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

Pest Risk Analysis (PRA) of Coconut in Bangladesh




May 2017

Government of the People's Republic of Bangladesh
Ministry of Agriculture

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

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FORWARD

The Strengthening Phytosanitary Capacity in Bangladesh (SPCB) Project under Plant Quarantine Wing (PQW), Department of Agricultural Extension (DAE), Ministry of Agriculture conducted the study for the "**Pest Risk Analysis (PRA) of Coconut in Bangladesh"** according to the provision of contract agreement signed between SPCB-DAE and Development Technical Consultants Pvt. Ltd. (DTCL) on December 2016. The PRA study is a five month assignment commencing from 1 January 2017 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 coconut and evaluate their risk, to identify endangered areas, and to identify risk management options. To carry out the PRA study, the consulting firm conducted field investigations in 70 upazila under 30 major coconut growing districts of Bangladesh. The study covered the interview 7000 coconut farmers. The key informant interviews were conducted with the extension personnel at field and head quarter level of DAE, officials of Plant Quarantine Centers at Sea and Land ports; Entomologist and Plant Pathologist of BARI/BADC and Agricultural Universities. A total of 45 key personnel were interviewed using a semi-structured KII Checklist. The survey was also covered 30 FGDs each of which conducted in one district for qualitative data and visits of the coconut orchards under sampled districts. The consultants also reviewed secondary sources of information related to PRA of coconut.

The study findings evidenced that a total of 29 pests of coconut were recorded in Bangladesh, of which 13 were arthropod pests (both insect and mite pests), 11 species of disease causing pathogenic microorganisms and 5 weeds. The study also revealed that 23 pests of coconut were identified as quarantine importance for Bangladesh that included 11 insect and 1 mite pests, 10 disease causing pathogen including 3 fungi, 3 bacteria, 2 nematode species, 2 viruses and one weed that could be introduced into Bangladesh through importation of commercially produced coconut. 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, out of twenty three (23) potential hazard organisms, 13 hazard organisms were identified with high risk potential, 1 identified with moderate risk potential and 2 with low risk rating and other 7 species of pests were identified as uncertain species were likely to be associated with host plants during importation from exporting countries, but remained as uncertain hazards due to lack of detail information.. These mean that these pests pose unacceptable phytosanitary risk to Bangladesh's agriculture.

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

I would like to congratulate study team 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 Coconut 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 coconut.

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PREFACE

This report intends to respond to the national requirement to make a comprehensive list of pests like insect and mite pests, diseases and weed pests of coconut in Bangladesh as well as to identify the quarantine pests of coconut for Bangladesh, their pathways to be imported from exporting countries coconut, to assess their risks and to identify their management options according to the provision of contract agreement signed between Project Director of Strengthening Phytosanitary Capacity in Bangladesh (SPCB) and the Development Technical Consultants Pvt. Ltd. (DTCL) for **"Conducting Pest Risk Analysis (PRA) of Coconut in Bangladesh"** under Plant Quarantine Wing (PQW), Department of Agricultural Extension (DAE), Ministry of Agriculture (MOA), Government of the Peoples Republic of Bangladesh. The PRA study is a five month assignment commencing from 1 January 2017 under the SPCB-DAE.

Consultancy services for "Conducting Pest Risk Analysis (PRA) of Coconut in Bangladesh" were 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 objectives of the study are to listing of major and minor pests of Coconut, 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.

This report includes study design, sampling framework and data collection instruments, guidelines and checklists, details of survey and data collection method, data management and analysis and survey finding as well as the stages of PRA, risk assessment strategies of the pests likely to be associated with the coconut and it's seedlings 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. This report had been presented in the national level workshop for further comments and suggestions. The consultants finally revised and prepared this report of the PRA study based on comments and suggestions of the client and experts.

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It is indeed a great honor for us that Strengthening Phytosanitary Capacity in Bangladesh (SPCB) Project under Plant Quarantine Wing (PQW) of Department of Agricultural Extension (DAE) has entrusted Development Technical Consultants Pvt. Ltd. (DTCL) to carry out the "**Pest Risk Analysis (PRA) of Coconut in Bangladesh"**. The report has been prepared based on the past five months (January 2017 to May 2017) activities of the survey study in major 30 coconut 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 analysis and report writing, we have enjoyed the support of SPCB-PQW. The principal author is Dr. Md. Razzab Ali, Team Leader with inputs from Dr. M. M. Amir Hossain, (Entomologist), Dr. M. Salahuddin M. Chowdhury (Plant Pathologist), Md. Lutfor Rahman (Agronomist), and Dr. Bazlul Ameen Ahmad Mustafi (Economist) of the PRA study team.

The authors are grateful to all persons involved in the PRA study. Our special gratitude to Md. Golam Maruf, 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 Dr. Mohammad Ali, Project Director, Strengthening Phytosanitary Capacity in Bangladesh (SPCB) Project; Mr. Md. Ahsan Ullah, Consultant (PRA); Mrs. Marina Jebunehar, Senior Monitoring and Evaluation Officer, 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 are also given to Mohammad Mohsin, Director, PQW of DAE for his kind cooperation and suggestions during the study period. The active support and inspiration and cooperation of Dr. M. M. Amir Hossain, Managing Director, Development Technical Consultants Pvt. Ltd. (DTCL) are praise-worthy during the entire period of study.

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

ACRONYMS

AEO	: Agricultural Extension Officer
BADC	: Bangladesh Agricultural Development Corporation
BARI	: Bangladesh Agricultural Research Institute
BBS	: Bangladesh Bureau of Statistics
BRRI	: Bangladesh Rice Research Institute
CABI	: Centre for Agriculture Bio-resources International
DAE	: Department of Agricultural Extension
DD	: Deputy Director
DPP	: Development Project Proforma
DTCL	: Development Technical Consultants Ltd.
EPPO	: European and Mediterranean Plant Protection Organization
FAO	: Food and Agricultural Organization
FGD	: Focus Group Discussion
FPC	: Finite Population Correction
HQ	: Headquarter
IPM	: Integrated Pest Management
IPPC	: International Plant Protection Convention
ISPM	: International Standard for Phytosanitary Measures
KII	: Key Informant Interview
LMOs	: Living Modified Organisms
Ltd.	: Limited
OEPP	: Organization for European and Mediterranean Plant Protection
PFA	: Pest Free Area
PFPP	: Pest Free Place of Production
PPW	: Plant Protection Wing
PQ	: Plant Quarantine
PQW	: Plant Quarantine Wing
PRA	: Pest Risk Analysis
QC	: Quarantine Centers
RMG	: Readymade Garments
RNQPs	: Regulated Non-Quarantine Pests
SPCB	: Strengthening Phytosanitary Capacity in Bangladesh Project
ToR	: Terms of References
USD	: United States Dollar
WTO	: World Trade Organization

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EXECUTIVE SUMMARY

The study "Pest Risk Analysis (PRA) of Coconut in Bangladesh" documents the pests of coconutplants available in Bangladeshand the risks associated with the import pathway of coconut from the exporting countries namely Sri Lanka, Vietnam, India, Philippines, Thailand, Malaysia, Myanmar into Bangladesh.

The findings evidenced that the 29 pests of coconut were recorded in Bangladesh, of which 13arthropod peststhat included 12 insect pests and 1 mite pest; 11disease causingpathogens and 5weeds. The incidences of insect pests of coconut recorded in Bangladesh were coconut scale (*Aspidiotus destructor),* green shield scale (*Pulvinaria psidii),* lantana scale (*Hemiberlesia lataniae),* oriental yellow scale (*Aonidiella orientalis),* pineapple mealybugs (*Dysmicoccus brevipes),* guava mealybug (*Ferissia virgata*), black headed caterpillar (*Opisina arenosella),* coconut rhinoceros beetle (*Oryctes rhinoceros),* red palm weevil (*Rhynchophorus ferrugineus),*bark beetle (*Dendroctonus* spp.), white grub/ dung beetle (*Phyllophaga* spp.) and coconut termite (*Odontotermes obesus*). The eriophyid coconut mite (*Aceria guerreronis)* was also recorded as a major pest of coconut.Among these insect and mite pests of coconut, coconut rhinoceros beetle and Eriophyid coconut mite were more damaging than other arthropod pests. The coconut rhinoceros beetle, coconut scale, eriophyid coconut mite and black headed caterpillar were designated as major pest of coconut and caused damage with high infestation intensity.

A total number of 12 species of disease causing pathogens of coconut were reported in Bangladesh, among which 10 diseases were caused by fungi, 1 caused by bacteria and 1 caused by algae. The incidences of fungal diseases of coconut reported in Bangladesh were coconut bud rot (*Phytophthora palmivora*), anthracnose (*Glomerella cingulated),* bitten leaf of coconut (*Ceratocystis paradoxa),* bipolaris leaf spot (*Bipolaris incurvata*),diplodia rot (*Lasiodiplodia theobromae),* stem bleeding disease (*Thielaviopsis paradoxa),* heart rot (*Phytophthora katsurae*), grey leaf spot of coconut (*Pestalotiopsis palmarum*), Cercospora leaf spot (*Cercospora palmivora*) and Curvularia leaf spot (*Cervularia* sp.). The bacterial disease was bacterial bud rot (*Erwinia* spp.). The nemic disease of coconut was algal disease was algal leaf spot (*Cephaleuros virescens*). Among these diseases, the diplodia rot and stem bleeding disease were more damaging than others. But diseases were reported as minor diseases of coconut and caused damage with low infection intensity in Bangladesh.

A total number of 5 weeds were reported as the problem in the field of coconut in Bangladesh and these were parthenium weed (*Parthenium hysterophorus* L.), iron weed (*Cyanthillium cinereum),* mission grass (*Pennisetum polystachion),* snake roots (*Rauvolfia serpentine)* and siam weed *(Chromolaena odorata)*. The parthenium weed (*Parthenium hysterophorus*)was recorded and found only in some restricted areas of Bangladesh namely Rajshahi, Natore, Pabna, Kustia, Jessore districts. These districts are nearly attached with the Western border of Bangladesh and Eastern border of West Bengall of India. It was also reported that the parthenium weed might be entered into Bangladesh through cross boundary pathway from India by the transportation system of border trading. Among the five weeds, the Parthenium grows in the whole season. 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. Other four weeds were reported as minor weeds with low infestation intensity in the field coconut.

Information on pests associated with coconut in the exporting countries—Sri Lanka, Vietnam, India, Philippines, Thailand, Malaysia, Myanmar —revealthat pests of quarantine importance exist. The study also revealed Twenty three (23) species of quarantine pests of coconut for Bangladesh were identified those were present in Sri Lanka, Vietnam, India, Philippines, Thailand, Malaysia, Myanmar, but not in Bangladesh. Among these 23 species of quarantine pests, 11 species were insect pests, 1 species was mite pest, 3 disease causing fungi, 3 bacteria, 2 nematode species, 2 viruses and 1 species of weed. Without mitigation, these pests could be introduced into Bangladesh through importation of commercially produced coconut. The quarantine insect pests are coconut bug (*Pseudotheraptus wayi),* lesser snow scale (*Pinnaspis strachani),* red scale (*Chrysomphalus dictyospermi),* spiked mealybug (*Nipaecoccus*

nipae), long-tailed mealybug (*Pseudococcus longispinus),* black tea thrips (*Heliothrips haemorrhoidalis),* coconut leaf roller (*Omiodes blackburni),* coconut hispine beetle, (*Brontispa longissima),* nettle caterpillar (*Darna trima (*Moore*)),* saddle back caterpillar (*Acharia stimulea*) and bag worm (*Scoriodyta* spp.). The quarantine mite pest of coconut for Bangladesh is red palm mite (*Raoiella indica*).

On the other hand, ten (10) disease causing pathogens have been identified as quarantine pests of coconut for Bangladesh. Among these, three quarantine fungus named thanjavur wilt (*Ganoderma lucidum*), leaf scorch (*Fusarium* sp.) and leaf rot (*Cholletotrichum* sp.)*:* three quarantine bacteria namely tatipaka (*Phytoplasma* spp.), lethal yellowing (Palm lethal yellowing) (*Candidatus Phytoplasma palmae (PLY))* and root wilt (*Mycoplasma like organism*)*;* two species of nematode namely red ring nematode (Coconut palm nematode) (*Bursaphelenchus cocophilus) and* burrowing nematode (*Radopholus similis);* two viruses namely cadang-cadang (*Coconut cadang-cadang viroid (CCCVd)) and* coconut foliar decay (*Coconut foliar decay virus (CFDV)).* One species of quarantine weed has been identified Bangladesh named parthenium weed (*Parthenium hysterophorus*).

The consequences and potential/likelihood of introduction of each quarantine pest were assessed individually, and a risk rating estimated for each. The consequence and potential of introduction value was estimated assessing biology, host, distribution, hazard identification, risk assessment, consequence assessment, risk estimation and risk management of the pests: 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 17 quarantine pests associated with the pathway risk assessed. Out of 17 potential hazard organisms, 14 hazard organisms were identified with high risk potential, 1 moderate and 2 low and 7uncertain species was found which likely to be associated with host plants during importation from exporting countries, but remained as uncertain hazards due to lack of detail information.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 coconut industry and specific phytosanitary measures are strongly recommended. While for moderate risk potential pest, specific phytosanitary measures may be necessary to reduce pest risk.

CHAPTER 1

SCOPE AND METHODOLOGY OF PEST RISK ANALYSIS

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 a 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 and economic evidence. If the risk is deemed unacceptable, the analysis may continue by suggesting management options that can reduce the risk to an acceptable level. Subsequently, pest risk management options may be used to establish phytosanitary regulations. For some organisms, it is known beforehand that they are pests, but for others, the question of whether or not they are pests should initially be resolved.

The pest risks posed by the introduction of organisms associated with a particular pathway, such as a commodity, should also be considered in a PRA. The commodity itself may not pose a pest risk but may harbour organisms that are pests. Lists of such organisms are compiled during the initiation stage. Specific organisms may then be analyzed individually, or in groups where individual species share common biological characteristics.Less commonly, the commodity itself may pose a pest risk. When deliberately introduced and established in intended habitats in new areas, organisms imported as commodities (such as plants for planting, biological control agents and other beneficial organisms, and living modified organisms (LMOs) may pose a risk of accidentally spreading to unintended habitats causing injury to plants or plant products. Such risks may also be analyzed using the PRA process.

The PRA process is applied to pests of cultivated plants and wild flora, in accordance with the scope of the IPPC. It does not cover the analysis of risks beyond the scope of the IPPC. Provisions of other international agreements may address risk assessment (e.g. the Convention on Biological Diversity and the Cartagena Protocol on Biosafety to that convention).

Bangladesh has been importing coconutas well as seeds of coconut from different exporting counties such as Sri Lanka, Vietnam, Phillipines, India, or other counties of the world. Due to imports ofcoconutwith 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. Moreover, Bangladesh is highly suitable for coconut production due to its favorable climatic, topography and other conditions like labour cost and relatively low capital investment in contrast with high value addition. Therefore, the pathway risk analysis of coconut from exporting countries to Bangladesh is essential. In this context, the Pest Risk Analysis (PRA) of Coconut in Bangladesh is indispensable. Thus, the assignment on PRA of Coconutin Bangladesh was undertaken aiming to identify pests and/or pathways of quarantine concernfor the coconutgrown 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 withcoconut imported from different exporting countries such asSri Lanka,Vietnam, India, Phillipines, Thailand, Malaysia, Myanmar (Plant Quarantine Wing of DAE, 2017). Risk in this context is defined as the likelihood of the occurrence and the likely magnitude of the consequences of an adverse event.

1.3. Objective of the PRA study

The overall objective of a Pest Risk Analysis by the SPCB Project is to support National Plant Protection Organization (NPPO) to identify pests and/or pathways of quarantine pests to be associated with the commodity which brings along with them a certain risk of the introduction of diseases and pests that are harmful to agriculture.

According to the Terms and Reference (ToR) of the study, the consulting firm is required to listing of the major and minor pests of coconut in Bangladesh and identify quarantine pests of coconut for Bangladesh that follow the pathway(s) during importation of coconut from exporting countries, as well as to evaluate their risk, and finally to formulate the risk management options etc.

1.4. PRA Areas

The entire Bangladesh is considered as PRA area in this risk analysis because coconut is grown almost all over the country. Moreover, coconut and coconut seedlings is imported through different Sea and Land ports which are located all regions of Bangladesh. However, survey on insect pests, diseases, weeds and other hazard organisms was done in major coconut growing districts of Bangladesh.

1.5. Methodology of Pest Risk Analysis

PRA process includes three major stages such as Initiation, Pest Risk Assessment and Pest Risk Management as adapted from ISPM No. 2 (2007). The following methods were sequentially followed to conduct PRA of coconut.The process and methodology for undertaking import risk analyses are shown in Figure 1.

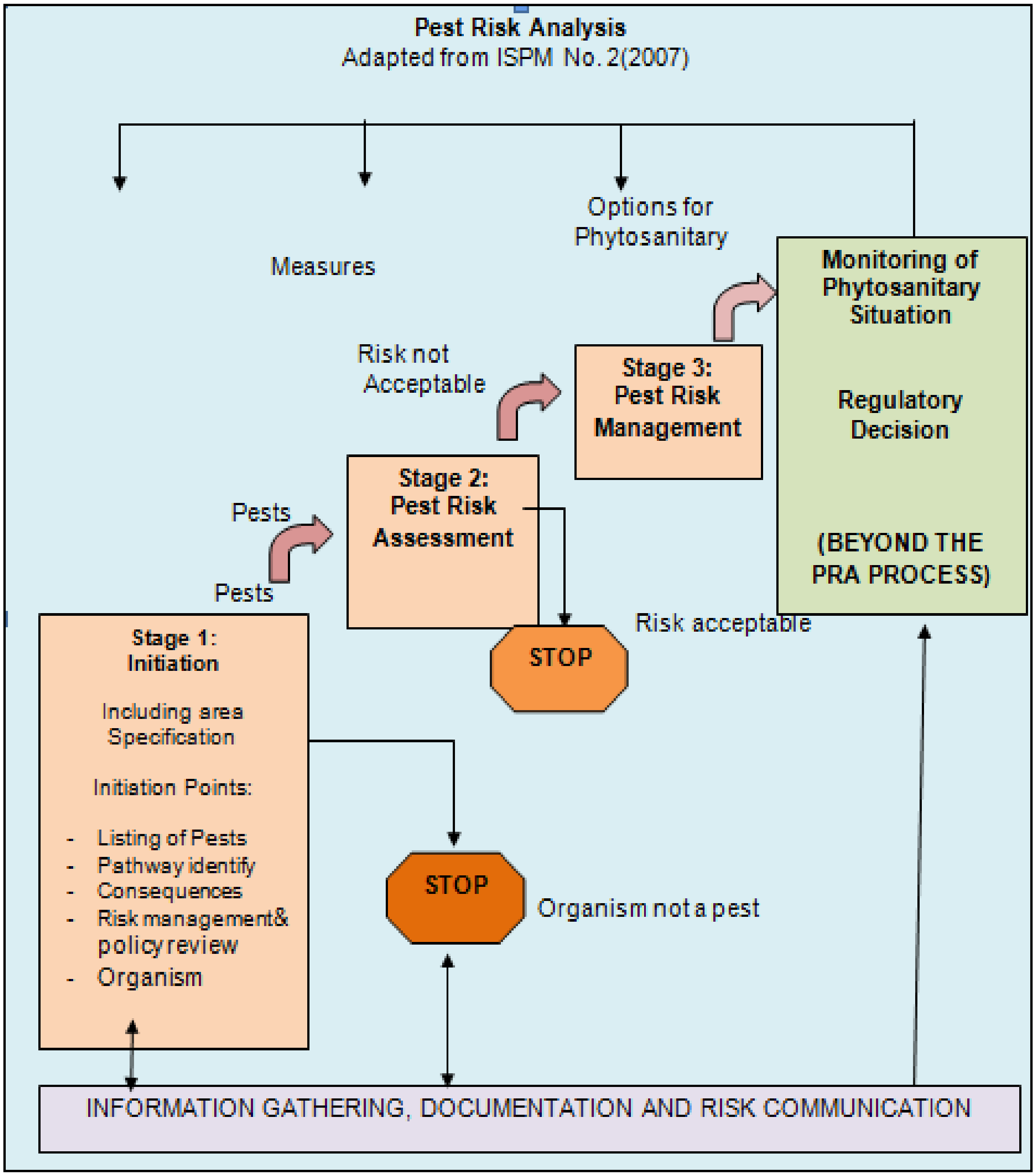


Figure 1: Schematic Diagram of Pest Risk Analysis

1.6. Methodology for data collection

1.6.1. Introduction

The methodology for the present PRA study used system-wide approach, which involved wide-ranging and sequenced discussion with relevant stakeholders aiming to identify the insect pests, diseases and other associated pests of coconut, 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.

