2.3 Which diseases of mango cause severe damage to mango every year in your area?

2.4 What are the diseases of mango, which incidences are being seen in recent years, but not seen earlier in your area?

2.5 Is there any presence of Grey Leaf Spot of mango [*Pestalotiopsis mangiferae*] in your area?

2.6 Is there any information about the diseases of mango available in the exporting country of mango to Bangladesh? If yes, what are those diseases? Please mention the name of diseases?

2.7 What are the quarantine diseases of mango that might already be entered into Bangladesh through importation of mango mango/seedlings/planting materials/seeds from other countries or through cross boundary from neighboring countries that were not seen earlier?

2.8 What are the possible ways of entry of newly introduced diseases of mango that were not seen earlier in your area?

2.9 What are the options to prevent the entry and spread of potential diseases of mango within Bangladesh?

2.10 What are the effective options to control the quarantine diseases that are found in the mango in your area?

2.11 What are the effective ways to prevent the entry of quarantine diseases of mango into Bangladesh from the countries of mango export?

2.12 What steps are being taken by the PQW of DAE to prevent the entry of quarantine diseases of mango through imported mango?

2.13 Give your suggestions for the better management of the diseases of mango in Bangladesh.

3.0 INFORMATION ABOUT WEEDS OF MANGO

3.1 What are the major weeds that cause potential damage to mango in your area?

3.2 What are the minor weeds of mango?

3.3 What are the weeds of mango, which incidences are being seen in recent years, but not seen earlier in your area?

3.4 Is there any presence of Parthenium weed in your area? If yes, how does there severity of damage?

3.5 Is there any information about the weeds of mango available in the exporting country of mango to Bangladesh? If yes, what are those weeds? Please mention the name of weeds?

3.6 What are the quarantine weeds of mango that might already be entered into Bangladesh through importation of mango mango/seedlings/planting materials/seeds from other countries or through cross boundary from neighboring countries that were not seen earlier?

3.7 What are the possible ways of entry of quarantine weeds of mango that were not seen earlier in your area?

3.8 What are the options to prevent the entry and spread of potential weeds of mango within Bangladesh?

3.9 What are the effective options to control the quarantine weeds that are found in the mango in your area?

3.10 What are the effective ways to prevent the entry of quarantine weeds of mango into Bangladesh from the countries of mango export?

3.11 What steps are being taken by the PQW of DAE to prevent the entry of quarantine weeds of mango through imported mango?

3.12 Give your suggestions for the better management of the weeds of mango in Bangladesh.

THANKS FOR PATIENCE CO-OPERATION

Government of the People's Republic of Bangladesh
Department of Agricultural Extension
Strengthening Phytosanitary Capacity in Bangladesh,
Khamarbari, Farmgate, Dhaka, Phone: 9103774

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Set-3b: KII Checklists for Officials of Plant Quarantine Wing, DAE at HQ

Name of the Key Informant... ………………………………. Designation …………………………..….

District: ……………………………………………………… Mobile:..………………….……………….

1.0 INFORMATION ABOUT INSECT PESTS OF MANGO

1.1 What are the major insect pests that cause potential damage to mango in your area?

1.2 What are the minor insect pests of mango?

1.3 What are the insect pests of mango, which incidences are being seen in recent years, but not seen earlier in your area?

1.4 What is the status of mango mealy bug in your area? Is it present or absent in your area?

1.5 Is there any presence of Mediterranean fruit fly [*Ceratitis capitata* (Weidemann)] and/or Queensland Fruit fly [*Bactrocera tryoni* (Froggatt)] of mango in your area/Bangladesh? If yes, how did you conform?

1.6 Is there any presence of Tapioca scale insect (*Aonidomytilus albus*) and white mango scale (*Aulacaspis tubercularis*) in your area? If yes, how did you conform and what is it's severity of damage to mango?

1.7 Is there any presence of pink gypsy moth (*Lymantria mathura* Moore) in the orchard of mango in your area/Bangladesh? If yes, how did you conform and what is it's severity of damage to mango?

1.8 Is there any presence of shoot borer of mango (*Chluonetia transsiersa*) in your area? If yes, how did you conform and what is it's severity of damage to mango?

1.9 What are the quarantine insect pests of mango that might already be entered into Bangladesh through importation of mango/seedlings/planting materials/seeds from other countries or through cross boundary from neighboring countries that were not seen earlier?

1.10 What are the possible ways of entry of newly introduced insect pests of mango that were not seen earlier in your area?

1.11 What are the options to prevent the entry and spread of potential insect pests of mango within Bangladesh?

1.12 What are the effective options to control the quarantine insect pests of mango that are found in your area?

1.13 What are the effective ways to prevent the entry of quarantine insect pests of mango into Bangladesh from the countries of mango export?

1.14 Give your suggestions for the better management of the insect pests of mango in Bangladesh.

2.0 INFORMATION ABOUT DISEASES OF MANGO

2.1 What are the major diseases that cause potential damage to mango in your area?

2.2 What are the minor diseases of mango?

2.3 Which diseases of mango cause severe damage to mango every year in your area?

2.4 What are the diseases of mango, which incidences are being seen in recent years, but not seen earlier in your area?

2.5 Is there any information about the diseases of mango available in the exporting country of mango to Bangladesh? If yes, what are those diseases? Please mention the name of diseases?

2.6 What are the quarantine diseases of mango that might already be entered into Bangladesh through importation of mango mango/seedlings/planting materials/seeds from other countries or through cross boundary from neighboring countries that were not seen earlier?

2.7 What are the possible ways of entry of newly introduced diseases of mango that were not seen earlier in your area?

2.8 What are the options to prevent the entry and spread of potential diseases of mango within Bangladesh?

2.9 What are the effective options to control the quarantine diseases that are found in the mango in your area?

2.10 What are the effective ways to prevent the entry of quarantine diseases of mango into Bangladesh from the countries of mango export?

2.11 Give your suggestions for the better management of the diseases of mango in Bangladesh.

3.0 INFORMATION ABOUT WEEDS OF MANGO

3.1 What are the major weeds that cause potential damage to mango in your area?

3.2 What are the minor weeds of mango?

3.3 What are the weeds of mango, which incidences are being seen in recent years, but not seen earlier in your area?

3.4 Is there any presence of Parthenium weed in your area? If yes, how does there severity of damage?

3.5 Is there any information about the weeds of mango available in the exporting country of mango to Bangladesh? If yes, what are those weeds? Please mention the name of weeds?

3.6 What are the quarantine weeds of mango that might already be entered into Bangladesh through importation of mango mango/seedlings/planting materials/seeds from other countries or through cross boundary from neighboring countries that were not seen earlier?

3.7 What are the possible ways of entry of quarantine weeds of mango that were not seen earlier in your area?

3.8 What are the options to prevent the entry and spread of potential weeds of mango within Bangladesh?

3.9 What are the effective options to control the quarantine weeds that are found in the mango in your area?

3.10 What are the effective ways to prevent the entry of quarantine weeds of mango into Bangladesh from the countries of mango export?

3.11 Give your suggestions for the better management of the weeds of mango in Bangladesh.

THANKS FOR PATIENCE CO-OPERATION

Government of the People's Republic of Bangladesh
Department of Agricultural Extension
Strengthening Phytosanitary Capacity in Bangladesh (SPCB)
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Set-3c: KII Checklists for Officials of PQW-DAE at HQ

Name of Key Informant…….. ………………………………. Designation ………………………..….

Working area: ……………………………………………..., Mobile:……….…………..……

1.0 INFORMATION ABOUT INSECT PESTS OF MANGO

1.1 What are the major insect pests that cause potential damage to mango in Bangladesh?

1.2 What are the insect pests of mango, which incidences are being seen in recent years, but not seen earlier in Bangladesh?

1.3 What is the status of mango mealy bug in Bangladesh? What is its severity of damage to mango?

1.4 Is there any presence of Mediterranean fruit fly [*Ceratitis capitata* (Weidemann)] and/or Queensland Fruit fly [*Bactrocera tryoni* (Froggatt)] of mango in your area/Bangladesh? If yes, how did you conform?

1.5 Is there any presence of Tapioca scale insect (*Aonidomytilus albus*) and white mango scale (*Aulacaspis tubercularis*) in your area? If yes, how did you conform and what is it's severity of damage to mango?

1.6 Is there any presence of pink gypsy moth (*Lymantria mathura* Moore) in the orchard of mango in your area/Bangladesh? If yes, how did you conform and what is it's severity of damage to mango?

1.7 Is there any presence of shoot borer of mango (*Chluonetia transsiersa*) in your area? If yes, how did you conform and what is it's severity of damage to mango?

1.8 What are the quarantine insect pests of mango that might already be entered into Bangladesh through importation of mango/seedlings/planting materials/seeds from other countries or through cross boundary from neighboring countries that were not seen earlier?

1.9 From which countries, the mangoes are being usually imported into Bangladesh?

1.10 Is there any information about the insect pests of mango available in the exporting country of mango to Bangladesh? If yes, what are those insect pests? Please mention the name of insect pests?

1.11 What are the quarantine insect pests of mango that might already be entered into Bangladesh through importation of mango seeds from other countries or through cross boundary from neighboring countries that were not seen earlier?

1.12 Is there any record, the consignment of mango imported from foreign country that was intercepted and returned from Bangladesh, due to occurrence of any insect pests in the consignment? If yes, which country and what are those insect pests? Please mention the name.

1.13 What are the possible ways of entry of newly introduced insect pests of mango that were not seen earlier in Bangladesh?

1.14 What are the options to prevent the entry and spread of potential insect pests of mango within Bangladesh?

1.15 What are the effective options to control the quarantine insect pests of mango that are found in Bangladesh?

1.16 What are the effective ways to prevent the entry of quarantine insect pests of mango into Bangladesh from the countries of mango export?

1.17 What steps are being taken by the PQW of DAE to prevent the entry of quarantine insect pests of mango through imported mango?