1.6.2. Field survey

The survey study was conducted with the direct interview of coconut growers in 30 major coconutgrowing 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 collected through focus group discussions (FGD) with coconut growers and through key informant interviews (KII) with extension personnel at field and headquarer level, Quarantine personnel of 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 officials of BADC etc.

1.7.Secondary data collection and review

The current PRA related secondary data were collected and gathered from secondary sources such as journals, books, reports, proceedings, CD-ROM (CABI) searchand others. The documents were then critically reviewed, synthesized in relation to identify the quarantine pests of coconut available in the coconut exporting counties namelySri Lanka, Vietnam, India, Phillipines, Thailand, Malaysia, Myanmar as well as PRA related activities performed there. Ultimately, formulated all of these synthesized information based on the requirement of the current PRA.

1.6.4.Internet browsing

The PRA related information on pests of coconut were also collected and gathered through internet browsing especially through websites of CAB International, EPPO Bulletin and different LAN based e-Journals namely TEEAL, HINARI, AGORA, OARE etc. The documents were then critically reviewed, synthesized in relation to identify the quarantine pests of coconut available in the exporting counties of commodities as well as PRA related activities performed there. Ultimately, formulated all of these synthesized information based on the requirement of the current PRA.

1.6.5. Listing of pests of coconut

There is no comprehensive list of coconut pests in Bangladesh. Therefore, it is required to make a comprehensive list of coconut pests in Bangladesh through primary and secondary data collection for conducting the risk analysis of coconut pests. The insect pests, diseases, weeds and other associated pests of coconut 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 coconut. Risk analysis was done for quarantine pests of coconut 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 coconut in Bangladesh were also listed.

1.6.6. PRA location and study sampling

The survey study sas conducted in the 30 major coconut growing districts of Bangladesh as selected by the client—Project Director, Stenghthening Phytosanitary Capacity in Bangladesh (SPCB) under Plant Quarantine Wing (PQW), DAE, Bangladesh. A total 70 upazilas were covered under the 30 sampled distrcts, where 10 agricultural blocks were covered under each upazilla and 10 coconutgrowers were interviewed in each block through pre-tested questionnaire. Thus, a total of 7000growers were interviewed from all of 30 sampled districts. The focus group discussion (FGD) meeting was also conducted for each of 30 sampled districts with the participation of at least 10 coconutgrowersfor each FGD aiming to gather qualitative data related to pests of coconut in Bangladesh. Besides, one officer designated as Additional Deputy Director (Plant Protection) from each district had also been interviewed through semi-structured key informant interview (KII) checklist. The district and upazila wise distribution of respondents are given below:

Table-1: Distribution of the respondents in major coconut growing districts of Bangladesh

SN	District	Upazilla	No. of Block	No. of Farmers	No. of FGD	KII
1	Noakhali	Sadar	10	100	1	1
		Subarna char	10	100		
		Hatia	10	100		
2	Lakshmipur	Raipur	10	100	1	1
		Ramgonj	10	100		
		Sadar	10	100		
3	Chittagong	Anwara	10	100	1	1
		Mirswarai	10	100		
		Putia	10	100		
4	Cox'sbazar	Sadar	10	100	1	1
		Ramu	10	100		
		Teknaf	10	100		
5	Jessore	Noapara	10	100	1	1
		Sadar	10	100		
6	Chandpur	Sadar	10	100	1	1
		Hajigonj	10	100		
7	Khulna	Sadar	10	100	1	1
		Fultala	10	100		
8	Satkhira	Kaligonj	10	100	1	1
		Kolaroa	10	100		
9	Bagerhat	Sadar	10	100	1	1
		Chitolmari	10	100		
		Mongla	10	100		
10	Barishal	Sadar	10	100	1	1
		Uzirpur	10	100		
		Gouronadi	10	100		
11	Bhola	Sadar	10	100	1	1
		Borhanuddin	10	100		
		Tojumudduin	10	100		
12	Barguna	Pathargata	10	100	1	1
		Amtali	10	100		
13	Jalokhati	Sadar	10	100	1	1

SN	District	Upazilla	No. of Block	No. of Farmers	No. of FGD	KII
		Kathalia	10	100		
14	Pirojpur	Sadar	10	100	1	1
		Motbaria	10	100		
15	Patuakhali	Kalapara	10	100	1	1
		Mirjagonj	10	100		
16	Rajshahi	Puthia	10	100	1	1
		Chargat	10	100		
17	Chapainwabgonj	Sadar	10	100	1	1
		Shibgonj	10	100		
18	Kishoregonj	Bhairab	10	100	1	1
		Shibgonj	10	100		
19	Chuadanga	Sadar	10	100	1	1
		Damurhuda	10	100		
20	Brammanbaria	Akhaura	10	100	1	1
		Sadar	10	100		
		Bancharampur	10	100		
21	Dinajpur	Sadar	10	100	1	1
		Godaghari	10	100		
22	Gopalgonj	Sadar	10	100	1	1
		Tungipara	10	100		
23	Faridpur	Sadar	10	100	1	1
		Modhukhali	10	100		
24	Dhaka	Savar	10	100	1	1
		Dhamrai	10	100		
		Keranigonj	10	100		
25	Comila	Choddougram	10	100	1	1
		Chandina	10	100		
		Daudkandi	10	100		
26	Feni	Sadar	10	100	1	1
		Companygonj	10	100		
27	Rangpur	Sadar	10	100	1	1
		Pirgonj	10	100		
28	Sylhet	Goainghat	10	100	1	1
		Sadar	10	100		
29	Mymensingh	Gouripur	10	100	1	1
		Sadar	10	100		
30	Munshigonj	Sadar	10	100	1	1
		Lohoganj	10	100		
Total=30		**70**	**700**	**7,000**	**30**	**30**

1.6.7. Data collection tools

The most appropriate tools used in this field study were questionnaire for direct interview of coconut growers, FGD guidelines for coconut growers, KII checklist for DAE personnel, quarantine personnel, Entomologist and Plant Pathologiest of BARI, officials of BADC, Agricultural Universities etc. and observation checklist for field visit are discussed below:

Field survey questionnaire: For quantitative analysis, the field survey was conducted in 30 major coconut growing districts of Bangladesh through face to face interview with 7000coconutgrowers using a set of pre-designed and pre-tested questionnaire (**Appendix-1)** encompassing the relevant study indicators.

Focus Group Discussion (FGD) guidelines: For qualitative analysis, 30 FGD meetings were organized considering one FGD for each sampled districts with the participantion of at least 10 coconutgrowers for each. The FGD meetings were conducted using pre-designed FGD guidelines (**Appendix-2**).

Key Informant Interview (KII) checklist: 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 importers and exporters. A total of 65 key personnel were interviewed using a semi-structured KII Checklist (**Appendix 3-6)** 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 infestation status of the insect pests, diseases, weeds and other associated pest problems in field condition**.**

1.6.8. Interpretation of results

The collected information on pests of coconut, their risk and management options were analyzed and interpreted. The most vulnerable stages of plant growth as well as parts of plants affected by the pests of coconut were also determined based on both primary and secondary data. Finally, a checklist was prepared based on locally available pests of coconut in Bangladesh as well as quarantine pests of coconut for Bangladesh as recorded in exporting countries of coconut.

CHAPTER 2

METHODOLOGY OF RISK ANALYSIS

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

2.1.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

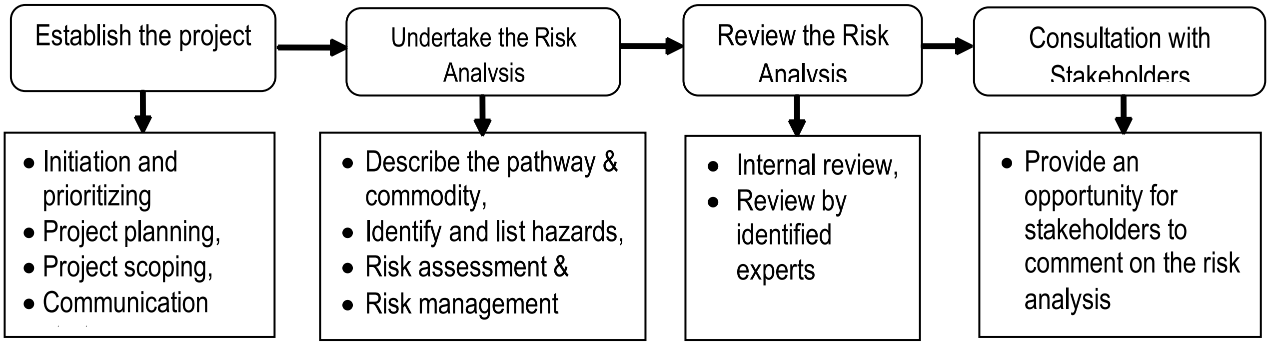
In most cases, these steps were applied sequentially in a PRA but it is not essential to follow a particular sequence. Pest risk assessment needs to be only as complex as is technically justified by the circumstances. This standard allows a specific PRA to be judged against the principles of necessity, 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 following figure 2:

Figure 2: A summary of the risk analysis development process



2.2. Pathway Description

2.2.1. Import pathways of coconut

For the purpose of this risk analysis, coconut is presumed to be from anywhere in exporting countries such as Sri Lanka, Vietnam, India, Phillipines, Thailand, Malaysia and Myanmar.

To comply with existing Bangladesh import requirements for coconut, the commodity would need to be prepared for export to Bangladesh by ensuring certain pests (insect & mite pests, diseases, weeds or any othe pests) are not associated with the product. Commodity would then be sea or land or air freighted to Bangladesh where it go to a holding facility before being distributed to dealers, distributors, markets, sellers and growers for cultivation or users of the imported coconutand seedlings.

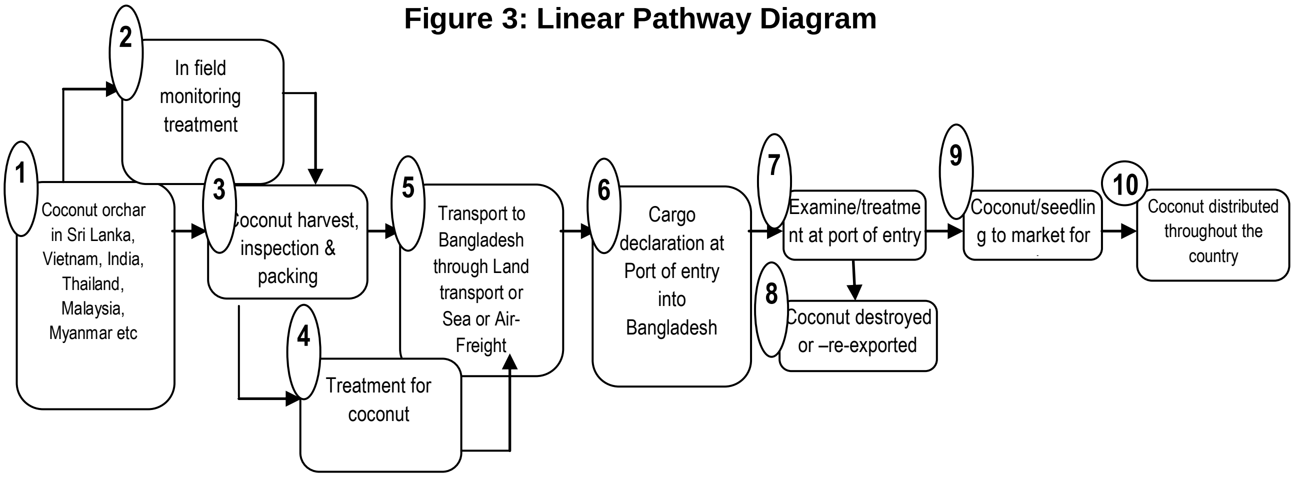
2.2.2. Pathway Description

- Coconut or seedlings in Sri Lanka, Vietnam, India, Phillipines, Thailand, Malaysia, and Myanmar are being grown in the orchard, either as a single crop or beside other field or horticultural crops.
- Monitoring of the insect and mite pests, diseases, weeds and any other pests of coconut is undertaken, with appropriate controls applied.
- Coconuts are being harvested, inspected and the best quality coconut washed, pre-treated and packed in boxes.
- Post harvest disinfestations including fumigation or cold disinfestations are being undertaken either before or during transport of the coconut or seedlings to Bangladesh.
- Transport to Bangladesh is by air or sea or land port.
- Each shipment must be accompanied by the appropriate certification, e.g. a phytosanitary certificate attesting to identity the coconut, any treatments completed, or other information required to help for mitigating the risks.
- Coconut and its seedlingsare examined at the border to ensure compliance.
- Any coconut, seedlings not complying with Bangladesh biosecurity requirements (e.g. found harboring pest organisms) are either treated or re-shipped or destroyed.
- Beside these, natural entry of some pests of coconut may occure from other neighbouring country(ies) into Bangladesh. For example, it is belived that eriophyid coconut mite established in India via natural dispersal and than it was established in Bangladesh by natural dispersal. Because they can fly long distance for finding their suitable host.
- Possibility of entry of pests of coconut from exporting country(ies) into Bangladesh through transportation of commodities by escaping the phytosanitary inspection in the port of entry. For example,pathogen of fire blight of coconut infests coconut seedlings

without any visible symptoms; the disease developing when the seedlings are planted in the field.

- Coconut and seedlings are stored before being distributed to market for sale.
- Dealers and sellers of coconutor seedlings stock and these are bought to users and or growers within the local area these are sold in.The linear pathway diagram of import risk of coconut is furnished below:

Figure 3: Linear Pathway Diagram



2.3. Hazard Identification

The first step for any risk assessment is to identify the hazard as the risk is related to hazard. Hazards are the unwanted insect pests, diseases (pathogen) or weeds or any oth pests of coconutwhich could be introduced into Bangladesh by risk goods, and are potentially capable of causing harm to coconut production, must be identified. This process begins with the collection of information on insect pests, diseases (pathogen) or weed or any other pests of coconutpresent in the country of origin. Such list is compared with the existing pests present in Bangladesh to prepare a list of exotic pests that might be associated with the commodity harmful for Bangladesh, if introduce.
This list is further refined and species removed or added to the list depending on the strength of the association and the information available about its biology and life cycle. Each pest or pathogen is assessed mainly on its biological characteristics and its likely interaction with the Bangladesh environment and climate. Hitch-hiker organisms sometimes associated with a commodity, but which do not feed on it or specifically depend on that commodity in some other way are also included in the analysis. This is because there may be economic, environmental and human health consequences of these organisms entering and/or establishing.

2.4. Risk Assessment of Potential Hazards

Risk assessment is the evaluation of the likelihood of entry, exposure and establishment of a potential hazard, and the environmental, economic, human and animal health consequences of the entry within Bangladesh. The aim of risk assessment is to identify hazards which present an unacceptable level of risk, for which risk management measures are required. A risk assessment consists of four inter related steps:

- Assessment of likelihood of entry
- Assessment of likelihood of exposure and establishment
- Assessment of consequence
- Risk estimation

The approach taken in this Risk Analysis is to assume the commodity is imported without any risk management. In this risk analysis hazards have been grouped where appropriate to avoid unnecessary duplication of effort in the assessment stage of the project.

2.5. Assessment of Uncertainties

The purpose of this section is to summarize 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.

2.6. Risk Management

Risk management in the context of risk analysis is the process of identifying measures to effectively manage the risks posed by the hazard(s) associated with the commodity or organisms under consideration.

Since zero-risk is not a reasonable option, the guiding principle for risk management should be to manage risk to achieve the required level of protection that can be justified and is feasible within the limits of available options and resources. Risk management identifies ways to react to a risk, evaluating the efficacy of these actions, and presenting 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 consideration of risk management options. Where there is significant uncertainty, a precautionary approach may be adopted. However, the measures selected must nevertheless be based on a risk assessment that takes account of the available scientific information. In these circumstances the measures should be reviewed as soon as additional information becomes available. It is not acceptable to simply conclude that, because there is significant uncertainty, measures will be selected on the basis of a precautionary approach. The rationale for selecting measures must be made apparent.

Each hazard or group of hazards will be dealt with separately using the following framework:

2.7. Risk Evaluation

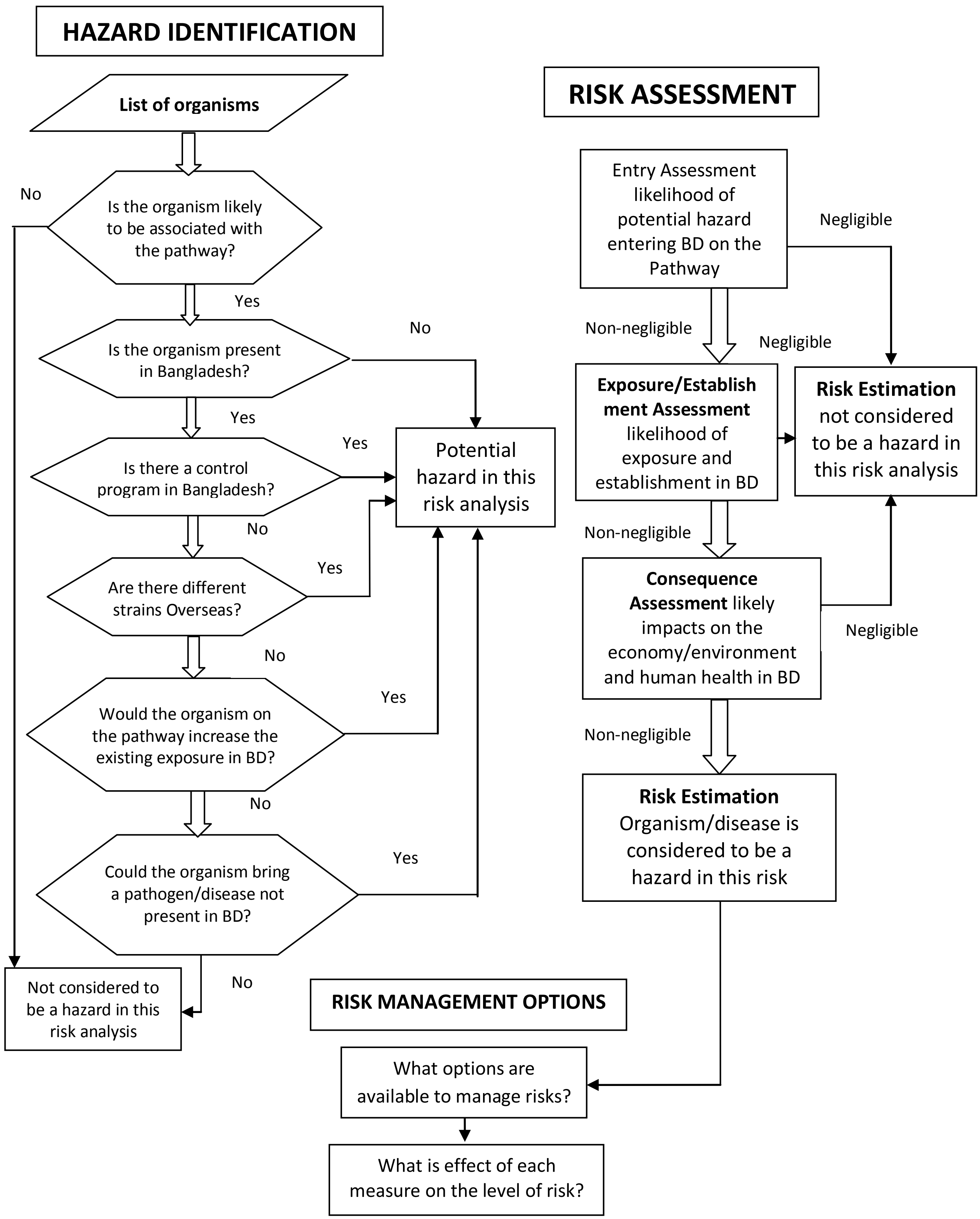
If the risk estimate determined in the risk assessment is significant, measures can be justified.