1.18 Give your suggestions for the better management of the insect pests of mango in Bangladesh.

2.0 INFORMATION ABOUT DISEASES OF MANGO

2.1 What are the major diseases that cause potential damage to mango in Bangladesh?

2.2 Among the diseases of mango available in Bangladesh, which insect pests cause severe damage to mango every year in Bangladesh?

2.3 What are the diseases of mango, which incidences are being seen in recent years, but not seen earlier in Bangladesh?

2.4 Is there any information about the diseases of mango available in the exporting country of mango to Bangladesh? If yes, what are those diseases? Please mention the name of diseases?

2.5 What are the quarantine diseases of mango that might already be entered into Bangladesh through importation of mango from other countries or through cross boundary from neighboring countries that were not seen earlier?

2.6 Is there any record, the consignment of mango imported from foreign country that was intercepted and returned by Bangladesh, due to occurrence of any diseases in the consignment? If yes, from which country and what are the diseases? Please mention the name.

2.7 What are the possible ways of entry of newly introduced diseases of mango that were not seen earlier in Bangladesh?

2.8 What are the options to prevent the entry and spread of potential diseases of mango within Bangladesh?

2.9 What are the effective options to control the quarantine diseases that are found in the mango in Bangladesh?

2.10 What are the effective ways to prevent the entry of quarantine diseases of mango into Bangladesh from the countries of mango export?

2.11 What steps are being taken by the PQW of DAE to prevent the entry of quarantine diseases of mango through imported mango?

2.12 Give your suggestions for the better management of the diseases of mango in Bangladesh.

3.0 INFORMATION ABOUT WEEDS OF MANGO

3.1 What are the major weeds that cause potential damage to mango in Bangladesh?

3.2 Among the weeds of mango available in Bangladesh, which weeds cause severe damage every year in Bangladesh?

3.3 What are the weeds of mango, which incidences are being seen in recent years, but not seen earlier in Bangladesh?

3.4 Is there any presence of Parthenium weed in Bangladesh? If yes, how does there severity of damage?

3.5 Is there any information about the weeds of mango available in the exporting country of mango to Bangladesh? If yes, what are those weeds? Please mention the name of weeds?

3.6 What are the quarantine weeds of mango that might already be entered into Bangladesh through importation of mango from other countries or through cross boundary from neighboring countries that were not seen earlier?

3.7 Is there any record, the consignment of mango imported from foreign country that was intercepted and returned from Bangladesh, due to occurrence of any weeds/weed seeds in the consignment? If yes, which country and what are the weeds? Please mention the name.

3.8 What are the possible ways of entry of quarantine weeds of mango that were not seen earlier in Bangladesh?

3.9 What are the options to prevent the entry and spread of potential weeds of mango within Bangladesh? [DAE (PQW & PPW), SCA, **Additional DD (PP)/PPS**, BARI, Agril. University]

3.10 What are the effective options to control the quarantine weeds that are found in the mango in Bangladesh?

3.11 What are the effective ways to prevent the entry of quarantine weeds of mango into Bangladesh from the countries of mango export?

3.12 What steps are being taken by the PQW of DAE to prevent the entry of quarantine weeds of mango through imported mango?

3.13 Give your suggestions for the better management of the weeds of mango in Bangladesh.

THANKS FOR PATIENCE CO-OPERATION

Government of the People's Republic of Bangladesh
Department of Agricultural Extension
Strengthening Phytosanitary Capacity in Bangladesh (SPCB)
Plant Quarantine Wing (PQW), Khamarbari, Farmgate, Dhaka, Phone: 9103774

Prepared by:

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E-mail: info@dtcltd.com, Website: www.dtcltd.com

Set-3c: KII Checklists for Officials of PQW-DAE at HQ

Name of Key Informant…….. ………………………………. Designation …………………………..….

Working area: ……………………………………………..,   Mobile:……….………….……

1.0 INFORMATION ABOUT INSECT PESTS OF MANGO

1.1 What are the insect pests of mango, which incidences are being seen in recent years, but not seen earlier in Bangladesh?

1.2 What are the quarantine insect pests of mango that might already be entered into Bangladesh through importation of mango/seedlings/planting materials/seeds from other countries or through cross boundary from neighboring countries that were not seen earlier?

1.3 From which countries, the mangoes are being usually imported into Bangladesh?

1.4 Is there any information about the insect pests of mango available in the exporting country of mango to Bangladesh? If yes, what are those insect pests? Please mention the name of insect pests?

1.5 What are the quarantine insect pests of mango that might already be entered into Bangladesh through importation of mango seeds from other countries or through cross boundary from neighboring countries that were not seen earlier?

1.6 Is there any record, the consignment of mango imported from foreign country that was intercepted and returned from Bangladesh, due to occurrence of any insect pests in the consignment? If yes, which country and what are those insect pests? Please mention the name.

1.7 What are the possible ways of entry of newly introduced insect pests of mango that were not seen earlier in Bangladesh?

1.8 What are the effective options to control the quarantine insect pests of mango that are found in Bangladesh?

1.9 What are the effective ways to prevent the entry of quarantine insect pests of mango into Bangladesh from the countries of mango export?

1.10 What steps are being taken by the PQW of DAE to prevent the entry of quarantine insect pests of mango through imported mango?

1.11 Give your suggestions for the better management of the insect pests of mango in Bangladesh.

2.0 INFORMATION ABOUT DISEASES OF MANGO

2.1 What are the diseases of mango, which incidences are being seen in recent years, but not seen earlier in Bangladesh?

2.2 Is there any information about the diseases of mango available in the exporting country of mango to Bangladesh? If yes, what are those diseases? Please mention the name of diseases?

2.3 What are the quarantine diseases of mango that might already be entered into Bangladesh through importation of mango from other countries or through cross boundary from neighboring countries that were not seen earlier?

2.4 Is there any record, the consignment of mango imported from foreign country that was intercepted and returned by Bangladesh, due to occurrence of any diseases in the consignment? If yes, from which country and what are the diseases? Please mention the name.

2.5 What are the possible ways of entry of newly introduced diseases of mango that were not seen earlier in Bangladesh?

2.6 What are the effective options to control the quarantine diseases that are found in the mango in Bangladesh?

2.7 What are the effective ways to prevent the entry of quarantine diseases of mango into Bangladesh from the countries of mango export?

2.8 What steps are being taken by the PQW of DAE to prevent the entry of quarantine diseases of mango through imported mango?

2.9 Give your suggestions for the better management of the diseases of mango in Bangladesh.

3.0 INFORMATION ABOUT WEEDS OF MANGO

3.1 What are the weeds of mango, which incidences are being seen in recent years, but not seen earlier in Bangladesh?

3.2 Is there any presence of Parthenium weed in Bangladesh? If yes, how does there severity of damage?

3.3 Is there any information about the weeds of mango available in the exporting country of mango to Bangladesh? If yes, what are those weeds? Please mention the name of weeds?

3.4 What are the quarantine weeds of mango that might already be entered into Bangladesh through importation of mango from other countries or through cross boundary from neighboring countries that were not seen earlier?

3.5 Is there any record, the consignment of mango imported from foreign country that was intercepted and returned from Bangladesh, due to occurrence of any weeds/weed seeds in the consignment? If yes, which country and what are the weeds? Please mention the name.

3.6 What are the possible ways of entry of quarantine weeds of mango that were not seen earlier in Bangladesh?

3.7 What are the effective ways to prevent the entry of quarantine weeds of mango into Bangladesh from the countries of mango export?

3.8 What steps are being taken by the PQW of DAE to prevent the entry of quarantine weeds of mango through imported mango?

3.9 Give your suggestions for the better management of the weeds of mango in Bangladesh.

THANKS FOR PATIENCE CO-OPERATION

Appendix-4: Tables of Survey Findings for PRA of Mango in Bangladesh

Table -1: Education of the respondents

Sl. No.	Education level	Number of respondents [N=6900]	% response
1	Illiterate	660	9.40
2	Upto primary	1470	21.0
3	Up to Class Eight	1750	25.30
4	SSC	1000	14.30
5	HSC	1310	18.70
6	Bachelor degree	400	6.60
7	Masters or higher degree	300	4.60
8	Phd, MPhil	10	0.10
Total		**6900**	**100.0**

Table-2: Ages of the respondents

Sl. No.	Age range	Number of respondents [N=6900]	% response
1	> 20 years	150	2.10
2	21-30 years	750	10.70
3	31-40 years	2130	30.40
4	41-50 years	2530	37.60
5	51-60 years	1120	16.00
6	> 60 years	220	3.10
Total		**6900**	**100.0**

Table-3: Categories of the farmers participated in the survey

Sl. No.	Age range	Number of respondents [N=6900]	% response
1	Large farmers	1977	28.2
2	Middle farmer	1326	18.9
3	Small farmers	1693	24.2
4		1904	28.6
Total		**6900**	**100.0**

Table-4: Land uses pattern for Mango cultivation

a. Average land uses under crop cultivation: ---232.16 decimal
b. Percent land uses under Mango cultivation-----58.79 %
c. Average years of Mango cultivation by the farmers------10.01 years

Table-5: Cultivation pattern of Mango varieties by the farmers

Mango varieties cultivated by the farmers	Land under Mango cultivation in current year (decimal)	Production (Bag/acre)
BARI Aam-1 (Mohanonda)	10.01	115.2
BARI Aam-2 (Nilum)	70.47	5.10
BARI Aam-3 (Amrupali)	71.49	4.82
BARI Aam-4 (Hybrid)	115.89	5.50
Fazli	187.88	2.57
Langra	67.33	2.67
Khrishapat	187.88	2.57
Gopalbhogh	115.89	5.50
Lakhonbhogh	187.88	2.57
Himsagor	10.01	115.2
Mohanghogh	70.47	5.10
Ahaina	71.49	4.82
Kalapahari	115.89	5.50
Chosha	187.88	2.57
Bombay	67.33	2.67

Mango varieties cultivated by the farmers	Land under Mango cultivation in current year (decimal)	Production (Bag/acre)
Harivagha	187.88	2.57
Goti am	115.89	5.50
Mishiribhogh	70.47	5.10
Surjapori	10.01	115.2
Lal shindur	67.33	2.67
***1 bag= 85 kg**		