2.8. Option Evaluation

Measures that are expected to be effective against the hazard species are considered. A package of risk management measures is likely to be required to address the risk from all identified hazards. While there are currently six established pathways Sri Lanka, Vietnam, India, Thailand, Malaysia and Myanmar for coconutfruits and seedlingscoming into Bangladesh, border interception for these pathways cannot be extrapolated to predict any possible level of slippage or efficacy of treatments. However, border interceptions can be used as evidence of hazard organism association with the commodity. Each new pathway must be regarded as unique, given differing pre and post harvest practices and treatment measures. Different pest species are associated with each pathway and measures therefore must be tailored to the individual organisms. So, it consists of

- Identify possible options, including measures identified by international standard setting bodies, where they are available.
- Evaluate the likelihood of the entry, exposure, establishment or spread of the hazard according to the option(s) that might be applied.

Figure 4. Diagram of the Risk Analysis Process. The three main aspects of analysis include: hazard identification, risk assessment and risk management



2.9. Review and Consultation

Peer review is a fundamental component of a risk analysis to ensure it is based on the most up-to-date and credible information available. Each analysis must be submitted to a peer review process involving appropriate staff within those government departments with applicable biosecurity responsibilities, plus recognized and relevant experts fromBangladesh. The critique provided by the reviewers where appropriate, is incorporated into the analysis. If suggestions arising from the critique were not adopted the rationale must be fully explained and documented.

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CHAPTER 3

INITIATION

3.1. Introduction

This chapter provides information on the commodity that is relevant to the analysis of biosecurity risks and common to all organisms or diseases potentially associated with the coconut. It also provides information on climate and geography of the country of origin as well as Bangladesh for assessing the likelihood of establishment and spread of potential hazard organisms when enter and exposed to Banladesh.

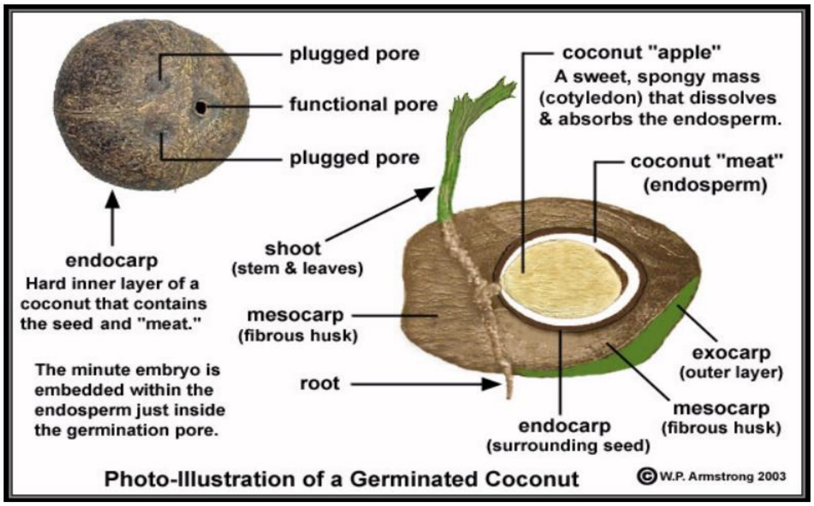
3.2. Commodity Description

3.2.1. Introduction

The coconut palm (*Cocos nucifera*) is a member of the Family Arecaceae (palm family). It is the only species in the genus Cocos, and is a large palm, growing up to 30m tall, with pinnate leaves 4-6 m long, pinnae 60-90 cm long; old leaves break away cleanly leaving the trunk smooth. The term coconut refers to the fruit of the coconut palm. A coconut is a simple dry fruit known as a fibrous drupe (not a true nut). The husk (mesocarp) is composed of fibers called coir and there is an inner "stone" (the endocarp). This hard endocarp (the outside of the coconut as sold in the shops of non-tropical countries) has three germination pores that are clearly visible on the outside surface once the husk is removed. It is through one of these that the radicle emerges when the embryo germinates. Adhering to the inside wall of the endocarp is the testa, with a thick albuminous endosperm (the coconut "meat"), the white and fleshy edible part of the seed. The endosperm surrounds a hollow interior space, filled with air and often a liquid referred to as coconut water, not to be confused with coconut milk. Coconut milk is made by grating the endosperm and mixing it with (warm) water. This produces a thick, white liquid called coconut milk that is used in much cooking, for example, in curries. Coconut water from the unripe coconut, on the other hand, is drunk fresh as a refreshing drink. When the coconut is still green, the endosperm inside is thin and tender, often eaten as a snack. But the main reason to pick the fruit at this stage is to drink its water; a big fruit contains up to one litre. When the fruit has ripened and the outer husk has turned brown, a few months later, it will fall from the palm of its own accord. At that time the endosperm has thickened and hardened, while the coconut water has become somewhat bitter. When the fruit is still green the husk is very hard, but green fruits rarely fall, only when they have been attacked by moulds, etc. By the time the fruit naturally falls, the husk has become brown, the coir has become dryer and softer, and the fruit is less likely to cause damage when it drops Inside the functional germination pore is a minute embryo embedded in the endosperm tissue. During germination, a spongy mass develops from the base of the embryo and fills the seed cavity. This mass of tissue is called the "coconut apple" and is essentially the functional cotyledon of the seed. It dissolves and absorbs the nutrient-rich endosperm tissue to supply the developing shoot with sugars and minerals. Eventually, the developing palm becomes self sufficient, as its leaves produce sugars through photosynthesis and its roots absorb minerals from the soil. The coconut "apple" is rich in sugars and is a sweet delicacy in tropical countries (Retrieved from "http://en.wikipedia.org/wiki/Coconut"). A germinating nut is husked with the use of a sturdy, pointed metal stake or stick set about waist high in concrete. The germinating nut is struck onto the point nearer the pointed end and twisted. The process is repeated until the husk is loose and removed by hand. An experienced husker can husk a coconut in less than ten seconds. For clarification of terminology used in this risk analysis green coconuts are those which are used for drinking. They are not fully mature and contain a substantial amount of liquid inside. The outer husk is green. Brown coconuts are fully mature most often dehusked, and utilised for the hard flesh inside the nut and the water.

The coconut apple is the growing embryo inside the nut. It will commonly appear dehusked with the growing roots and stems cut off. There are seven varieties of coconuts grown in Tuvalu, they are Rennel tall (RT), Malayan dwarf (MD), RT & MD hybrid, Green dwarf (niu leka), and the 3 local varieties (Te kula (red), Te alava (light red), Te ui (green). Currently there is no treatment required for dehusked coconuts from anywhere in the Pacific. However methyl bromide fumigation is usually applied when live organisms are found.

Figure 5: Coconut dehusked (left), and with husk, showing coconut embryo, shoot and root (right)



3.2.2. History

In prehistoric times, wild forms of *C. nucifera* are believed to have been carried on oceanic currents to islands in the Pacific (Melanesia, Polynesia, and Micronesia) and to coastal India, Sri Lanka, and islands in the India Ocean (i.e., Seychelles, Andaman, and Mauritius). It is also believed that Polynesians migrating into the Pacific 4500 years ago brought with them coconut palms. At about the same time, people from Indo-Malaysia were colonizing islands in Micronesia. About 3000 years ago, Malay and Arab traders spread improved coconut types to India, Sri Lanka and East Africa (Chan and Elevitch, 2006). During the sixteenth century, European explorers introduced C. nucifera into West Africa, the Atlantic Coast of America and the West Indies (Little and Skolmen, 2003; Chan and Elevitch, 2006). The arrival of Europeans in the Pacific islands in the nineteenth century signalled the international commercialization of this species and coconut oil was the first vegetable oil commercialized in world trade. During this period, large coconut plantations were established in European colonies around the world including India, the Philippines, Tanzania, Papua New Guinea, the Solomon Islands, Fiji, Vanuatu and Samoa (Duke, 1983; Chan and Elevitch, 2006; PROTA, 2014).

3.2.3. Coconut in Bangladesh

Dr Rahman described the importance of coconut and termed it as “Laxmi Phal” and he also mentioned that according to Yogic Therapy “Coconut is the best and the first rate brain forming food; curd and milk belonging to the second rate; vegetables, pulses and fruits as third rate. For windbreak and erosion control, coconut is very effective.

3.2.3.1. Coconut Production in Bangladesh

The southern part of the country contributes about 80% of total production (BBS 2002). The national yield of coconut has been estimated at 21 nuts /palm /year with a total production of 736425 metric tonns /year from 40000 ha planted to coconut (BBS 2013). Islam (2002) reported that around 44% of production is consumed as tender nut and 40% as mature nut for fresh consumption. Only 9% is processed in industries while 7% is used for seedling purposes.

3.2.3.2. Kinds of coconut in Bangladesh

In Bangladesh, coconut is considered as a crop with high economic importance because of its variety of uses. The crop is commonly grown in homesteads following a unique farming system that makes effective and efficient utilization of land. Bangladeshi Typica is the coconut variety commonly grown throughout the country, which takes about six to eight years to flower and bear fruits after planting. Bangladesh Agricultural Research Institute (BARI) collected coconut germplasm from home and abroad for research. Although, BARI recommended two coconut varieties, BARI Narikel-1 and BARI Narikel-2, in 1996 for general cultivation throughout the country, information on genetic diversity of coconut of Bangladesh is meager.

3.2.3.3.Yearly Acreage, production and yield of Coconut in Bangladesh

According to the BBS (2014), the area under coconut production in Bangladesh was 5649 acre in 2011-12 and 4876 acre in 2012-13, of which maximum area under coconut production was 1728 in Jessore region in 2011-12. Considering the production of coconut, the total production of coconut was 372006 metric tones in 2011-12 and 364419 metric tones in 2012-13.

Table-2.1: Area and Production of Coconut by Region 2011-12 to 2012-13 in Bangladesh

(Area in acres and production in metric tons)

Region	Area under garden		Average yield per tree (kg)		Production of inside gar-den		Production of outside garden		Total production	
	2011 -12	2012 -13	2011 -12	2012 -13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Banderban	93	170	65	70	340	435	591	771	931	1206
Chittagong	496	478	61	73	3057	3798	10253	13175	13310	17513
Comilla	-	-	57	57	-	-	20787	21106	40787	21107
Khagrachhari	15	145	27	30	22	25	562	681	584	706
Noakhali	-	-	38	40	-	4173	22295	22456	22296	26628
Rangamati	311	67	58	53	750	1888	2977	1027	3727	2915
Sylhet	45	45	68	68	1545	1174	8943	10160	10488	11334
Dhaka	99	115	55	56	578	663	14066	13904	14644	14567
Faridpur	549	549	40	41	5609	5615	22406	20715	28014	26330
Jamalpur	-	-	49	51	-	-	4448	4839	4448	4839
Kishoreganj	140	122	60	59	854	854	8501	8103	9355	8957
Mymensingh	14	14	47	41	463	437	10417	8591	10889	9028
Tangail	328	388	33	35	94	100	3217	3694	3221	3794
Barisal	961	885	57	45	1710	1313	73199	54456	74909	54769
Jessore	1728	1095	43	50	8817	10206	23320	28626	32117	38832
Khulna	264	268	51	44	10946	9156	38960	26714	49906	35871
Kushtia	142	268	36	40	3227	3293	12032	12434	15259	15727
Patuakhali	39	31	24	65	1105	1344	6003	18114	7109	19548
Bogra	79	28	33	33	425	123	4467	4481	4892	4604
Dinajpur	78	80	51	65	351	397	5188	5844	5539	6241
Pabna	186	80	51	54	486	520	9021	11512	9507	12032
Rajshahi	166	187	56	64	790	1296	15986	19665	16776	20961
Rangpur	-	-	84	65	-	-	13309	7000	13309	7000
Total	**5649**	**4876**	**49**	**45**	**41169**	**46810**	**330837**	**317609**	**372006**	**364419**

Source: BBS (2014)

3.2.4. Morphological characteristics

The Coconut Palm is a large palm, growing to 30 m tall. It has pinnate leaves 4–6 m long, the leaflets 60-90 cm long; old leaves break away cleanly, leaving the trunk smooth. Despite its solo status in this monotypic genus, it has countless variations, but is always easily identified by everyone the world over as the Coconut Palm. Propagation is by seed (the fruit).Canopy palm. Stem solitary, erect, 25-40 cm in diameter. Leaves numerous, 3-6 m long; pinnae to 100 on each side, regularly inserted in one plane, straight, the central ones to 1 m long and 5 cm wide. Inflorescences 60-100 m long, once branched, overhung by a large, boat shaped, persistent peduncular bract; the basal part of each inflorescence branch with a few large female flowers, these yellow or greenish, 3-5 cm long; the distal part of the branches with numerous cream coloured male flowers, these 5-8 mm long. Fruits rounded to triangular, green or yellow, 20-30 cm long.

Plant characteristics: Trees are typical single-trunked palms, reaching up to 100 ft in height, but generally 20-50 ft in cultivation. Leaves are among the largest of any plant (up to 20 ft), pinnately compound with 200 or more leaflets, and borne in a spiral arrangement at the apex of the trunk. Leaf life span may be 3 years, and mature, healthy palms have about 30 leaves, forming a new one and dropping the oldest one each month.

Flowers characteristics: Separate male and female flowers are borne in the same inflorescence, which is a compound spadix arising in the leaf axil. Flowers are off-white to gray or yellow, and inconspicuous. They are generally protandrous, meaning that male flowers release pollen before females become receptive. Flowering occurs continuously, since each leaf axil produces one inflorescence, and new leaves are produced approximately monthly.

Pollination: Since coconuts are protandrous, they are believed to be largely cross pollinated. Dwarf cultivars, particularly the popular ornamentals, are largely self-pollinating as opposed to the Tall cultivars of commerce which rarely pollinate themselves.

Fruit: Coconuts are large, dry drupes, ovoid in shape, up to 15″ long and 12″ wide. The exocarp or skin is green, yellow, or bronze-gold, turning to brown, depending on cultivar and maturity. The mesocarp is fibrous and dry at maturity; the product coir is derived from this layer. The endocarp is the hard shell enclosing the seed. Seeds are the largest of any plant, and have a thin brown seed coat. Seeds are filled with endosperm, which is solid and adherent to the seed coat, and also in liquid form, called “milk”. Copra is derived from the solid endosperm.

3.2.5. Classification of coconut

There are only there distinct varieties of coconut. (1) Tall, (2) Dwarf and (3) Hybrid

1) Tall Varieties:It is extensively cultivated in ail the coconut tracts of the world. It has long and stout trunk with a swollen base called as 'bole'. This variety grows to the height of about 15 to 18 m the crown will have 35 to 40 fronds and the length of full open frond will be about 6m .It is comparatively hardy late bearing and lives up to 80 to 90 years. It tolerates diverse soil and climatic conditions and bears fruits in seven to ten years under rain fed conditions. The copra, oil and fiber of this variety are of good quality. The nut matures within a period of 12 months after pollination.

2. Dwarf Varieties:Dwarf varieties occur in most of the coconut growing countries. This variety is characterized by its short statute and earliness in bearing, generally autogamous or self pollinating. Trunk is thin without swollen bole. Full developed fords rarely exceeds 4 m. under hormai conditions, the palm starts flowering in about 3 to 4 years. Fuli grown tree rarely exceeds .5 m height. It yields heavily but, irregular in bearing. Economic, bearing age is up to 25 years of late, the dwarf variety received much attention in India' and else where because of its use as a parent in evolving high yielding hybrids. The Malayan dwarf one of the important dwarf type in the world is reported to be resistant to devastating lethal yellowing disease in 'Jamaica'. In India, 2 important dwarf types commonly found are (i). Chowghat dwarf green and (ii) Ghowchat dwarf orange.

3. Hybrid Palms:The manifestation of hybrid, vigour or heterosis, in perennial crops like / coconut was first reported in 1932 in inter-varietal crosses involving the tall variety as the female and dwarf variety as male. The seedling exhibited hybrid vigor. The seedlings from hybrid nut had rapid growth with a higher rate of leaf production, short preparing period high bearing capacity and economic nut characters. The inter-varietal hybrid produced for the commercial planting are the tall x dwarf and Dwarf x tall.

Tall x Dwarf Hybrid: In this hybrid, ordinary tall is female and dwarf as male parent. The dwarf parents used are dwarf orange, dwarf green, ganga badam and Malyan dwarf yellow.

3.2.6. Cultivation

To maximize the utilization of soil and sunlight in the coconut garden, intercropping can be adopted with a variety of crops like pineapple, banana, elephant foot yam, groundnut, chillies, sweet potato, tapioca etc. upto 8-10 years. During 10-22 years of age of the palms, crop like colocasia which can tolerate shade can be cultivated. In older plantations, perennials like cocoa, pepper, cinnamon, clove and nutmeg can be grown as mixed crops along with intercrops. Mixed farming by raising fodder grasses such as hybrid napier or guinea grass along with leguminous fodder crops in coconut garden has been found to be profitable which can support rearing of milk animals.

3.2.7. Climatic requirements

Agro - climatic requirements: Coconut is essentially a tropical plant but has been found to grow under varying agro climatic condtions. The mean annual temperature for optimum growth and maximum yield is stated to be 27^{o}C with a diurnal variation of 60^{o}C to 70^{o}C and relative humidity more than 60%. The coconut palm thrives well up to an altitude of 600 m above MSL. The coconut palm thrives well under an evenly distributed annual rainfall ranging from 1000 mm to 3000 mm. However, a well distributed rainfall of about 2000 mm is the ideal rainfall for proper growth and higher yield.

Soil: The coconut palm can tolerate wide range of soil conditions. But the palm does show certain growth preferences. A variety of factors such as drainage, soil depth, soil fertility and layout of the land has great influence on the growth of the palm. The major soil types that support coconut in India are laterite, alluvial, red sandy loam, coastal sandy and reclaimed soils with a pH ranging from 5.2 to 8.0.