Table-6: Susceptibility of mango varieties to different categories of mango pests in Bangladesh

Sl. No.	Mango varieties	Status of susceptibility to different pests					
		Susceptibility to insect		Susceptibility to disease		Susceptibility to parasitic weed	
		Insect susceptible variety	Insect tolerant variety	Disease suscepti ble variety	Disease tolerant variety	Weed suscepti ble variety	Weed tolerant variety
1.	BARI Aam-1 (Mohanonda)	0.0	0.5	0.0	1.6	1.1	2.0
2.	BARI Aam-2 (Nilum)	0.0	0.3	0.0	0.6	0.0	1.5
3.	BARI Aam-3 (Amrupali)	21.4	53.4	21.6	51.6	15.3	43.6
4.	BARI Aam-4 (Hybrid)	0.0	0.0	0.5	0.0	0.0	1.0
5.	Fazli Aam	8.6	4.0	11.1	2.7	15.3	2.0
6.	Langra	45.0	3.4	32.5	6.2	43.5	4.0
7.	Khirshapat	1.2	2.1	5.3	2.1	0.0	0.0
8.	Gopalbhogh	0.6	1.0	1.2	2.5	2.8	3.0
9.	Lakhonbhogh	0.0	0.7	1.4	0.8	0.0	2.0
10.	Himsagor	10.9	15.5	20.9	15.4	4.5	34.2
11.	Mohanghogh	0.0	0.2	0.0	0.0	0.0	0.0
12.	Ashina	2.3	9.1	0.7	7.2	8.5	0.0
13.	Kalapahari	0.0	0.0	0.0	0.0	0.0	0.0
14.	Chosha	0.0	0.2	0.2	0.2	0.0	0.5
15.	Bombay	0.7	0.2	1.2	1.0	4.0	0.0
16.	Harivagha	1.0	0.7	0.2	0.0	0.0	0.0
17.	Goti aam	2.7	0.2	0.0	0.0	0.0	0.0
18.	Mishribhogh	0.1	0.2	0.2	0.0	0.0	0.0
19.	Surjapori	0.1	2.4	0.2	1.0	0.0	2.0
20.	Lal Shindur	0.5	0.2	0.2	0.2	0.0	0.5
21.	Others	2.0	5.9	2.6	7.4	5.1	4.0
Multiple response							

Table-7: Sources of purchasing mango seedlings usually used for cultivation

Sources of purchasing s mango seedling	Number of respondents [N=6900]	Response (%)
1. Farmers' own grafted seedling	1640	15.2%
2. Neighbors	1610	14.9%
3. BADC Nursery	510	4.7%
4. Local nursery	6380	59.1%
5. Seedlings importer from neighboring countries	0	0.0
6. Research Organization	360	3.3%
7. NGOs	140	1.3%
8. Others	150	1.4%
Multiple response		

Table-8: Occurrence and status of the insect and vertebrate pests of mango in storage

Sl. No.	Name of pests	Pest status			
		Major pest		Minor pest	
		Number	% response	Number	% response

1	Bird	570	8.3	6330	86.2
2	Porcupine	940	14.5	5960	85.5
3	Bat	1110	16.6	5790	83.4
4	Others	50	6.3	6850	93.8
Multiple response					

Table-9: Infestation severity of mango crops by the insect pests in field condition

Sl. No.	Name of Insects pest	Pest incidence		Pest status		Severity of infestation		
		Yes	No	Major	Minor	High	Medium	Low
1	Mango Hopper	99.6	0.4	74.6	25.4	62.3	33.7	4.1
2	Mango fruit fly					44.6	51.9	3.5
3	pulp weevil	78.8	21.2	32.0	68.0	27.2	39.4	33.4
4	Stone weevil	66.0	34.0	7.9	92.1	4.1	24.0	71.9
5	Stem borer	74.7	25.3	15.8	84.2	15.0	30.0	55.0
6	Mango defoliator	74.6	25.4	14.7	85.3	11.9	38.5	49.6
7	Mango fruit borer	87.4	12.6	19.7	80.3	6.9	44.5	48.6
8	Leaf cutting weevil	84.7	15.3	8.0	92.0	2.8	54.2	43.0
9	Mango shoot gall	44.3	55.7	4.8	95.2	4.1	10.6	85.3
10	Mango leaf gall	74.6	25.4	11.1	88.9	9.4	29.2	61.4
11	Mango mealy bug	41.6	58.4	2.4	97.6	2.9	8.7	88.4
12	Leaf/flower weaver	49.6	50.4	8.5	91.5	5.7	15.8	78.5
13	Leaf miner	30.6	69.4	2.5	97.5	1.4	4.9	93.7
14	Leaf caterpillar	23.0	77.0	3.0	97.0	3.0	1.5	95.5
15	Scale insect	40.4	59.6	6.0	94.0	2.0	4.7	93.3
16	Shoot borer	34.5	65.5	5.4	94.6	1.4	5.8	92.8
17	Pink gypsy moth	23.7	76.3	2.3	97.7	1.2	2.6	96.2
18	Eriophyid mite	35.0	65.0	2.3	97.7	0.3	5.0	94.8
Multiple response								