3.2.8. Coconut imports from exporting countries into Bangladesh

Bangladesh does not export coconut to any country, but it is essential to import coconuts from different countries such as Sri Lanka, Phillipines, Malaysia and Vietnam etc. Bangladesh mainly imports coconut seedlings. According to the information provided by the Department of Agricultural Extension (DAE), Bangladesh imported 56700 seedlings in 2015-16 from above mentioned countries (DAE, 2016).

3.2.9. Uses of coconut

The coconut is known for its great versatility as seen in the many domestic, commercial, and industrial uses of its different parts. Coconuts are part of the daily diet of many people. Its endosperm is known as the edible "flesh" of the coconut; when dried it is called copra. The oil and milk derived from it are commonly used in cooking and frying; coconut oil is also widely used in soaps and cosmetics. The clear liquid coconut water within is a refreshing beverage and can be processed to create alcohol or blended with gums and whiteners to make a popular milk substitute. The husks and leaves can be used as material to make a variety of products for furnishing and decorating. It also has cultural and religious significance in many societies that use it. As of 2009, coconut was grown commercially in 80 countries, with total production of 61 million tons; leading producers were the Philippines, Indonesia, and India.

Coconuts have been used in traditional medicine around the world to treat numerous ailments, ranging from sore throat, colds, and earaches to tuberculosis, tumors, and ulcers. Recent medical studies have found that coconut can have antibacterial, antifungal, antihelmintic, and antiviral properties, among other health benefits. Coconut oil was once avoided because it is composed of saturated fats, which were thought to raise cholesterol. However, recent research suggests that because it has medium- rather than long-chain fatty acids, coconut oil does not raise cholesterol, but may actually protect against heart disease. Coconut has now become popular as a health food, with numerous products and web sites extolling its benefits.

The term coconut can refer to the entire coconut palm, the seed, or the fruit, which is not technically a nut. The spelling cocoanut is an old-fashioned form of the word. The term is derived from 16th century Portuguese and Spanish “cocos,” meaning "grinning face," from the three small holes on the coconut shell that resemble human facial features.

3.2.11. Pests of coconut

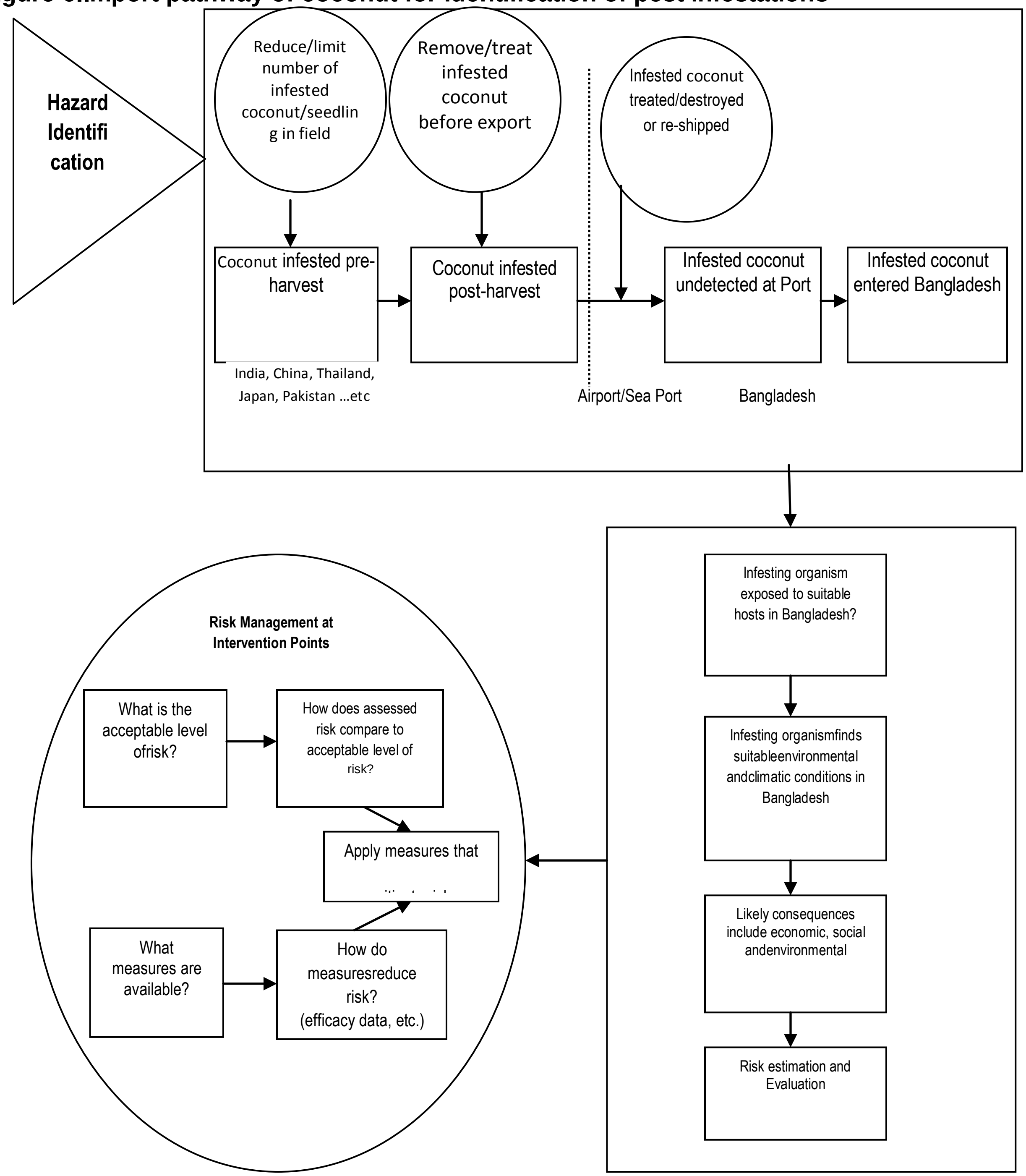
Insect pests: More than 900 species of pests are associated with cultivated and wild coconut palm. This number includes both invertebrates and vertebrates. Of these, red palm weevil, (*Rhynchophorus ferrugineus* Olivier), rhinoceros beetle (*Oryctes rhinoceros* L.), and coconut black-headed caterpillar (*Opisina arenosella* Walker) are the most important devastating insect pests of coconut in major coconut-growing areas of the world. These three insect pests are distributed wherever coconut palm occurs.

Diseases: Coconut palms are susceptible to lethal yellowing disease, bud rot caused by *phytophthora palmivora*fungus, *thielaviopsis* trunk rot, stem bleeding, and *chalara paradoxa* fungus. Most of these can be prevented through well-drained soil and avoidance of damage to tree trunks, particularly during transplantation. Lethal yellowing can be treated with antibiotic injections either on a preventative basis when the disease is found or as a repeated treatment after infection.

3.3. Description of the Import Pathway

For the purpose of this risk analysis, coconutis presumed to be from anywhere in Sri Lanka, Vietnam, India, Phillipines, Thailand, Malaysia, Myanmar (DAE, 2016). To comply with existing Bangladesh import requirements for coconut, the commodity would need to be prepared for export to Bangladesh by ensuring certain pests are not associated with the product. Coconut would then be sea or air freighted to Bangladesh where it go to a holding facility before being distributed to dealers, distributors, markets, sellers and growers for cultivation and uses of the imported coconut. The import pathway of coconutindicating how the risk analysis process applied at the pathway level is given below:

Figure 6.Import pathway of coconut for identification of pest infestations



3.4. General Clicmate of Exporting Countries

3.4.1. India

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 a 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.

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 a 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 (WeatherOnline, 2015a)

3.4.2. Thailand

Thailand's Climate can be described as tropical monsoonclimate. 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 a climate, a hot, humid climate with all months above 18°C (WeatherOnline, 2015c).

3.4.3. Vietnam

Vietnam`s Climate can be divided a tropical and a temperate zone. 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. Regions located near the tropics and in the mountainous regions have a slightly cooler, more temperated climate.

The annual average **temperature** ranges from 22°C to 27°C year-round. There are almost no significant differences in temperature in the southern parts of Vietnam, while the northern regions can be quite cold in the winter. There are essentially four distinct seasons, which are most evident in the Northern provinces.

There are two distinguishable seasons in the southern areas. The cold season occurs from November to April and the hot season from May to October. The northern parts of Vietnam have essentially four distinct seasons; it can be quite **cool** in the winter there, but very warm in summer. [http://www.weatheronline.co.uk/reports/climate/Vietnam.htm]

3.4.4. Philippines

The main variable of the **Phillippines** climate is not temperature or air pressure, but rainfall. In general, the climate of the Phillippines can be decribed as tropical, with the coastal plains averaging year-round **temperatures** about 28°C. The area's relative humidity is quite high, and ranges between 70 and 90 percent.

The extreme variations in rainfall are linked with the monsoons. Generally speaking, there is a dry season (June to September), and a rainy season (December to March). Western and northern parts of the Phillippines experience the most precipitation, since the north- and westward-moving monsoon clouds are heavy with moisture by the time they reach these more distant regions. [http://www.weatheronline.co.uk/reports/climate/Phillippines.htm]

3.4.5. Sri Lanka

Regional differences observed in air temperature over Sri Lanka are mainly due to altitude, rather than to latitude. The mean monthly temperatures differ slightly depending on the seasonal movement of the sun, with some modified influence caused by rainfall. The mean annual temperature in Sri Lanka manifests largely homogeneous temperatures in the low lands and rapidly decreasing temperatures in the highlands. In the lowlands, altitude of 100 m to 150 m, the mean annual temperature various between 26.5 °C to 28.5 °C, with an annual temperature of 27.5 °C. In the highlands, the temperature falls quickly as the altitude increases. The mean annual temperature of Nuwaraeliya, at 1800 m sea level, is 15.9 °C. The coldest month with respect to mean monthly temperature is generally January, and the warmest months are April and August.

The mean annual temperature varies from 27°C in the coastal lowlands to 16°C at NuwaraEliya, in the central highlands (1900m above mean sea level). Rainfall in Sri Lanka has multiple origins. Monsoonal, Convectional and expressional rain accounts for a major share of the annual rainfall. The mean annual rainfall varies from under 900mm in the driest parts (southeastern and northwestern) to over 5000mm in the wettest parts (western slopes of the central highlands).

3.4.6. Malaysia

Local climates are affected by the presence of mountain ranges throughout Malaysia, and climate can be divided into that of the highlands, the lowlands, and coastal regions. The coasts have a sunny climate, with temperatures ranging between 23 and 32 °C (73.4 and 89.6 °F), and rainfall ranging from 10 to 30 centimetres (4 to 12 in) a month. The lowlands have a similar temperature, but follow a more distinctive rainfall pattern and show very high humidity levels. The highlands are cooler and wetter, and display a greater temperature variation. A large amount of cloud cover is present over the highlands, which have humidity levels that do not fall below 75%.

The highest temperature was recorded at Chuping, Perlis on 9 April 1998 at 40.1 °C (104.2 °F). The lowest temperature (Official) was recorded at Cameron Highlands on 1 February 1978 at 7.8 °C (46.0 °F). The highest rainfall recorded in a day was 608 mm (23.9 in) in Kota Bharu, Kelantan on 6 January 1967. The highest rainfall recorded in a year was 5,687 mm (223.9 in) at

Sandakan, Sabah in 2006. Meanwhile, the lowest rainfall recorded in a year was 1,151 mm (45.3 in) at Tawau, Sabah in 1997. The wettest place in Malaysia is Kuching, Sarawak with an average rainfall of 4,159 mm (163.7 in) with 279 days of rain a year. The driest place in Malaysia is in Sitiawan, Perak with average rainfall of only 1,787 mm (70.4 in) a year.

3.4.6. Myanmar

Myanmar has a 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 degrees Celsius (72° Fahrenheit) to 27 degrees Celsius (81° Fahrenheit) year-round.

There are three distinct seasons in Myanmar: The cold and dry season, from November to February, with average monthly temperatures of between 20°C and 24°C. The hot-dry season from March to April with average monthly temperatures between 30°C and 35°C. The wet season between May and October with average temperature between 25°C and 30°C. Annual rainfall in the delta region is approximately 2,500 millimetres (Yangon 2700 mm), while average annual rainfall in the Dry Zone is less than 1,000 millimetres (Mandalay 840 mm), the coastal regions receiving over 5,000 millimetres of rain annually.

3.5. General Climate of Bangladesh

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^{o}C in Mymenshing district to 36.10^{o}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

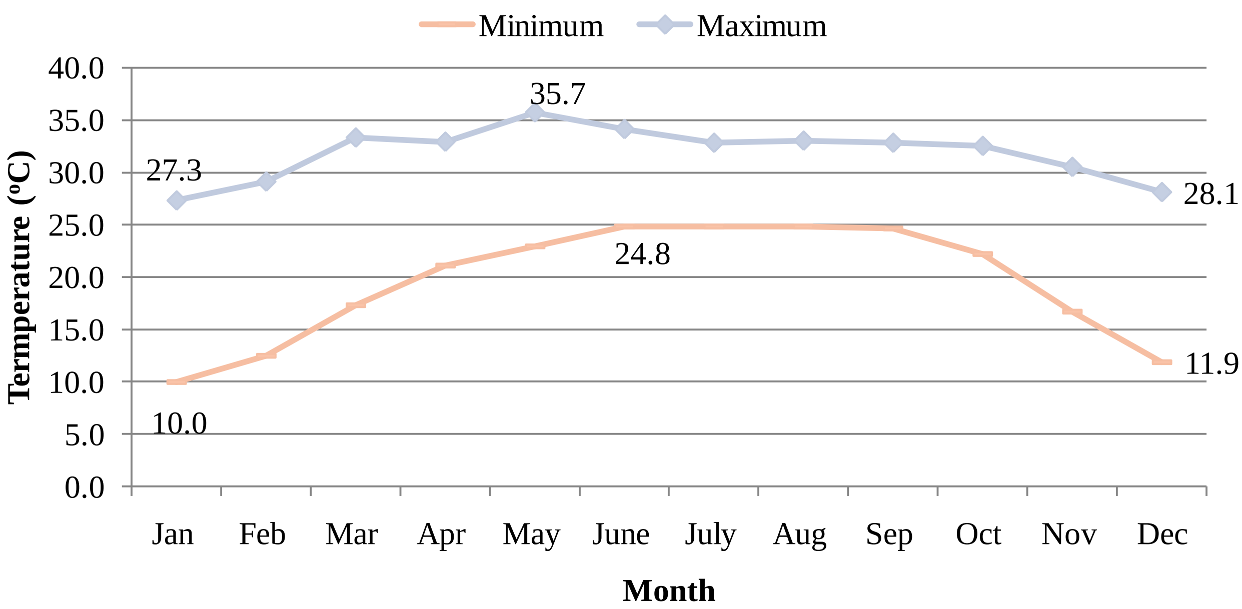


Figure 7. Monthly distribution pattern of standard normal temperature in Bangladesh, 1981-2012

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

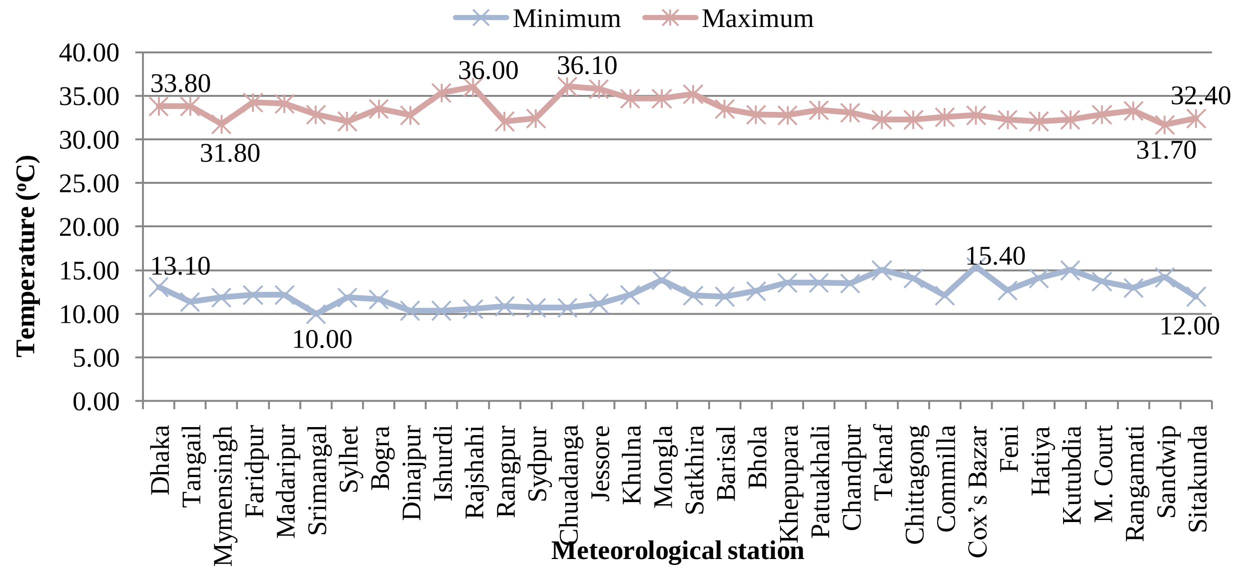


Figure 8. Location-wise distribution pattern of standard normal temperature in Bangladesh, 1981-2012

Source: BBS (2013)

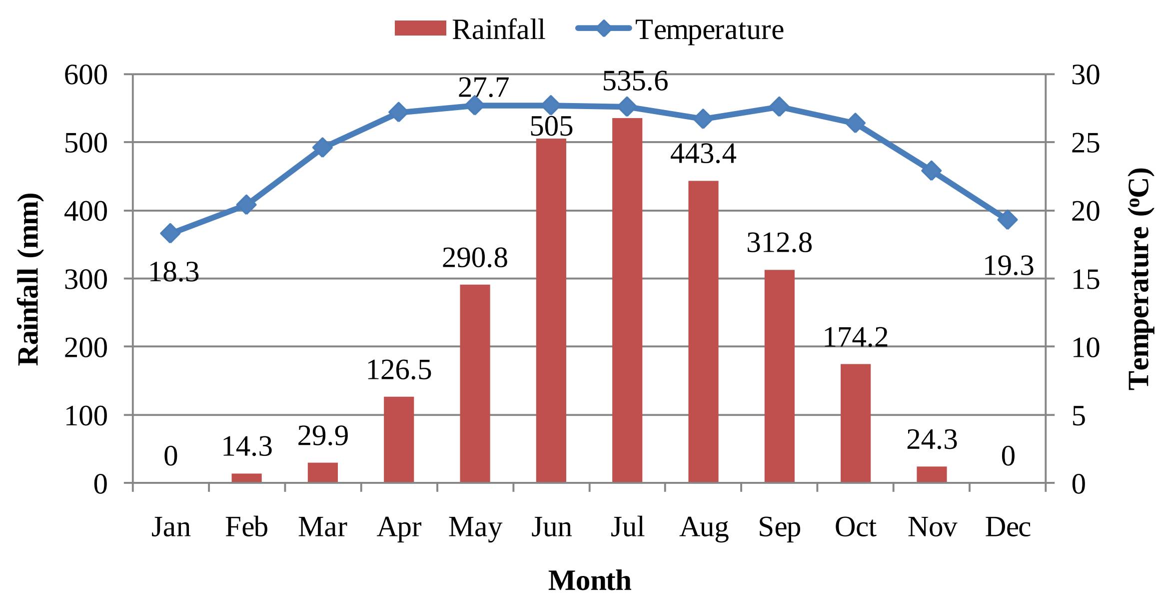


Figure 9. Average monthly Temperature and Rainfall for Bangladesh from 1960-1990

Source: World Bank Group (2015)

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CHAPTER 4

HAZARD IDENTIFICATION

4.1. Introduction

This chapter outlines the potential hazards associated with coconutin Sri Lanka, Vietnam, India, Phillipines, Thailand, Malaysia, and Myanmarand considerssome of the major risk characteristics of the commodity and its hazards.