Table-10: Vulnerable stages and parts of mango plants to insect pests in field condition

Name of Insects pest	Vulnerable stage of mango plants					Vulnerable parts of Mango plants					
	Seedling	Vegetative	Inflorescence	Fruit	Matured fruits	Leaf	Stem	Inflorescence	Immature fruit	Matured fruit	Stone
Mango Hopper	-	36.9	58.1	3.7	-	0.2	4.2	59.7	35.8	-	-
Mango fruit fly	0.1	0.1	2.2	74.6	23.0	-	-	2.5	50.0	47.5	
Pulp weevil	-	5.3	-	63.1	31.6	-	-	-	11.1	88.9	-
Stone weevil	-	-	-	74.1	25.1	-	-	-	2.3	4.3	85.0
Stem borer	5.1	94.9	-	-	-	-	100	-	-	-	-
Mango defoliator	7.3	92.7	-	-	-	94.8	5.2	-	-	-	-
Mango fruit borer	-	-	-	78.7	21.3	-	-	-	32.9	67.1	-
Leaf cutting weevil	17.3	82.7	-	-	-	96.2	3.8	-	-	-	-
Mango shoot gall	15.6	84.4	-	-	-	24.1	73.9	2.0	-	-	-
Mango leaf gall	14.6	85.4	-	-	-	87.2	12.8	-	-	-	-
Mango mealy bug	6.7	67.5	10.1	13.9	1.7	24.2	53.1	19.2	2.9	0.6	-
Leaf webber	10.3	87.5	2.2	-	-	90.2	7.1	2.7	-	-	-
Leaf miner	16.1	83.9	-	-	-	90.3	-	-	-	-	-
Leaf caterpillar	11.0	89.0	-	-	-	86.3	13.3	-	0.3	-	-
Scale insect	11.0	86.4	-	0.6	2.0	29.3	59.1	1.7	5.0	5.0	-
Shoot borer	58.3	41.7	-	-	-	25.4	73.4	-	-	-	-
Pink gypsy moth	23.9	76.1	-	-	-	76.5	23.5	-	-	-	-
Eriophyid mite	15.9	84.1	-	-	-	90.6	5.3	-	4.1	-	-
Multiple response											

Table-11: Incidence of mango mealy bug / giant mealy bug in mango tree

Type of response	Number of respondents [N=6900]	% response
Yes	2040	29.1
No	4860	70.9
Total	**6900**	**100.0**

Table-11: Duration of incidence of mango mealy bug in Bangladesh

Duration of incidence	# of respondent	% of response
2014-15	690	33.8
2010-15	1070	52.5
2005-15	270	13.2
2000-15	10	.5
Before 2000	0	0.0
Don't know	0	0.0
Total	**2040**	**100.0**

Table-12: Vulnerable stages of mango plants to mango mealy bug

Vulnerable stages	No. of respondents [N=2040]	% response
Seedling	240	12.0
Vegetative stage	180	9.1
Inflorescence	600	29.8
Immature fruits	1020	49.0
Matured fruits	0	0
Multiple response		

Table-13: Vulnerable parts of mango plants to mango mealy bug

Vulnerable parts	No. of respondents [N=]	% response
Leaf	170	8.3
Stem	190	9.3
Inflorescence	80	3.9
Fruit at marble size	1140	55.9
Fruit stalk	340	16.7
Matured fruits	0	0
All parts	120	5.9
Multiple response		

Table-14: Infestation severity mango plants to mango mealy bug

Level of infestation severity	No. of respondents [N=]	% response
Low	0	0
Medium	2040	100.0
High	0	
Total	**2040**	**100.0**

Table-15: New insect pests of mango currently seen in the field/storage of mango, those were not seen earlier

Type of response	Number of respondents [N=6900]	% response
Yes	988	14.1
No	5912	85.9
Total	**6900**	**100.0**

Table-16: Newly seen insect pests of Mango, those were not seen earlier

Sl. No.	Name of Insects pest	Frequency of response	% response
1	Mango fruit fly	60	4.6
2	Pulp weevil	20	1.5
3	Stem borer	10	0.8
4	Leaf cutting weevil	60	4.6
5	Mango leaf gall	120	9.2
6	Mango mealy bug	310	23.7
7	Leaf/flower weaver	20	1.5
8	Scale insect	110	8.4
9	Shoot borer	20	1.5
Multiple response			

Table-17: Currently more damaging insect pests of mango in field/storage than previous infestation

Sl. No.	Name of Insects pest	Frequency of response	% response
1	Mango hopper	4790	69.42
2	Mango fruit fly	4010	58.12
3	pulp weevil	1450	21.01
4	Stone weevil	150	2.17
5	Stem borer	680	9.86
6	Mango defoliator	420	6.09
7	Mango fruit borer	90	1.30
8	Leaf cutting weevil	90	1.30
9	Mango shoot gall	10	0.14
10	Leaf/flower weaver	80	1.16
11	Scale insect	30	0.43
Multiple response			

Table-18: Idea about insect pests of mango entered into Bangladesh from neighboring countries, those were not seen earlier

Type of response	Number of respondents [N=6900]	% response
Yes	250	3.6
No	6650	96.4
Total	**6900**	**100.0**

Table-19: Newly entered insect pests of mango from neighboring countries, those were not seen earlier

Sl. No.	Name of insects pest	Frequency of response	% response
1	Mango fruit fly	80	13.8
2	Pulp weevil	50	8.6
3	Stone weevil	50	8.6
4	Stem borer	40	6.9
5	Leaf cutting weevil	40	6.9
6	Mango leaf gall	40	6.9
7	Mango mealy bug	10	1.7
8	Scale insect	70	12.1
Multiple response			

Table-20: Options for controlling insect pests of mango

Code No.	Control options	Number of respondents [N=6900]	% response
1	Spraying of insecticides on the mango tree	6680	35.7
2	Fumigation under mango tree	200	1.1
3	Used of Pheromone Trap	1190	6.4
4	Unnecessary branch are remove after complete the season	3820	20.4
5	Application of granular insecticide at the base of the tree	630	3.4
6	Remove weed from the base of the tree	1180	6.3
7	Application of insecticide with irrigation	980	5.2
8	Use of tolerant variety	940	5.0
9	Leave of bird	920	4.9
10	IPM	240	1.3
11	Balance fertilizer	1890	10.1
Multiple response			

Table-21: Occurrence and infestation status of the diseases of mango in field condition

Sl. No.	Diseases	Occurrence of disease		Pest status	
		Yes	No	Major disease	Minor disease
1	Leaf anthracnose	83.3	16.7	60.9	39.1
2	Fruit anthracnose	98.3	1.7	68.1	31.9
3	Powdery mildew	60.3	39.7	15.1	84.9
4	Stem/flower malformation	77.3	22.7	11.8	88.2
5	Stem/fruit end rot	65.1	34.9	11.3	88.7
6	Flower sooty mold	34.9	65.1	32.6	67.4
7	Die back	44.0	56.0	12.9	87.1
8	Red rust	46.7	53.3	8.1	91.9
9	White rust	29.1	70.9	8.2	91.8
10	Leaf scab disease	20.6	79.4	2.3	97.7
11	Alternaria leaf spot	18.6	81.4	1.4	98.6
12	Bacterial leaf blight (*Pseudomonas syringae)*	24.9	75.1	1.9	98.1
13	Scab of mango	26.1	73.9	5.6	94.4
14	Grey leaf spot	18.7	81.3	1.5	98.5
Multiple response					

Table-22: Vulnerable stages and parts of Mango plants to diseases in field condition

Name of Insects pest	Vulnerable stage of mango plants					Vulnerable parts of Mango plants					
	Seedling	Vegetative	Inflorescence	Fruit	Matured fruits	Leaf	Stem	Inflorescence	Immature fruit	Matured fruit	Stone
Leaf anthracnose	16.5	83.5	-	-	-	98.2	1.8	-	-	-	-
Fruit anthracnose	0.6	2.2	0.3	51.6	45.3	0.6	0.3	0.9	26.4	71.3	-
Powdery mildew	6.7	17.5	75.9			7.5	2.2	90.3	-	-	-
Stem/flower malformation	4.5	57.2	38.3	-	-	4.0	48.8	47.1	-	-	-
Stem/fruit end rot	0.2	15.5	5.9	17.2	61.1	-	25.3	-	-	74.7	-
Flower sooty mould	5.0	26.6	68.4	-	-	-	-	88.6	11.4	-	-
Die back	18.9	81.1	-	-	-	14.2	85.8	-	-	-	-
Red rust	8.8	89.1	0.2	-	-	100.0	-	-	-	-	-
White rust	7.5	92.5	-	-	-	3.6	96.4	-	-	-	-
Leaf scab disease	2.6	97.4	-	-	-	97.3	2.7	-	-	-	-
Leaf alternaria disease	7.5	92.2	-	-	-	96.4	3.6	-	-	-	-
Bacterial blight disease	7.9	92.1	-	-	-	92.6	7.4	-	-	-	-
Scab of mango	-	8.8	-	83.0	8.2	-	-	-	79.6	20.4	-
Grey leaf spot	1.4	98.6	-	-	-	90.3	9.7	-	-	-	-
Multiple response											

Table-23: Severity of mango plants to disease infection in field condition

Sl. No.	Name of diseases	Level of disease severity		
		High	Medium	Low
1	Leaf anthracnose	43.8	40.3	16.0
2	Fruit anthracnose	46.6	51.8	1.6
3	Powdery mildew	7.7	34.0	58.3
4	Stem/flower malformation	14.9	29.4	55.7
5	Stem/fruit end rot	17.0	40.3	42.6
6	Flower sooty mold	2.8	14.4	82.8
7	Die back	7.6	21.9	70.6
8	Red rust	6.6	31.5	61.9
9	White rust	5.4	30.2	64.4
10	Leaf scab disease	0.7	9.8	89.5
11	Alternaria leaf spot	1.0	4.1	94.8
12	Bacterial leaf blight (*Pseudomonas syringae)*	0.9	5.4	93.7
13	Scab of mango	1.7	12.2	86.1
14	Grey leaf spot	0.4	4.3	95.3
Multiple response				