An initial hazard list was made of all pests and pathogens associated with coconut found Sri Lanka, Vietnam, India, Phillipines, Thailand, Malaysia, Myanmar and other exporting countries of the world. The Plant Quarantine Wing of theDepartment of Agricultural Extension (DAE) in Bangladesh list for pests of coconut from these exporting countries was used as its basis, withvarious species added or excluded after considerations of association. This original list waslater refined to include only those organisms directly associated with coconut and found tobe present in these exporting countries. Some hitch-hiker pests are included in the pest analyses where entryand establishment of a species into the country would cause potential economic,environmental or health consequences. The following a list of those organisms assessed anddiscarded as likely hazards based on biology, and lack of association with the commodity. Then all potential hazards and individual pest riskassessments and recommend measures where required.

4.2. Potential Hazard Groups

Pests and pathogens can be grouped in two main ways regarding their association with thecommodity. Under their taxonomic category, i.e. Lepidoptera, Coleoptera, Acari, Fungi etc, orwithin the trophic role they play in their association, and whatstructures or part of the plants they attack, e.g. surface feeder, seed feeder, pathogen. In this risk analysis hazard organismsare grouped according to their general taxonomic category. Where a genus contains more thanone species, information on all species is contained within one pest risk assessment. Iforganisms that are hitch hikers or vectors this is noted in the individual pest risk assessment.

The following categories are used are as follows:

Insect pests
Mite pests
Fungi
Bacteria
Nematode
Virus
Algae
Weeds

4.3. Interception of Pests on Coconut from Existing Pathways

In the past, there was no previous pest risk assessment on Coconut from any of the exporting countries including the Sri Lanka, Vietnam, Philippines, Indonesia, Malaysia, India, Mayanmar, etc. As reported by the Plant Quarantine Wing (PQW) under Department of Agricultural Extension (DAE), Bangladesh, during inspection in port of entry of Coconut from these exporting counties, not a pest had been intercepted yet today on the commodity imported into Bangladesh.

4.4. Review of earlier PRA

No PRA on coconut had been done in Bangladesh earlier. However, damage assessment and other studies on insect pests, diseases or other pests associated with Coconut in Bangladesh and abroad helped to prepare this PRA report.

4.5. Organism Interception on Commodity from Existing Pathways

In the past, there was no previous pest risk assessment on coconut from any of the exporting countries including the Sri Lanka, Vietnam, India, Phillipines, Thailand, Malaysia and Myanmar. As reported by the Plant Quarantine Wing (PQW) under Department of Agricultural Extension (DAE), Bangladesh, during inspection in port of entry of coconut from these exporting counties, not a pest had been intercepted yet today on the commodity imported into Bangladesh.

4.6. Other Risk Characteristics of the Commodity

Although many pests dealt with in this risk analysis have adequate information for assessment, we can not predict future or present risks that currently escape detection for a variety of reasons.

4.6.1. Unlisted Pests

These include pests that are not yet identified. With a trend towards decreasing use of chemical products in agriculture and further reliance on Integrated Pest Management (IPM) strategies it is assumed that new pests enter the system at some time in the future.

Prolonged use of large doses of pesticides and fertilizers can lead to previously non pest species becoming economically important through resistance to pest treatments. Any of these types of organism could initially appear in very small numbers associated with the commodity, and may not be identified as hazards before their impacts become noticeable.

4.6.2. Symptomless Micro-organisms

Pests such as microbes and fungi infect coconut before transit and may not produce symptomsmaking them apparent only when they reach a suitable climate to sporulate or reproduce.

Many fungi can infect coconutafter arrival making it difficult to distinguish the origin ofsaprobes and pathogens without adequate identification. Consumers tend to throw awaymoulded coconut rather than take it to a diagnostic laboratory so there is little data on post entryappearance of “invisible organisms”.

4.7. Assumptions and Uncertainties

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 moderate rated insect pests, diseases and weed of coconutin Sri Lanka, Vietnam, India, Thailand, Malaysia, Myanmar and other countries of coconut and seedlings 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 coconutin the importing countries, and preferably, any information on incidence level in pests infested coconut consignments or lots would be valuable.

Thus, the assessment of uncertainties and assumptions for each organism often covers similar areasof 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.

4.8. Assumptions and Uncertainties around hazard biology

The species of mealybug (*Pseudococcus* spp.) and scale insects are the well known hitch-hiker species, and has been associated with coconutin Sri Lanka, Vietnam, India, Thailand, Malaysia, and Myanmar. Currently there are no data demonstrating this association between this hitch-hiker pest and the pathway imported from these countries 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 have in a new environment, particularly if it has not become established as a pest elsewhere outside its natural range. Therefore, there 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.

4.9. Assumption and Uncertaintiesaround the Inspection Procedure

Some uncertainty exists around the efficacy of risk management measures. Interception data is one way of estimating efficacy, as records of live and dead organisms indicate the success of a treatment and the thresholds for growth and development of each individual organism. A sample audit is required to monitor efficacy. Currently this is 600 units of fruit/vegetable product per consignment. The assumption is that this monitoring will adequately record type and number of organisms associated with each commodity. The 600 sample inspection requirement to achieve a 95 percent level of confidence that the maximum pest level will not be exceeded makes assumptions around consignment homogeneity, that samples will be random, and that the inspector has a 100 percent likelihood of detecting pests if they are present in the sample. It is accepted that the sampling system is based on a level (percentage) of contamination rather than a level of surviving individuals, and that because for lines of less than 600 units, 100 percent inspection is required, it is therefore acceptable that the effective level of confidence gained by the sampling method significantly increases as the consignment size moves below 10,000. This is because a sample of around 590 provides 95 percent confidence that a contamination level of 1 in 200 (0.5 percent) will be detected in consignments larger than about 25,000 individuals.

4.10. Assumption around Transit Time of Commodity on the Air Pathway

An assumption is made around the time the fresh coconut/seedling take to get from the field in Sri Lanka, Vietnam, India, Phillipines, Thailand, Malaysia and Myanmar to Bangladesh ready for wholesale if it is transported by Landport or Sea shipment.

4.11. Assumption around Commodity Growon in Bangladesh

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 coconut 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	-

CHAPTER 5

REVIEW OF MANAGEMENT OPTIONS

5.1. Introduction

This chapter reviews some management options for organisms considered to be an unacceptable risk on coconuts imported from Sri Lanka, Vietnam, India, Thailand, Malaysia and Myanmar. Visual inspection, site hygiene, ant baiting, washing and cold storage are the treatments and systems approaches to risk mitigation considered. It is expected that the majority of coconuts for export to Bangladesh will be seedling, significantly increasing the pest loading on the commodity.

5.2. In field control, pre-export measures and area freedom

There is no comprehensive pest management and pest control system for specific pests of coconut in many exporting countries. *Aspidiotus destructor* is considered the most important pest, with field measures to reduce outbreak intensity undertaken.

5.3. Site hygiene measures

Examples of site hygiene practices that require remediation are featured in Appendix 3. The following site hygiene measures relate directly to the review of post harvest handling and storage of coconuts in exporting countries.

5.3.1. Post harvest

- Fallen coconuts should not be left on the ground in contact with soil to mature. This increases the likely association of pests with the commodity.
- After dehusking, coconuts should immediately be removed and stored separately from husks. All husks and old coconut shells should be removed from in and around storage facilities.
- When coconuts are being prepared for coconut apple production, contact with the ground is generally the common germination technique. Polythene or plastic sheeting as a single layer in a shady place, with regular watering can also be utilised (P. Fernando pers comm. September 2008).

5.3.2. Warehouse

- Any rotting fruit such as bananas or plant material inside or in close proximity to warehouse storage facilities should be regularly cleaned up and disposed of.
- Coconut seedlings ready for export should be stored upright and in rows.
- Where other products in containers such as toddy are being stored in the same space in warehouses, care should be taken to clean the outside of containers to prevent sweet dried liquid becoming an attractant for hitchhiker species such as ants.
- It is suggested that crab cages outside the warehouse facility, be removed from their close proximity to the building.
- Building materials including timber, metal and scrap piled up along the front and side walls of the warehouse building provide shelter and nest sites for ants. All building material should be removed from this area and stored elsewhere.

5.3.3. In transit

- Loose seedling next to seeding could increase recontamination in transit. Coconut must be segregated from loose coconuts.
- Fresh plant material such as pandanus leaves should not travel in contact with coconuts for export as recontamination could occur. All non packaged organic material should be segregated from coconuts for export.
- Cold storage will maintain quality and freshness of the product while deterring recontamination by pest organisms

5.4. Washing, brushing and waxing

There is no literature around washing regimes to clean coconuts for quarantine purposes. One experiment is reported for estimating the population size of coconut mite *Aceria guerreronis* on coconut. Mites were removed by washing bracts and the surface of an infested coconut (with the intact husk) with 30ml of detergent solution. Shaking the wash for 5 seconds allowed the mites to distribute uniformly (Siriwardena et al. 2005). Literature around washing, brushing and waxing in the citrus industry is reviewed here, as good data exist. Often producers in the Pacific do not harvest their coconuts. Mature nuts are left on the ground and are gathered by the farmer or the family members of the farming family at regular intervals. Harvested nuts are usually gathered together in a single layer on the ground. If the soil is moist there is always the tendency for the nuts to germinate. Hence nuts are not allowed on the damp ground for a long time but are moved to drier places. If the end product required is coconut apples, coconuts are often arranged on the ground so they can easily germinate in rows which makes harvesting the embryo (apple) easier.

Often nuts are kept for about a month in this way. This practice promotes desirable changes in the greener or somewhat less mature nuts. Producers claim that seasoning or storage of 10- 11 month old green nuts for one month or so improved the coconut kernel, and makes dehusking easier (FAO information sheet). This increases the likelihood of pest organisms becoming associated with the fallen coconuts before export. Unless the coconut is dehusked, or prepared with calyx trimmed off green nuts and the outer surface washed and scrubbed clean it is highly likely that small insects such as mites, scales and mealybugs will remain. The USDA-PPQ Treatment Manual for fruit nuts and vegetables (2007) states that water used for washing, treatments and cooling must be fortified with sodium hypochlorite (household bleach) and be constantly maintained at a chlorine level not to exceed 200ppm. The FAO (2004) advocates harvested fruit should be trimmed of any leaves or stem and well washed to remove any superficial dirt, plant debris, pests and pathogens. The water should be clean and contain the appropriate concentration of sanitizers to minimise the transmission of pathogens from water to fruit, from infected fruit to healthy fruit within a single batch and from one batch of fruit to another batch over time (FAO 2004). Both organisations provide treatment schedules for methyl bromide only regarding coconut or copra products.

5.5. Visual inspection

Visual inspection by a trained inspector can be used in three main ways for managing biosecurity risks on goods being imported into Bangladesh, as:

- a biosecurity measure, where the attributes of the goods and hazard organism provide sufficient confidence that an inspection will be able to achieve the required level of detection efficacy;
- an audit, where the attributes of the goods, hazard organisms and function being audited provide sufficient confidence that an inspection will confirm that risk management has achieved the required level of efficacy;
- a biosecurity measure in a systems approach, where the other biosecurity measures are not able to provide sufficient efficacy alone or have significant levels of associated uncertainty.

In the case of inspection for audits, this is considered a function of assurance and is considered as part of the implementation of the identified measures. Inspection as a biosecurity measure uses the direct comparison of required efficacy to manage risk versus actual efficacy of an inspection (maximum pest limit versus expected measure efficacy).

Inspection as a biosecurity measure in a systems approach can be used either directly, as a top-up to the efficacy achieved by other measures in the system or indirectly as a check to ensure an earlier measure was completed appropriately. In the latter case an appropriate inspection for the target organism may not be practical (the sample size may be too large) and an indirect sign of less-than-adequate efficacy may be used. Examples of indirect indications of failed treatments include:

- surviving non-target organisms that are more easily detected;
- symptoms of infestation such as frass or foliage damage in the case of cut flowers or nursery stock; • symptoms of treatment such as damage to goods;
- the use of indicators during treatment such as live organisms or colour indicators.

The following assessment of pre- and post-harvest practices reflects the current systems approach for risk management employed for commercially produced coconut. It is proposed that these practices combined with specific post-harvest treatment (such as fumigation 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 coconut from exporting countries. The management options for different insect and mite pests as well as diseases of coconut crops have been reviewed and presented below:

5.6. Insect and Mite Pest Management of Coconut

Coconutis the most common palm trees grown in Bangladesh. Although there are a large variety of pests in common such as Scale insects, mealybug, termites, mites, Coconut rhinoceros beetle, etc. The timing of control tactics is critical for many of these pests-miss the window and the tree can be severely affected. Some growers choose to spray weekly thinking this lead to good control, but not only does this lead instead to wasted resources and ineffective controls, excessive sprays also lead to secondary pest outbreaks and the development of resistance by pests to some chemical controls.

The key to any successful pest management program is to develop a regular scouting plan to gain information on insect pest populations that is used to determine if insecticide applications are needed. Monitoring can consist of sampling groups of 10 plants which are randomly selected at different locations in a field. Samples should be distributed throughout the field so that plants near the edges and middle of the field are examined. In recent years there has been a great increase in new control technologies available to growers, this makes management of insect pests in coconut an ongoing process. The new insecticides generally act against a narrower range of pest species than the older, broadspectrum materials. Therefore, it is critical to properly identify the pest to be controlled and to determine its potential for damage. The only way to obtain this information is through routine scouting. The purpose of this guide is to serve as a reference for insect pest identification and for general management guidelines.

5.6.1. Coconut scale

Chemical Control

Chemical control may be difficult owing to the height of the trees and may not be commercially viable in some cases owing to the cost. Chemical control may be necessary in the dry season. Malathion has been used successfully. However, insecticide sprays may also kill natural enemies and affect biological control. Jalaluddin and Mohanasundaram (1991) describe effective chemical treatment for *A. destructor* in coconut nurseries in India. Zhou *et al.* (1993) describe the effective chemical control of the larval stages of *A. destructor* in China. Mariau and Julia (1977) describe the effective chemical control of *A. destructor* on young coconuts on the Ivory Coast.

Cultural Control

During the early stages of an outbreak of *A. destructor* on coconut, cutting and burning the affected fronds may be effective.

Phytosanitary Measures

Dharmaraju and Laird (1984) describe the transport of *A. destructor* around Oceania, mainly through human agency. They emphasize the importance of rigid quarantine procedures.

Biological Control

The most successful biological control of *A. destructor* has been achieved using predators rather than parasitoids (Rosen, 1990). An early example of biological control was the introduction of *Cryptognatha nodiceps* from Trinidad into Fiji in 1928, which stemmed devastating losses in the coconut/copra industry. During 1955, *C. nodiceps* was introduced into Principe and again almost complete control was obtained and massive economic losses in the copra industry were eliminated (Rosen, 1990). *C. nodiceps* has since been introduced to a number of oceanic islands; however, it was less successful in the New Hebrides, where Rhyzobius pulchellus, introduced from New Caledonia, was more effective (Rosen, 1990). Biological control programmes have been described in the Federated States of Micronesia (Suta and Esguerra, 1993), American Samoa (Tauili' ili and Vargo, 1993) and New Hebrides (Chazeau, 1981). The predatory coccinellid, *Chilocorus nigritus*, was successfully introduced into Oman from India during 1985 as a biocontrol agent against A. destructor (Kinawy, 1991). Sadakathulla (1993) has developed a technique for the mass production of Chilocorus nigritus. Rhyzobius lophanthae effectively controlled *A. destructor* in tea plantations in the Republic of Georgia (Gaprindashvili, 1975). In Taiwan, the natural enemies of *A. destructor* were so effective in areas with a rich flora that no chemical control measures were required (Wu and Tao, 1976).

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5.6.2. Spiked mealybug

Heat Treatment

Heating pineapple crowns in a large water bath at 50°C for 30 minutes permitted 100% plant survival and rendered 100% of the plants free of pineapple wilt-associated-virus (Ullman *et al*., 1991). Following heat treatment of pineapple crowns in Hawaii, pineapple wilt-associated closterovirus could not be detected and growth of the heat-treated plants was more rapid than that observed in non-heat-treated plants. The heat-treated plants were not readily colonized by mealybugs, nor did they show mealybug wilt even after more than 2 years from being planted in a commercial plant crop with severe mealybug pineapple wilt (Ullman *et al*., 1993).

Regulatory Control

Importation of pineapple plants for planting from countries where mealybug wilt of pineapple occurs should be prohibited.

Biological Control

The following species of parasites and predators have been introduced into Hawaii for the biological control of *D. brevipes*, and have become established: the encyrtid parasitoids Anagyrus ananatis, Euryrhopalus [Blepyrus] propinquus and Hambeltonia pseudococcinna; a cecidomyid predator Lobodiplosis [Diadiplosis] pseudococci, and the predatory coccinellids Nephus bilucenarius and Scymnus uncinatus (Rohrbach *et al.,* 1988). Of these, the encyrtids and cecidomyid are the most effective. These natural enemies, however, do not control the mealybug colonies in the presence of ants and ant control is therefore important.

Chemical Control

Pineapple crowns and slips used for new plantings need to be dipped or fumigated before planting to prevent spreading infestations of the mealybug. In Brazil, fenitrothion and fenpropathrin (Santa Cecilia and Sousa, 1993) and diazinon (Cecilia and Rossi, 1991) have been found to be effective against *D. brevipes* on pineapple.

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5.6.3 Coconut rhinoceros beetle

Physical Control

A method for trapping adults has been developed and tested by Hoyt (1963) and Bedford (1973). Hoyt (1963) designed a simple, cheap trap, consisting of a piece of coconut trunk, the cap with a beetle-size hole drilled through the centre, and resting on a tin can a tin can placed right below it leaving no space between them. The whole trap is set at a height of 1.8 m from the ground. There was no chemical attractant used in this trap: the decaying trunk served as the attractant. When a small quantity of the synthetic chemical attractant ethyl dihydrochrysanthemumate (chrislure) was applied to the coconut cap of the Hoyt trap, catch was increased (Bedford, 1973) compared to dispensing the lure from a more expensive metal vane-type trap (Barber *et al*., 1971). Chrislure was subsequently superseded by ethyl chrysanthemumate (rhinolure) (Maddison *et al*., 1973). Hoyt's trap was used by Bedford (1975) to monitor population trends at a density of 23 traps per 8 hectares. To control beetle infestation, the density of the traps should be increased at the borders of a known source of infestation rather than inside the field (Young, 1972). The use of light traps for controlling populations has been found to be ineffective: Wood (1968a) indicated that beetles do not often enter traps although they are attracted to the light source. However, light traps may be useful for monitoring purposes.

Pheromonal Control

A male-produced aggregation pheromone, ethyl 4-methyloctanoate (E4-MO) was discovered (Hallett *et al.,* 1995; Morin *et al.,* 1996). It has been synthesised and is available commercially (for details of synthesis and types of traps available, see Bedford (2013a)). It is reported to be 10 times more attractive than ethyl chrysanthemumate. The pheromone is stored in a small, heat-sealed, polymer membrane bag and placed between interlocking metal vanes mounted on a plastic bucket. The beetles attracted by the pheromone are trapped inside the bucket. It is very useful as a monitoring tool, and as an economical control method particularly in young oil palm replant areas when placed at one trap per 2 ha (Norman and Basri, 2004; Oeschlager, 2007; Bedford, 2014).

Cultural Control

Sanitation within and surrounding the plantations, especially destruction of the potential or existing breeding sites of this pest, provides an important basis for its control (Wood, 1968a; Turner, 1973). Manure heaps and pits may have to be covered or alternatively turned regularly for the removal of the grubs (Catley, 1969). The establishment of a good, fast-growing ground cover crop provides a vegetative barrier that hampers the movement of the adult beetle looking for suitable breeding sites or young oil palms in replant areas (Wood, 1968b). This restricts the damage in oil palm to low levels (Wood *et al.,* 1973). Removal of the adults from the point of attack in young palms by using a hooked piece of wire (winkling) can be considered a common mechanical control technique to reduce the number of adults in an infested area (Toh and Brown, 1978). This practice is often costly, labour intensive and needs to be conducted regularly, provided that sufficient labour is available. However, some additional damage may be inflicted to the young palms during the search for the adults, making the practice not entirely satisfactory.

Biological Control

Early attempts at biological control of *O. rhinoceros* concentrated on the introduction of predators and scoliid parasitoids of other Oryctes species mainly from Africa. None of those that became established was able to provide satisfactory control. However, biological control effort concentrated on Oryctes rhinoceros nudivirus (OrNV) after its discovery in Malaysia in 1965 (Huger, 1966) and its successful introduction into Western Samoa in 1967 (Swan, 1974; Waterhouse and Norris, 1987). Endemic natural enemies of *O. rhinoceros* offer a cheap and long-term control of the pest, leading to a reduction in the use of chemical insecticides. OrNV and the pathogenic fungus Metarhizium anisopliae have been utilized further for field control of this pest in several countries (George and Kurian, 1971; Latch and Falloon, 1976; Zelazny, 1979b; Bedford, 1986; Darwis, 1990). For OrNV, the adult beetles are dipped in a suspension of ground, infected grubs. They are then allowed to crawl about for 24 hours through sterilized sawdust mixed with the above suspension. They are then released back into the plantation to infect other adults and larvae in the breeding sites (Bedford, 1976d). OrNV suspension may also be applied directly to the mouthparts of adults to infect them for release (Ramle *et al.,* 2005). A supply of beetles for infecting and release may be obtained from a mass-rearing facility. The fungus Metarhizium anisopliae var. major may be produced commercially or in bulk by various methods, for release by suitable means into breeding sites, particularly into chipped decaying oil palm trunk material in oil palm replant areas (Sivapragasam and Tey, 1995; Tey and Ho, 1995; Ramle *et al*., 1999, 2006, 2007, 2009, 2011; Ramle and Kamarudin, 2013).

Chemical Control

Most of the chemicals applied are targeted to control the adult stages attacking the spear of the palm. The point of application is therefore at the base of the leaf sheath (Sadakathulla and

Ramachandran, 1990). Granular formulations of the insecticide gamma-BHC were effective as this facilitates applying them in the frond axils and thereby lowering costs compared to spraying liquid formulations (Ho and Toh, 1982). Eleven types of insecticides were evaluated for the control of the adults in the nursery and immature stages of the oil palm (Chung *et al.,* 1991). On immature oil palm, the most effective treatment in reducing the number of broken spears and spear dieback, was lambda cyhalothrin. Cypermethrin was effective in reducing the number of holes on spears and fronds. Systemic insecticides have been used in trunk injections in tall coconut palms in Malaysia, but their effectiveness is uncertain. Insect-repellent naphthalene applied (as moth balls) fortnightly to the frond axils provided 95% control of the pest (Singh, 1987). Juvenile hormone mimics have been tested on pupae of *O. rhinoceros* and indicated that methoprene was effective in causing death of the developing adult at the pupal stage (Dhondt *et al.,* 1976). The use of long residual insecticides for drenching the breeding sites (i.e. coconut stumps) has been found effective to suppress the larval stages up to 7 months (Ho and Toh, 1982). Insecticidal treatment at the bottom soil of manure pits may also be useful to suppress the larval stages (Visalakshi *et al.,* 1988).

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5.6.4. Red palm weevil

Integrated Pest Management Programmes

Integrated pest management for *R. ferrugineus* has been developed and tested in coconut palms in India (Kurian *et al.,* 1976; Sathiamma *et al.,* 1982, Abraham *et al*., 1989). Included in the IPM programme were cultural measures such as plant and field sanitation; physical methods by preventing entry of weevils through cut ends of petioles and wounds; and use of attractants and other chemicals (including filling of leaf axils with gamma BHC and sand as a preventive measure). Abraham *et al.* (1989) found the IPM approach very effective in reducing the number of infested palms in Kerala, India. Abraham *et al.* (1998) suggested that the major components of the IPM strategy for *R. ferrugineus* are surveillance, trapping the weevil using pheromones lures, detecting infestation by examination of palms, eliminating hidden breeding sites, clearing abandoned gardens, maintaining crop and field sanitation, using preventive chemical treatments, curative chemical control, implementing quarantine measures, training and education. In the Al Qatif region of Saudi Arabia, Vidyasagar *et al.* (2000a) successfully developed an IPM programme which, in addition to mass pheromone trapping, included a survey of all the cultivated gardens, systematic checking of all palms for infestation, periodic soaking of palms, and mass removal of neglected farms. A review of control strategies and IPM for the weevil were also presented by various other authors (Ramachandran, 1998; Nair *et al*., 1998; Murphy and Brisco, 1999). Faleiro (2006) has reviewed the issues and management of R. ferrugineus in coconut and date palm over the past 100 years.

Chemical Control

As damage symptoms by *R. ferrugineus* are difficult to detect during the early stages of infestations, emphasis is placed generally on preventive aspects. However, this is not always possible. The common and practical curative measure is through the use of insecticides. The use of the latter tends to be the major mode of control advocated as seen from the survey of literature. Preventive and curative measures include: trunk injection with systemic insecticides carried out during the early stages of infestations (Rao *et al*., 1973; Anon., 1976), recently, trunk injection using pirimiphos ethyl also gave good control (El Ezaby, 1997); treatment of wounds with repellents and filling leaf axils with insecticide dusts such as BHC mixed with sand (Mathen and Kurian, 1966; Abraham, 1971); and drenching of the crown of infested trees with insecticides (Kurian and Mathen, 1971). Barranco *et al.* (1998) recorded the percentage mortality of R. ferrugineus larvae treated with different rates of fipronil and azadirachtin (neem). Hernandez-Marante et al. (2003) reported highest mortality of *R. ferrugineus* with a combination of trunk injections and sprays with the same insecticide, with carbaryl, fipronil and imidacloprid providing highest efficacy against the pest.

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5.6.5. Eriophyid coconut mite

Chemical control of the coconut mite is possible; chinomethionate sprayed onto bunches of developing fruits every 20 or 30 days significantly reduced damage (Hernández, 1977). Similar results were obtained with acaricides applied at 15-day, but not 60-day, intervals (Mariau and Tchibozo, 1973).

Varietal differences in susceptibility occur (Mariau, 1986) and breeding may provide a long term solution. The tightness of fit of the perianth may be critical (Mariau, 1986; Moore, 1986; Howard and Abreu-Rodríquez, 1991) and this may be a varietal characteristic and also one influenced by agronomy and climate.

Experimentally, the use of Hirsutella species-based mycoacaricides has shown good field results but the development of successful products demands more research. Aratchige et al. (2009) summarized research on the potential of *Neoseiulus baraki* and *Hirsutella thompsonii* as biological control agents of *A. guerreronis* on coconut in Sri Lanka.

Good management, replacing old trees, providing balanced fertilizer regimes and generally maintaining healthy trees may increase the tolerance of trees to attack and hence reduce yield losses.

Nair *et al*. (2005) provide an overview of bioecology and management of *A. guerreronis*.

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5.6.6. Anthracnose diseases

Cultural control

The ubiquity of inoculum sources of *C. gloeosporioides* and its often rapid epidemic development under suitable conditions reduce the effectiveness of many general phytosanitary practices. Although general orchard hygiene has a place in integrated disease control, examples of good field control of Colletotrichum diseases effected solely by measures aimed at reducing inoculum sources are hard to find. Greater knowledge of the specificity of strains of the pathogen may enable effective phytosanitary practices to be developed. Options for integrated control of the disease on mango have been discussed by Arauz (2000). The necessity for wet conditions to coincide with susceptible crop stages for development of Colletotrichum epidemics should offer an opportunity for disease control through manipulation of cropping patterns. Chemical methods can also be used to change growth patterns: application of potassium nitrate sprays can stimulate mango flowering; defoliants have been used to modify the wintering pattern of rubber and avoid secondary leaf fall (Rao, 1972). Application of calcium salts can enhance resistance to bitter rot in apples (Biggs, 1999). Cultural practices such as spacing and pruning can reduce the suitability of environmental conditions for Colletotrichum disease development by assisting more rapid drying of the tree canopy, as well as allowing better penetration of fungicide sprays. The worst effects of Colletotrichum diseases may also be avoided if susceptible crops are grown in drier environments.

Because,*C. gloeosporioides* is an opportunistic pathogen, the avoidance of predisposing conditions such as mechanical or physiological damage is particularly significant. To control of other pests and diseases, avoidance of harvesting damage to fruit, all help to offset secondary infections.

Chemical Control

Due to the variable regulations around (de-)registration of pesticides, we are for the moment not including any specific chemical control recommendations. For further information, we recommend you visit the following resources:

- EU pesticides database (www.ec.europa.eu/sanco_pesticides/public/index.cfm)

- PAN pesticide database (www.pesticideinfo.org)

5.6.7. Bitten leaf of coconut

Heat Treatment

Berg (1926) showed that 30 minutes' immersion of sugarcane setts in water at 51°C prevented the spread of *C. paradoxa* and fungal development where planting was delayed.

Cultural Control

A general recommendation is to use healthy setts of an appropriate physiological age to ensure rapid germination, setts with at least three nodes to increase the likelihood that the buds towards the centre will germinate before the fungus invades all the tissues, and crop management practices that promote germination and rooting. Preferably, varieties which are quick to germinate should be selected and planted in disease-prone areas. Varieties which are slow to germinate should either be treated in hot water (50°C for 2 hours) or treated with a growth hormone (e.g. indole acetic acid) to promote early germination which is a prerequisite for escaping infection. The damage can be further reduced by avoiding extremely wet or dry soil conditions (Agnihotri, 1990; Wismer and Bailey, 1989). Kalaimani *et al.* (1996) reported that the application of farmyard manure at the rate of 25t/ha per week in plots before planting sugarcane reduced the incidence of C. paradoxa and improved yields. Polyethylene coating of short hot-water treated setts significantly improved control of the disease in pineapple, especially if the setts were also treated with fungicide (Croft and Hogarth, 1998).

Chemical Control

Due to the variable regulations around (de-)registration of pesticides, we are for the moment not including any specific chemical control recommendations. For further information, we recommend you visit the following resources:

- EU pesticides database (www.ec.europa.eu/sanco_pesticides/public/index.cfm)

- PAN pesticide database (www.pesticideinfo.org)

5.7.Phytosanitary measures

5.7.1. Post-Harvest Procedures

The procedure is to sorting/grading to remove damaged/overripe/infested/infected coconut or seedling. The grading process is likely to remove flowers showing obvious signs of fungal and bacterial disease as well as the presence of aphids, mealybugs, scale insects, caterpillars etc .

5.7.2.Visual Inspection

Visual inspection of coconut seedling occurs at several points during the routine production and post-harvest pathway for flowers and foliage. These include:

- In-field monitoring during the growing season
- Harvesting
- Post-harvesting sorting and grading
- Packaging seedlings for treatment
- Packaging of flowers for export
- Visual phytosanitary inspection

A visual inspection at multiple points of the pathway provides opportunities to remove infested/infected seedlings 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 ofcoconut.

5.7. Application of phytosanitary measures

A number of different phytosanitary measures may be applied to pests based on the outcome of an import or pest risk analysis. Required measures may include:

- Surveillance for pest freedom;
- Testing prior to export for regulated pests which cannot be readily detected by inspection (e.g. viruses on propagating material);
- Specific pre-shipment pest control activities to be undertaken by the supply contracting party;
- The application of a pre-shipment treatment;
- Inspection of the export consignment;
- Treatment on arrival in Bangladesh.

5.7.4. General conditions for coconut

- Coconut include fresh fruits intended for consumption and not for planting. For the purposes of this standard coconut excludes roots or viable seeds.
- Only inert/synthetic material may be used for the protection, packaging and shipping materials of coconut and branches.
- Coconut and branches shall not be shipped or contained in free-standing water.

5.7.5. Pre-shipment requirements

Inspection of the consignment: Bangladesh requires that the NPPO of the country of origin sample and inspect theconsignment according to official procedures for all the visually detectable regulated pestsspecified by Plant Quarantine Wing (PQW) of the Departemnt of Agiculture Extension of Bangladesh.

Treatment of the consignment

The PQW of Bangladesh requires that the NPPO of the country of origin ensure that the coconut from which the coconut were collected, have beentreated as specified by PQW of Bangladesh.

Documentation

- Bilateral quarantine arrangement: Required.
- Phytosanitary certificate: Required.
- Import permit/Authorisation to import: Required.

5.7.6. Phytosanitary certification

A completed phytosanitary certificate issued by the NPPO of the country of origin must accompany all coconutexported to Bangladesh.

Before a phytosanitary certificate is to be issued, the NPPO of the country of origin must besatisfied that the following activities required by Ministry of Agiculture of Bangladesh have been undertaken.

The coconuthave:

i) been inspected in accordance with appropriate official procedures and found to be freeof any visually detectable regulated pests specified by PQW of Bangladesh.

AND, ONE OR MORE OF THE FOLLOWING;

ii) been sourced from a pest free area that is, as verified by pest surveillance methods (inaccordance with the International Standards for Phytosanitary Measures;

Requirementsfor the Establishment of Pest Free Areas, IPPC, FAO, Publication 4, 1996), free from aregulated pest(s).

iii) been sourced from a pest free place of production that is, as verified by pest surveillancemethods (in accordance with the International Standards for Phytosanitary Measures;Requirements for the Establishment of Pest Free Places of Production and Pest Free Production Sites, IPPC, FAO, Publication 10, 1996), free from a regulated pest(s).

AND;

iv) been devitalised (rendered non-propagable) using an effective devitalisation treatmentor process.

5.7.7. Additional declarations to the phytosanitary certificate

If satisfied that the pre-shipment activities have been undertaken, the NPPO of the country of origin must confirm this by providing the following additional declarations to the phytosanitary certificate:

"The coconut in this consignment have been:

- inspected according to appropriate official procedures and are considered to be free from the regulated pests specified by Plant Quarantine Wing under Department of Agriculture of Bangladesh, and to conform with Banglasesh's current phytosanitary requirements".

AND,

- subjected to an effective devitalisation treatment [details of treatment must be included on the phytosanitary certificate] rendering the consignment non-propagatable."

5.7.8. Transit requirements

The coconut must be packed and shipped in a manner to prevent infestation and/or contamination by regulated pests.

Where a consignment is split or has its packaging changed while in another country (or countries) *en route* to Bangladesh, a "Re-export Certificate" is required. Where a consignment is held under bond as a result of the need to change conveyances and is kept in the original shipping container, a "Re-export Certificate" is not required.

5.7.9. Inspection on arrival in Bangladesh

Plant Quarantine Wing of DAE, Bangladesh will check the accompanying documentation on arrival to confirm that it reconciles with the actual consignment.

5.7.10. Testing for regulated pests

PQW of DAE of Bangladesh may, on the specific request of the Director, PQW, test the consignment for regulated pests.

5.7.11. Actions undertaken on the interception/detection of organisms/contaminants

If regulated pests are intercepted/detected on the commodity, or associated packaging, the following actions undertaken as appropriate (depending on the pest identified):

- Treatment (where possible) at the discretion of the Director, PQW of Bangladesh;
- Reshipment of the consignment;
- Destruction of the consignment;
- The suspension of trade, until the cause of the non-compliance is investigated, identified and rectified to the satisfaction of PQW of DAE of Bangladesh.

Actions for the interception/detection of regulated non-plant pests in accordance with the actions required by the relevant government department.

5.7.12. Biosecurity clearance

If regulated pests are not detected, or are successfully treated following interception/detection,and there is no evidence to suggest the plant material is propagatable, biosecurity clearancegiven.

5.7.13. Feedback on non-compliance

The NPPO will be informed by the Director, Plant Quarantine Wing of Bangladesh, of the interception(and treatment) of any regulated pests, “unlisted” pests, or non-compliance with otherphytosanitary requirements.

CHAPTER 6

IDENTIFICATION OF PESTS

6.1. Introduction

The pest risk assessment was done with the aim to determine Bangladesh's phytosanitary measure regarding thecoconutimported from anyexporting countries ofSri Lanka, Vietnam, India, Thailand, Malaysia and Myanmar into Bangladesh.

6.2. Pests of coconut recorded in Bangladesh

The study for "Conducting Pest Risk Analysis (PRA) of Coconut in Bangladesh" was done in 24 major coconut growing districts of Bangladesh. From the field survey and review of secondary documents, the precise findings of the study in-line with the presence of insect and mite pests, diseases and weed pests have been presented below:

6.2.1. Insect and mite pests of coconut in Bangladesh

A total number of 13 arthropod pests of coconut of which 12 were insects and 1 mite pest was reported in Bangladesh.

The incidences of insect pests of coconut recorded in Bangladesh were coconut scale (*Aspidiotus destructor),* green shield scale (*Pulvinaria psidii),* lantana scale (*Hemiberlesia lataniae),* oriental yellow scale (*Aonidiella orientalis),* pineapple mealybugs (*Dysmicoccus brevipes),* guava mealybug (*Ferissia virgata*),black headed caterpillar (*Opisina arenosella),* coconut rhinoceros beetle (*Oryctes rhinoceros),* red palm weevil (*Rhynchophorus ferrugineus),*bark beetle (*Dendroctonus* spp.), white grub/ dung beetle (*Phyllophaga spp.*) and coconut termite (*Odontotermes obesus*). The eriophyid coconut mite (*Aceria guerreronis)* was also recorded as a major pest of coconut.

Among these insect and mite pests of coconut, coconut rhinoceros beetle and Eriophyid coconut mite were more damaging than other arthropod pests. The coconut rhinoceros beetle, coconut scale, eriophyid coconut mite and black headed caterpillar were designated as major pest of coconut and caused damage with high infestation intensity. The pest status of all other insect pests was minor significance and caused low level of infestation. Usually Bangladesh's coconut growers always used chemical insecticides through which these pests were suppressed in every season.