Table-24: New diseases of mango currently seen in the field of mango, those were not seen earlier

Type of response	Number of respondents [N=6900]	% response
Yes	260	3.7
No	6640	96.3
Total	**6900**	**100.0**

Table-25: Newly seen diseases of mango, those were not seen earlier

Newly seen diseases	Number of respondents [N=260]	% response
Leaf anthracnose	90	15.5
Fruit anthracnose	120	20.7
Powdery mildew	30	5.2
Stem/flower malformation	260	44.8
Die back	50	8.6
Red rust	10	1.7
Leaf scab disease	10	1.7
Bacterial leaf blight (*Pseudomonas syringae)*	10	1.7
Multiple response		

Table-26: Currently more damaging diseases of mango in field/storage than previous infection

More damaging diseases	Number of respondents [N=6900]	% response
Leaf anthracnose	2080	23.3
Fruit anthracnose	3950	44.3
Powdery mildew	500	5.6
Stem/flower malformation	1440	16.2
Stem/fruit end rot	210	2.4
Flower sooty mold	10	0.1
Die back	660	7.4
Red rust	40	0.4
White rust	1440	16.2
Leaf scab disease	210	2.4
Alternaria leaf spot	10	0.1
Bacterial leaf blight	660	7.4
Scab of mango	40	0.4
Grey leaf spot	0	0
Multiple response		

Table-27: Idea about diseases of mango entered into Bangladesh from neighboring countries, those were not seen earlier

Type of response	Number of respondents [N=6900]	% response
Yes	110	1.6
No	6790	98.4
Total	**6900**	**100.0**

Table-28: Newly entered diseases of mango from neighboring countries, those were not seen earlier

Newly entered diseases	Number of respondents [N=110]	% response
Leaf anthracnose	30	23.1
Fruit anthracnose	10	7.7
Powdery mildew	80	61.5
Stem/fruit end rot	10	7.7
Multiple response		

Table-29: Options for controlling diseases of mango

Code No.	Control options	Number of respondents [N=6900]	% response
1	Spraying of fungicides on the mango tree	6880	47.4
2	Fumigation under mango tree	100	0.7
3	Pruning of the disease infested branch	2680	18.4
4	Unnecessary branch are remove after complete the season	710	4.9
5	Application of pesticide at the base of the tree	110	0.8
6	Remove weed from the base of the tree	1380	9.5
7	Use of tolerant variety	290	2.0
8	Application of organic fertilizer	910	6.3
9	IPM	80	0.6
10	Unnecessary branch are remove after complete the season	1390	9.6
Multiple response			

Table-30: Occurrence and infestation status of the weeds in the mango field

Sl. No.	Name of weeds	Pest status [N=6900]	
		Major weed	Minor weed
1	Loranthus	46.6	53.4
2	Orchid	25.4	74.6
3	Parthenium	8.4	91.6
Multiple response			

Table-31: Vulnerable stages mango plants and infestation severity of weeds in the field of mango

Sl. No.	Name of weeds	Vulnerable stage of mango plants				Level of infestation severity		
		Seedling	Vegetative	Inflorescence	Fruit	High	Medium	Low
1	Loranthus	3.5	53.8	0.2	42.5	2.3	27.9	69.7
2	Orchid	0.0	30.4	67.0	2.5	0.0	8.1	91.9
3	Parthenium	15.6	6.0	0.7	0.1	0.0	2.3	97.7
Multiple response								

Table-32: New weeds of mango currently seen in the field of mango, those were not seen earlier

Types of response	Number of respondents [N=6900]	% response
Yes	200	2.9
No	6700	97.1
Total	**6900**	**100.0**

Table-33: Newly seen weeds of mango, those were not seen earlier

Newly seen weeds	Number of respondents [N=200]	% response
Loranthus	50	15.2
Orchid	17	5.2
Parthenium	130	65.0
Multiple response		

Table-34: Currently more damaging weeds of mango in field than previous infestation

More damaging weeds	Number of respondents [N=6900]	% response
Loranthus	1420	77.2
Orchid	70	3.8
Parthenium	80	4.3
Multiple response		

Table-35: Idea about weeds of Mango entered into Bangladesh from neighboring countries, those were not seen earlier

Types of response	Number of respondents [N=6900]	% response
Yes	220	3.1
No	6680	96.9
Total	**6900**	**100.0**

Table-36: Newly entered weeds of mango from neighboring countries, those were not seen earlier

Newly entered weeds	Number of respondents [N=220]	% response
Loranthus	0	0.0
Orchid	0	0.0
Parthenium	220	100.0
Multiple response		

Table-37: Options for controlling weeds of mango

Code No.	Control options	Number of respondents [N=6900]	% response
1	Remove of weed from mango garden	5690	49.9
2	Clean the parasitic weed	3680	32.3
3	Remove the weed during fertilizer/ irrigation application	80	0.7
4	Clean parasitic weed from the tree	1470	12.9
5	Earthen up at the base of the tree	330	2.9
6	irrigation	90	0.8
7	others	60	0.5
Multiple response			