Table 2. Insect pests of coconut in Bangladesh, their status, plant parts affected and infestation severity

SN	Common Name	Scientific name	Family	Order	Plant parts affected	Pest status	Infestation severity
A. Insect pests							
1	Coconut scale	*Aspidiotus destructor*	Diaspididae	Hemiptera	Leaves, Fruit	Major	Medium
2	Green shield Scale	*Pulvinaria psidii*	Diaspididae	Hemiptera	Leaves, Fruit	Minor	Low
3	Lantana scale	*Hemiberlesia lataniae*	Diaspididae	Hemiptera	Leaves, Fruit	Minor	Low
4	Oriental yellow scale	*Aonidiella orientalis*	Diaspididae	Hemiptera	Leaves, Fruit	Minor	Low
5	Pineapple Mealybugs	*Dysmicoccus brevipes*	Pseudococcidae	Hemiptera	Leaves, Inflorescence	Minor	Low
6	Guava mealybug	*Ferissia virgata*	Pseudococcidae	Hemiptera	Leaves, Inflorescence	Minor	Low
7	Black headed caterpillar	*Opisina arenosella*	Crytophasidae	Lepidoptera	Green coconut, leaves	Major	Medium
8	Coconut rhinoceros beetle	*Oryctes rhinoceros*	Scarabaeidae	Coleoptera	Stem, Young leaves	Major	High
9	Red palm weevil	*Rhynchophorus ferrugineus*	Curculionidae	Coleoptera	Stem, Leaves, Fruit	Minor	Low
10	Bark beetle	*Dendroctonus* spp.	Curculionidae	Coleoptera	Stem, Leaves, Fruit	Minor	Low
11	Coconut termite	*Odontotermes obesus*	Termitidae	Isoptera	Stem, Leaves, root	Minor	Low
12	White grub/ dung beetle	*Phyllophaga spp.*	Scarabaeidae	Coleoptera	Stem, Leaves, Fruit	Minor	Medium
B. Mite pest							
13	Eriophyid coconut mite	*Aceria guerreronis*	Eriophyidae	Acarina	Fruit	Major	High

Some pictures of insect and mite pests coconut are presented below:

Plate 1. Scale insect infestation on coconut leaf

Plate 2. Green coconut infested by scale insects

Plate 3. Coconut leaf affected by mealybug

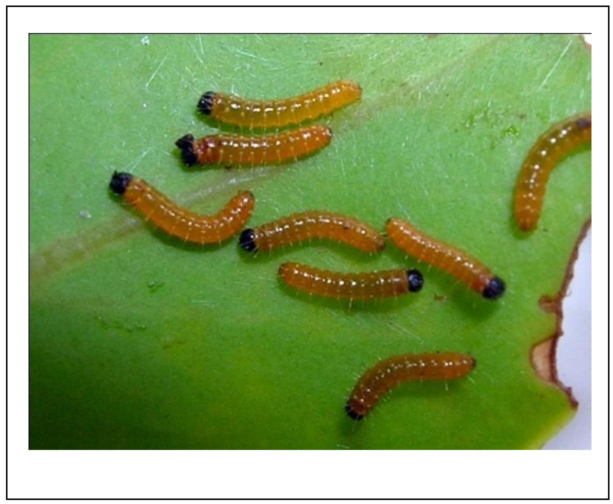

Plate 4. Black headed caterpillar

Plate 5. Rhinoceros beetle infesting coconut tree

Plate 6. Coconut leaves characteristically damaged by Rhinoceros beetle

Plate 7. Red palm weevil adult

Plate 8. Red palm weevil damaged coconut tree

Plate 9. Adult Termite

Plate 10. Termite infestation on coconut tree

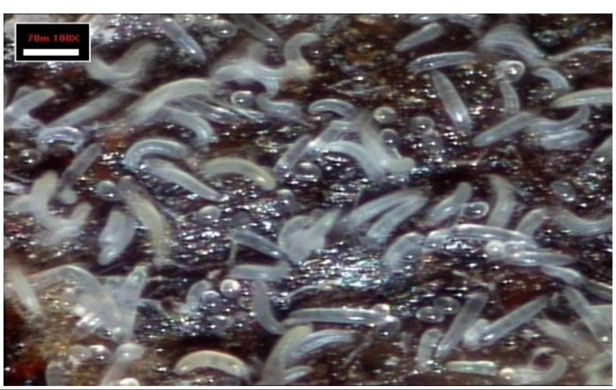

Plate 11. Juvenile Eriophyid mites

Plate 12. Green coconuts damaged by mite

6.2.2. Diseases of coconut recorded in Bangladesh

A total number of 12 species of disease causing pathogens of coconut were reported in Bangladesh, among which 10 diseases were caused by fungi, 1 caused by bacteriaand 1 caused by algae.

The incidences of fungal diseases of coconut reported in Bangladesh were coconut bud rot (*Phytophthora palmivora*), anthracnose (*Glomerella cingulated),* bitten leaf of coconut (*Ceratocystis paradoxa),*bipolaris leaf spot (*Bipolaris incurvata*),diplodia rot (*Lasiodiplodia theobromae),*stem bleeding disease (*Thielaviopsis paradoxa),* heart rot (*Phytophthora katsurae*), grey leaf spot of coconut (*Pestalotiopsis palmarum*), Cercospora leaf spot (*Cercospora palmivora*) and Curvularia leaf spot (*Cervularia* Sp.). The bacterial disease was bacterial bud rot (*Erwinia* spp.)and the algal disease was algal leaf spot (*Cephaleuros virescens*).

Among these diseases, the diplodia rot and stem bleeding disease were more damaging than others. But diseases were reported as minor diseases of coconut and caused damage with low infection intensity in Bangladesh. Most of cases, the damage severity was controlled by the growers through routine application of fungicides and other pesticides in the field of coconut.

6.2.3. Weeds of coconut recorded in Bangladesh

A total number of 5 weeds were reported as the problem in the field of coconut in Bangladesh. The incidences of weeds in the field of coconut were parthenium weed (*Parthenium hysterophorus* L.), iron weed (*Cyanthillium cinereum),* mission grass (*Pennisetum polystachion),* snakerootss (*Rauvolfia serpentine)* and *siam weed (Chromolaena odorata)*. The parthenium weed (*Parthenium hysterophorus*)was recorded and found only in some restricted areas of Bangladesh namely Rajshahi, Natore, Pabna, Kustia, Jessore districts. These districts are nearly attached with the Western border of Bangladesh and Eastern border of West Bengall of India. It was also reported that the parthenium weed might be entered into Bangladesh through cross boundary pathway from India by the transportation system of border trading.

Among the five weeds, the parthenium grows in the whole season. 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. Other four weeds were reported as minor weeds with low infestation intensity in the field coconut. Basically Bangladeshi growers controlled these weeds by weeding during intercultural operations of the field, thus these weeds remain as controlled condition except parthenium.

Table 3. Diseases of coconut in Bangladesh, their status, plant parts affected and infestation severity

Sl. No.	Common name	Scientific name	Family	Order	Plant parts affected	Pest status	Infestation severity
Causal organism: Fungi							
1	Coconut budrot	*Phytophthora palmivora*	Peronosporaceae	Peronosporales	Stem, fruit	Minor	Low
2	Anthracnose	*Glomerella cingulated*	Glomerellaceae	Sordariomycetidae	Leaves	Minor	Low
3	Bitten leaf of coconut	*Ceratocystis paradoxa*	Ceratocystidaceae	Microascales	Leaves	Minor	Low
4	Bipolaris leafspot	*Bipolaris incurvata*	Pleosporaceae	Pleosporales	Leaves	Minor	Low
5	Diplodia rot	*Lasiodiplodia theobromae*	Botryosphaeriaceae	Botryosphaeriales	Leaves	Minor	Low
6	Stem bleeding disease	*Thielaviopsis paradoxa*	Ceratocystidaceae	Microascales	Stem	Minor	Low
7	Heart rot	*Phytophthora katsurae*	Pythiaceae	Peronosporales	Stem, fruit	Minor	Low
8	Grey leaf spot of coconut	*Pestalotiopsis palmarum*	Amphisphaeriaceae	Xylariales	Leaves	Major	Medium
9	Cercospora leaf spot	*Cercospora palmivora*	Mycosphaerellaceae	Capnodiales	Leaves	Minor	Low
10	Curvularia leaf spot	*Curvularia* Sp.	Pleosporaceae	Pleosporales	Leaves	Minor	Low
Causal organism: Bacteria							
11	Bacterial bud rot	*Erwinia* spp.	Enterobacteriaceae	Enterobacteriales	Leaf, stem, fruit, inflorescence	Mainor	Low
Causal organism: Algae							
12	Algal leaf spot	*Cephaleuros virescens*	Trentepohliaceae	Trentepohliales	Leaf, stem, fruit	Minor	Low

Table 4. Weeds of coconut in Bangladesh, their status, plant stage affected and infestation severity

Sl. No.	Common name	Scientific name	Family	Order	Plant stage affected	Pest status	Infestation severity
1	Parthenium weed	*Parthenium hysterophorus* L.	Asteraceae	Asterales	Vegetative stage	Minor	Low
2	Iron weed	*Cyanthillium cinereum*	Asteraceae	Asterales	Vegetative stage	Minor	Low
3	Mission grass	*Pennisetum polystachion*	Poaceae	Cyperales	Vegetative stage	Minor	Low
4	Snake roots	*Rauvolfia serpentine*	Apocynaceae	Gentianales	Vegetative stage	Minor	Low
5	Siam weed	*Chromolaena odorata*	Asteraceae	Asterales	Vegetative stage	Minor	Medium

Some pictures of diseases of coconut are presented below;

Plate 13. Stem bleeding of coconut

Plate 14. Severely damaged coconut plant caused by stem bleeding

Plate 15. Anthracnose of coconut leaf

Plate 16. Coconut plant affected by *Hemicriconemoides mangiferae*

6.2.4. Management options for coconut pests in Bangladesh

Insect and mite pest management: The most effective and commonly practiced management options against the insect pests of coconut were spraying of insecticides in the tree. Irrigation was done for controlling soil dwelling insect namely termite and removal of harmful insects and infested fruits and parts of plants was also done. It was also reported that Integrated Pest Management (IPM) was also followed for controlling insect pests of coconut.

Disease management: The most effective and commonly practiced management options against the diseases of coconut were spraying of fungicides in the field, seedling treatment with fungicides for preventing seed borne diseases, and removal of diseased plants or parts of plants. Other management practices for controlling diseases of coconut were removal of weeds and spraying of insecticides in the coconut fields for disease transmitting vector control.

Weed management: The most effective and commonly practiced management options for weeds in the field of coconut were removal of weeds during land preparations and weeding during intercultural operations. Other options were earthing up at the base of plants, irrigation and use of herbicides.

6.3. Pests of Coconut in the Exporting Countries

The pests associated with fresh coconutand seedlingsas recorded in Sri Lanka, Vietnam, India, Thailand, Malaysia, Myanmar and other exporting countries of the world have been categorized and listed below based on their scientific name, taxonomic position, common name, plant parts affected, geographical distribution and their quarantine status for Bangladesh.

Fifty one(51) species of pests were recorded for coconutin the exporting countries as well as in Bangladesh, of which 23 species were insect pests and 2 species were mite pests; the species of disease causing fungi were 11, bacteria 4, nematode 3, virus & viroids were 2 and Algae 1. On the other hand, 5 species of weeds for coconut were recorded in the world.

Table 5depicted the lists of pests associated with the coconutthat also occur in Sri Lanka, Vietnam, India, Thailand, Malaysia, Myanmarand other countries of the worldas well as the absence or presence of these pests in Bangladesh.

6.4. Quaratine pests of coconut for Bangladesh

Twenty three(23) species of quarantine pests of coconut for Bangladesh were identified those were present in Sri Lanka, Vietnam, India, Phillipines, Thailand, Malaysia, Myanmar, but not in Bangladesh. Among these 23 species of quarantine pests,11 were insect pests,1 species was mite pest, 3 fungus, 3 bacteria, 2nematode species, 2viruses and weed was 1 species (Table 10).

The quarantine insect pests arecoconut bug (*Pseudotheraptus wayi),* lesser snow scale (*Pinnaspis strachani),* red scale (*Chrysomphalus dictyospermi),* spiked mealybug (*Nipaecoccus nipae),* long-tailed mealybug (*Pseudococcus longispinus),* black tea thrips (*Heliothrips haemorrhoidalis),* coconut leaf roller (*Omiodes blackburni),* coconut hispine beetle, (*Brontispa longissima),* nettle caterpillar (*Darna trima (Moore)),* saddle back caterpillar (*Acharia stimulea*) and bag worm (*Scoriodyta* spp.). The quarantine mite pest of coconut for Bangladesh is red palm mite (*Raoiella indica*) (Table 6).

On the other hand, ten (10) disease causing pathogens have been identified as quarantine pests of coconut for Bangladesh. Among these, three quarantine fungus named thanjavur wilt (*Ganoderma lucidum*), leaf scorch (*Fusarium* sp.) and leaf rot (*Cholletotrichum* Sp.)*:*three quarantine bacteria namely tatipaka (*Phytoplasma* spp.),lethal yellowing (Palm lethal yellowing) (*Candidatus Phytoplasma palmae (PLY))* and root wilt (*Mycoplasma like organism*)*;*two species of nematode namelyred ring nematode (*Coconut palm nematode*) (*Bursaphelenchus cocophilus) and* burrowing nematode (*Radopholus similis);* two viruses namelycadang-cadang (*Coconut cadang-cadang viroid (CCCVd)) and* coconut foliar decay (*Coconut foliar decay virus (CFDV)).* One species of quarantine weed has been identified Bangladesh named parthenium weed (*Parthenium hysterophorus*)(Table 6).

Table 5. Pests associated with coconut in the world and identification of quarantine organisms

SN	Common Name	Scientific name	Family	Order	Presence in Bangladesh	Quarantine status	References
Arthropod pests							
A. Insect pests							
1	Coconut bug	*Pseudotheraptus wayi*	Coreidae	Hemiptera	No	Yes	CABI/EPPO, 2014
2	Coconut scale	*Aspidiotus destructor*	Diaspididae	Hemiptera	Yes	No	APPPC, 1987
3	Green shield Scale	*Pulvinaria psidii*	Diaspididae	Hemiptera	Yes	No	CIE, 1994
4	Lantana scale	*Hemiberlesia lataniae*	Diaspididae	Hemiptera	Yes	No	NHM, undated
5	Oriental yellow scale	*Aonidiella orientalis*	Diaspididae	Hemiptera	Yes	No	NHM, 1927; CIE,1978
6	Lesser snow scale	*Pinnaspis strachani*	Diaspididae	Hemiptera	No	Yes	CABI, 2016
7	Red scale	*Chrysomphalus dictyospermi*	Diaspididae	Hemiptera	No	Yes	CIE, 1969; CABI, 2015
8	Spiked mealybug	*Nipaecoccus nipae*	Pseudococcidae	Hemiptera	No	Yes	APPPC, 1987; CABI/EPPO, 2005
9	Pineapple Mealybugs	*Dysmicoccus brevipes*	Pseudococcidae	Hemiptera	Yes	No	Ben-Dov, 1994; CIE, 1972
10	Guava mealybug	*Ferissia virgata*	Pseudococcidae	Hemiptera	Yes	No	CABI/EPPO, 2003; EPPO, 2014
11	Long tailed mealybug	*Pseudococcus longispinus*	Pseudococcidae	Hemiptera	No	Yes	CIE, 1984; AVA, 2001.
12	Coconut termite	*Odontotermes obesus*	Termitidae	Isoptera	Yes	No	APPPC, 1987
13	Black tea thrips	*Heliothrips haemorrhoidalis*	Thripidae	Hysanoptera	No	Yes	CIE, 1961; CABI, 2015
14	Coconut leaf	*Omiodes blackburni*	Crambidae	Lepidopter	No	Yes	Wikipedia, 2016

SN	Common Name	Scientific name	Family	Order	Presence in Bangladesh	Quarantine status	References
	roller			a			
15	Nettle caterpillar	*Darna trima* (Moore)	Limacodidae	Lepidoptera	No	Yes	CABI/EPPO, 2014
16	Black headed caterpillar	*Opisina arenosella*	Crytophasidae	Lepidoptera	Yes	No	Wikipedia, 2016
17	Coconut rhinoceros beetle	*Oryctes rhinoceros*	Scarabaeidae	Coleoptera	Yes	No	APPPC, 1987; EPPO, 2014; CABI/EPPO, 1998
18	Coconut hispine beetle	*Brontispa longissima*	Chrysomelidae	Coleoptera	No	Yes	EPPO, 2014
19	Red palm weevil	*Rhynchophorus ferrugineus*	Curculionidae	Coleoptera	Yes	No	Tabibullah & Ahmad, 1976; APPPC, 1987; CABI/EPPO, 2010; EPPO, 2014
20	Bark beetle	*Dendroctonus* spp.	Curculionidae	Coleoptera	Yes	No	Wikipedia, 2016
21	White grub/ dung beetle	*Phyllophaga spp.*	Scarabaeidae	Coleoptera	Yes	No	Selman, 2014
22	Saddle back caterpillar	*Acharia stimulea*	Limacodidae	Lepidoptera	No	Yes	Bibbs, C. S. and Frank, J.H., 2015
23	Bag worm	*Scoriodyta* spp.	Psychidae	Lepidoptera	No	Yes	Wikipedia, 2016
B. Mite pest							
24	Eriophyid coconut mite	*Aceria guerreronis*	Eriophyidae	Acarina	Yes	No	CABI/EPPO, 2006; EPPO, 2014
25	Red palm mite	*Raoiella indica* Hirst	Tenuipalpidae	Acarina	No	Yes	CABI/EPPO, 2007; EPPO, 2014
Diseases							
Causal organism: Fungi							
26	Coconut budrot	*Phytophthora palmivora*	Peronosporaceae	Peronosporales	Yes	No	Ramhan et al., 1989
27	Anthracnose	*Glomerella cingulated*	Glomerellaceae	Sordariomycetidae	Yes	No	Mridha et al., 1990

SN	Common Name	Scientific name	Family	Order	Presence in Bangladesh	Quarantine status	References
28	Bitten leaf of coconut	*Ceratocystis paradoxa* *Chalara paradoxa*	Ceratocystidaceae	Microascales	Yes	No	Ramhan et al., 1989
29	Bipolaris leafspot	*Bipolaris incurvata*	Pleosporaceae	Pleosporales	Yes	No	Wikipedia, 2014
30	Diplodia rot	*Lasiodiplodia theobromae*	Botryosphaeriaceae	Botryosphaeriales	Yes	No	CABI/EPPO, 2010; Shamim et al., 2010
31	Stem bleeding disease	*Thielaviopsis paradoxa*	Ceratocystidaceae	Microascales	Yes	No	Ramhan et al., 1989
32	Heart rot	*Phytophthora katsurae*	Pythiaceae	Peronosporales	Yes	No	Wikipedia, 2014
33	Grey leaf spot of coconut	*Pestalotiopsis palmarum*	Amphisphaeriaceae	Xylariales	Yes	No	Kohler et al., 1997
34	Thanjavur wilt	*Ganoderma lucidum*	Ganodermataceae	Polyporales	No	Yes	MAW, 1967
35	Leaf scorch	*Fusarium* sp.	Nectriaceae	Hypocreales	No	Yes	MAW, 1967
36	Leaf rot	*Cholletotrichum* Sp.	Glomerellaceae	Glomerellales	No	Yes	MAW, 1967
37	Cercospora leaf spot	*Cercospora palmivora*	Mycosphaerellaceae	Capnodiales	Yes	No	
38	Curvularia leaf spot	*Curvularia* Sp.	Pleosporaceae	Pleosporales	Yes	No	
Causal organism: Bacteria							
39	Bacterial bud rot/ Thanjavur wilt	*Erwinia* spp.	Enterobacteriaceae	Enterobacteriales	Yes	No	Ramhan et al., 1989
40	Lethal yellowing (Palm lethal yellowing)	*Candidatus Phytoplasma palmae (PLY)*	Acholeplasmataceae	Acholeplasmatales	No	Yes	Brown *et al.,* 2006; Howard, 1992; Wikipedia, 2017
41	Tatipaka	*Phytoplasma* spp.	Acholeplasm	Acholeplas	No	Yes	MAW, 1967

SN	Common Name	Scientific name	Family	Order	Presence in Bangladesh	Quarantine status	References
			ataceae	matales			
42	Root wilt	*Mycoplasma like organism*	Mycoplasmataceae	Mycoplasmatales	No	Yes	MAW, 1967
Causal organism: Nematode							
43	Red ring nematode (Coconut palm nematode)	*Bursaphelenchus cocophilus*	Parasitaphelenchidae	Aphelenchida	No	Yes	Wikipedia, 2015
44	Burrowing nematode	*Radopholus similis*	Pratylenchidae	Tylenchida	No	Yes	CABI/EPPO, 1999; EPPO, 2014
Virus							
45	Cadang-cadang	*Coconut cadang-cadang viroid (CCCVd)*	Pospiviroidae		No	Yes	EPPO, 2014
46	Coconut foliar decay	*Coconut foliar decay virus (CFDV)*	Nanoviridae		No	Yes	EPPO, 2014
Algea							
47	Algal leaf spot	*Cephaleuros virescens*	Trentepohliaceae	Trentepohliales	Yes	No	Thangavelu *et al.*, 2014
Weed							
Grasses							
48	Mission grass	*Pennisetum polystachion*	Poaceae	Cyperales	Yes	No	USDA-ARS, 2012
Broad leaf							
49	Parthenium weed	*Parthenium hysterophorus* L.	Asteraceae	Asterales	Yes	No	Mahadevappa, 1997; EPPO, 2014
50	Iron weed	*Cyanthillium cinereum*	Asteraceae	Asterales	Yes	No	Holm et al., 1997
51	Snakeroots	*Rauvolfia serpentine*	Apocynaceae	Gentianales	Yes	No	Wikipedia, 2017
52	*Siam weed*	*Chromolaena odorata*	Asteraceae	Asterales	Yes	No	Gautier, 1992b

Table 6. Quarantine pests for Bangladesh likely to be associated with coconutimported from flower exporting countries

Sl. No.	Common name	Scientific name	Distribution to flower exporting countries	Plant parts likely to carry the pest	References
Arthropods					
Insect pests					
1	Coconut bug	*Pseudotheraptus wayi*	Kenya, South Africa, Tanzania, Zambia	Fruit	CABI/EPPO, 2014
2	Lesser snow scale	*Pinnaspis strachani*	China, India, Malaysia	Fruit, Leaves	CABI,2016
3	Red scale	*Chrysomphalus dictyospermi*	China, India, Japan, Malaysia, Myanmar, Philippines, Sri Lanka, Thailand and Turkey	Fruits, leaves, seelings	CIE, 1969; CABI,2015
4	Spiked mealybug	*Nipaecoccus nipae*	China, India, Iran, Jordan, Soudi Arabia, Turkey, Egypt, USA, Brazil, France	Fruit, leaves, Seedlings	APPPC, 1987; CABI/EPPO, 2005
5	Long-tailed mealybug	*Pseudococcus longispinus*	China, India, Iran, Jordan, Soudi Arabia, Turkey, Egypt, USA, Brazil, France, Philippines, Malaysia	Fruit, leaves, seedlings	CIE, 1984; AVA, 2001.
6	Black tea thrips	*Heliothrips haemorrhoidalis*	China, India, Japan, Malaysia, Myanmar, Philippines, Sri Lanka, Thailand and Turkey	Fruit, leaves, seedlings	CABI, 2015
7	Coconut leaf roller	*Omiodes blackburni*	USA	Fruit	Wikipedia, 2016
8	coconut hispine beetle	*Brontispa longissima*	China, Indonesia, Japan, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam, Australia	Human Activities	EPPO, 2014
9	Nettle caterpillar	*Darna trima* (Moore)	Indonesia, Netherlands	Leaf, seedlings	CABI, 2014
10	Saddle back caterpillar	*Acharia stimulea*	USA	Leaf, stem, fruit, inflorescence	Bibbs, C. S. and Frank, J.H., 2015
11	Bag worm	*Scoriodyta* spp.	Through Europe	Leaf, stem, fruit, inflorescence	Wikipedia, 2016
Mite pest					
12	Red palm mite	*Raoiella indica* Hirst	India, Iran, Israel, Oman, Pakistan, Philippines, Saudi Arabia, Sri Lanka,	Palm handicrafts, cut flower and leaf	CABI/EPPO, 2007; EPPO, 2014

			Thailand, United Arab Emirates, Egypt, USA, Brazil, Russian Federation	arrangements from host plants and coconut seed	
Disease causing organisms					
Fungi					
13	Thanjavur wilt	*Ganoderma lucidum*	India, Sri Lanka	Leaf, stem, root	MAW, 1967
14	Leaf scorch	*Fusarium* sp.	India, Sri Lanka,	Leaf, stem, fruit	MAW, 1967
15	Leaf rot	*Cholletotrichum* Sp.	India	Leaf	MAW, 1967
Bacteria					
16	Tatipaka	*Phytoplasma* spp.	India, Sri Lanka	Stem, leaf, fruit	MAW, 1967
17	Lethal yellowing (Palm lethal yellowing)	*Candidatus Phytoplasma palmae (PLY)*	Africa, USA,	Seed	Brown *et al.,* 2006; Howard, 1992; Wikipedia, 2017
18	Root wilt	*Mycoplasma like organism*	India, Sri :anka	Stem, root, leaf	MAW, 1967
Nematode					
19	Red ring nematode (Coconut palm nematode)	*Bursaphelenchus cocophilus*	USA	Fruit	Wikipedia, 2015
20	Burrowing nematode	*Radopholus similis*	China, India, Indonesia, Japan, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand, USA,	Infested plants	CABI/EPPO, 1999; EPPO, 2014
Virus					
21	Cadang-cadang	*Coconut cadang-cadang viroid (CCCVd)*	Malaysia, Philippines, Sri Lanka, Solomon Islands	Seed, Fruit	EPPO, 2014
22	Coconut foliar decay	*Coconut foliar decay virus (CFDV)*	Vanuatu	Seed, Fruit	EPPO, 2014
Weeds					
23	Parthenium weed	*Parthenium hysterophorus*	Bhutan, India, Indonesia, Israel, Japan, Jordan, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam, South Africa, USA,	Transport, equipments	EPPO, 2014

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CHAPTER 7

RISK ASSESSMENT

The risk analysis of quarantine pests include the use of a developing or evolving process (PPQ, 2000; Orr *et al.,* 1993), the approach used to combine risk elements (Bier, 1999; Morgan and Henrion, 1990), and the evaluation of risk by comparisons to lists of factors within the guidelines (Kaplan, 1992; Orr *et al.,* 1993). The risk assessment was done in accordance with International Plant Protection Convention (IPPC) and the International Standards for Phytosanitary Measures (ISPM 2 and ISPM 11). The risk analysis of quarantine pests of coconut idenfied for Bangladesh has been analyzed details as follows:

7.A . Arthopod: Insect and mites pests

7.1. Coconut bug, *Pseudotheraptus wayi* Brown

7.1.1. Hazard identification

Scientific Name: *Pseudotheraptus wayi* Brown
Synonyms:
Theraptus sp. (Way, 1951)
Common names: Coconut bug
Taxonomic tree
Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Hemiptera
Suborder: Heteroptera
Family: Coreidae
Genus: *Pseudotheraptus*
Species: *Pseudotheraptus wayi*

EPPO Code: PSDTWA.
Bangladesh status: Not present in Bangladesh [CABI/EPPO, 2014]

7.1.2. Biology

Total developmental duration (egg to adult emergence) was approximately 43 days. Sex ratio was 0.44. Fifty percent of females lived up to the age of 154 days, while the median adult survival age for males was 183 days. Mean fecundity was 171 ± 39.2 (ranging from 2–339) eggs per female. Daily egg production ranged from 0–14 eggs per female per day. Development of *P. wayi* from egg through five instars to the adult stage on coconut and cashew takes 31–41 days under different temperature regimes, while adult females survive on coconut for 45–66 days and males for 83–84 days, at 24.6°C (Way, 1953a; Wheatley, 1961; Mitchell, 2000; CABI, 2005). Preoviposition period on these hosts is 9–13 days, and eggs are laid singly at a rate of 2–3 per day, for a total lifetime fecundity of 74– 100 eggs per female (Way, 1953a; Mitchell, 2000).

7.1.3. Hosts

P. wayi is considered a specialist phytophagous species. Its host range is wide. The coconut bug was observed on cashew nut, carambola, pecan, cinnamon, coconut, loquat, lichi, macadamia nut, mango, avocado, guava, cocoa etc.

7.1.4. Distribution

Africa: Botswana (CABI/EPPO, 2014), Cote d'Molre (CABI/EPPO, 2014), Kenya (CABI/EPPO, 2014), South Africa (Schoeman & Mohlala, 2013), Tanzania (CABI/EPPO, 2014), Zambia (CABI/EPPO, 2014).

7.1.5. Hazard Identification Conclusion

Considering the facts that *Pseudotheraptus wayi* -

- is not known to be present in Bangladesh [CABI/EPPO, 2014];
- is potentially less economic important to Bangladesh because it is an important pest of coconut in Africa including Botswana, Cote d'Molre, Kenya, **South Africa**, Tanzania, Zambia [CABI/EPPO, 2014] from where coconuts are not imported to Bangladesh.
- *P. wayi* is responsible for early nut-fall and gummosis of coconuts in East Africa. Young nymphs feed in the developing spadix at the base of the male flowers, or in the main stem and young branches which are still succulent. Older nymphs and adults tend to feed more on the developing nuts and female flowers. The toxic saliva of the bugs causes necrotic spots to appear. Young nuts are frequently killed by the toxic saliva (Hill, 1975).
- *Pseudotheraptus wayi* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

7.1.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 1.1 – Which of these descriptions best fit of this pest?

Description	**Establish ment Potential**
a. **Has this pest been established in several new countries in recent years-Yes**, • *Pseudotheraptus wayi* has been recorded in **Botswana, Cote d'Molre** and Zambia (CABI/EPPO, 2014). • The presence of *Pseudotheraptus wayi* has been confirmed in Kenya, **South Africa**, Tanzania (Zanzibar) (CABI/EPPO, 2014; Way, 1953b; Way, 1953a; Hill, 1975; Schoeman & Mohlala, 2013) from where Bangladesh does not import coconut seedlings. **b. Posibility of survival during transport, storage and transfer? Yes** • Development of *P. wayi* from egg through five instars to the adult stage on coconut and cashew takes 31–41 days under different temperature regimes, while adult females survive on coconut for 45–66 days and males for 83–84 days, at 24.6°C (Way, 1953a; Wheatley, 1961; Mitchell, 2000; CABI, 2005). • The transport duration of coconut from exporting countries to Bangladesh is about 20 days. So, the duration is favorable for this insect to survival. • For the transportation, storage and transfer coconut seedlings and coconut fruit temperature is maintained under 20°C, in which temperature *P. wayi* can survive. **c. Does the pathway appear good for this pest to enter Bangladesh and establish and dispersal? - Yes,** • *P. wayi* lay eggs on the under side of the leaves of coconut. And the tiny larvae just after hatch inter into the leaves. So it is difficult to diagnocis infection with nacked eyes. • For *P. wayi*, host plants are similar in Bangladesh. • Though in case of coconut there is no relation with South African countries. But in future if we import coconut or seedlings from such	**YES and Moderate**

countries, it became a great problem for us. • For this reason the pathway appear good for this pest to enter Bangladesh and establishment. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • These climatic requirements for growth and development of*A. assectella*is more or less similar with the climatic condition of **Bangladesh**.	
• NOT AS ABOVE OR BELOW	**Moderate**
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.1.7. Determine the Consequence establishment of this pest in Bangladesh

Table 1.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - Yes. • *P. wayi* is a serious pest in Kenya, Tanzania, and Zanzibar on coconut, but actual crop loss is difficult to assess, partly because of the natural nut-fall. Over 70% of young nuts will fall naturally and so many of the bug-damaged nuts would fall anyway. In certain areas of Zanzibar, crop losses of up to 100% can occur (Way, 1951). • Though the host plants and climate requirement of *P. wayi* are similar with Bangladesh, so it will be serious pest for Bangladesh. **b. Economic impact and yield loss** • *P. wayi* is a serious pest in Kenya, Tanzania, and Zanzibar on coconut, but actual crop loss is difficult to assess, partly because of the natural nut-fall. Over 70% of young nuts will fall naturally and so many of the bug-damaged nuts would fall anyway. In certain areas of Zanzibar, crop losses of up to 100% can occur (Way, 1951). • A packhouse survey of insect damage to avocados in the Nelspruit/Hazyview area of South Africa indicated that damage by P. wayi during the 1990 season amounted to 4.7% (Dennill and Erasmus, 1991), wheras a similar study by Erichsen and Schoeman (1992) reported a figure of 2.8%. If these figures are representative of the annual crop loss, the avocado industry loses 2-4 million South African Rand per annum to P. wayi. • Van der Meulen (1989) concluded that the percentage damage caused by the coconut bug on unsprayed guavas in the Nelspruit area, South Africa, could range between 12.2% and 52.4% at harvest. • In Eastern and Southern Africa damage of up to 99.8% on coconut (Way 1953a), 52.4% on guava (Van Der Meulen 1992), 76.2% on avocado fruits (Van Der Meulen and Schoeman 1994), and 80% on cashew nut (Nyambo 2009) has been attributed to *P. wayi*. **c. Environmental Impact** • *P. wayi* will be a new pest for Bangladesh and no research present for effective controlling measurement for this pest. As a result farmers will use chemical insecticides at excess and/or less dose. As a result, pest registant, outbreak will be occurred. And this chemical insecticides damage our	**Yes and High**

environment, kill animals, birds etc. and also damage aquatic ecosystem.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

7.1.8.. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table1.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	High	High
High	Moderate	High
Moderate	**High**	**High**
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

7.1.9. Risk Management Measures

- Avoid importation of buds, seedlings and seeds from countries, where this pest is available.
- In countries where *Pseudotheraptus wayi* is not already present, the enforcement of strict phytosanitary regulations as required for *A. assectella*, may help to reduce the risk of this coconut bug becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the pest (OEPP/EPPO, 1990). Particular attention is needed for consignments from countries where certain *Pseudotheraptus wayi* are present.

7.1.10 References

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7.2. Lesser snow scale, *Pinnaspis strachani* (Cooley) 1899

7.2.1. Hazard identification

Scientific Name: *Pinnaspis strachani (*Cooley) 1899
Synonyms:

Chionaspis (Hemichionaspis) aspidistrae Newstead, 1906
Hemichionaspis marchali Cockerell, 1902
Hemichionaspis minor var. strachani Cooley, 1899
Hemichionaspis strachani Cockerell, 1902
Hemichionaspis townsendi Cockerell, 1905
Pinnaspis gossypii (Newstead) Hall, 1946
Pinnaspis marchali (Cockerell) Hall, 1946
Pinnaspis temporaria Ferris, 1942

Common names: lesser snow scale, cotton white scale; Hibiscus snow scale

Taxonomic tree
Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Hemiptera
Suborder: Sternorrhyncha
Superfamily: Coccoidea
Family: Diaspididae
Genus: Pinnaspis
Species: *Pinnaspis strachani*
EPPO Code: PINNST
Bangladesh status: Not present in Bangladesh [CABI, 2016]

7.2.2. Biology

The first sign of hibiscus snow scale is the presence of armor on upper and lower leaf surfaces, fruits, and stems of plants. The female armor is about 1.5 to 2 5 mm long (1/16 to 1/8th inch). The adult female armor is flat, irregularly oyster shell or pear-shaped, tough, white or dirty white. The cast skins of the nymph form a yellowish-brown spot, called a terminal exuvium, at the narrow end of the armor (Dekle 1965). Male armor is also white, but smaller (1 mm, which is less than l/16 inch). Males are long and narrow with three ridges running lengthwise. The armor must be pried off to reveal the insect. Females and feeding nymphs are attached to the plant by hair-like mouthparts. The female body is a flat, elongated oval shape without wings, legs, or eyes, Dead ones are dark brown and are dried rather than plump. Armored scales feed on plant juices and cause loss of vigor, deformation of infested plant parts, yellowish spots on leaves, loss of leaves, and even death of the plant (Dekle 1965, Beardsley & Gonzalez 1975). Since scales are spread by introduction of infested material and are difficult to identify to species outside of the lab, scales of the genus Pinnaspis are a quarantine problem on exported potted plants, cut flowers, and cut foliage. The number of days for each developmental stage and the number of generations per year depend on temperature, humidity, and rainfall (Beardsley & Gonzalez 1975) Based on a generalized life history of other tropical species, 30 days is the approximate time to complete the life cycle from egg to reproducing adult.

7.2.3. Hosts

Hosts include asparagus, avocado, bird of paradise, carambola, cherimoya, chinaberry, citrus, coconut palm, croton, cycads, dracaena, ferns, geranium, hala, hi'aloa, hibiscus, jacaranda, Iychee, mango. Mexican creeper, native cotton, oleander, pikake, plumeria, poinciana, red pepper, sweet potato, ti and wisteria. This is a short list out of over 150 plant hosts listed for hibiscus snow scale (Deckle 1965).

7.2.4. Distribution

Widespread. An immigrant to the Hawaiian Islands, hibiscus snow scale was first recorded in 1910 (Zimmerman 1948).

- **Asia:** China (Ferris, 1947; NHM); **India** (Ferris, 1947), **Indonesia** (NHM); Korea, Republic of (Restricted distribution); **Malaysia** (NHM); Pakistan (NHM); **Philippines** (Ferris, 1947) and **Sri-Lanka** (Fernando & Kanagaratnam, 1987; Ferris, 1947)
- **Africa:** Cameroon, Kenya, Madagascar, Nigeria, Senegal, Sudan, Uganda (Mamet, 1954)
- **North America:** Bermuda, Mexico (Restricted distribution) and USA (Restricted distribution) (Miller, 1996; Ferris, 1947; Merrill, 1953)

7.2.5. Hazard Identification Conclusion

Considering the facts that *Pinnaspis strachani* -

- is not known to be present in Bangladesh [CABI,2016];
- Is potentially economic important to Bangladesh because it is an important pest of Sri-Lanka, India and Malaysia from where young seedlings are imported to Bangladesh.
- *P. strachani* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

7.2.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 2.1 – Which of these descriptions best fit of this pest?

Description	Establishment Potential
a. Has this pest been established in several new countries in recent years-No	

• There are no studies about the newly establishment of *P. strachani* in any other countries in the world. But it became a serious pest where it estabilished and it already estabilished in major coconut producing countries. **b. Posibility of survival during transport, storage and transfer? Yes** • Though young seedlings of coconut are imported to Bangladesh. This pest lay eggs under side of the leaf and this eggs remain dormant at low temperature. So this pest can survive during transport due to their overwintering characteristics at low temperature. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • The coconut seedlings are imported into Bangladesh from Sri-Lanka, Malaysia and India. *P. strachani* is a common problem in such countries. So, the pathway appear good for this pest to entire in Bangladesh. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • The host range of *P. strachani* is common in Bangladesh and the climate in Bangladesh is also suitable for establishment of *P. strachani* in Bangladesh.	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• **This pest has not established in new countries in recent years** • **The pathway does not appears good for this pest to enter Bangladesh and establish, and** • **Its hosts are not common in Bangladesh and climate is not similar to places it is established.**	Low

7.2.7. Determine the Consequence establishment of this pest in Bangladesh

Table 2.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - Yes. • Hosts include asparagus, avocado, bird of paradise, carambola, cherimoya, chinaberry, citrus, coconut palm, croton, cycads, dracaena, ferns, geranium, hala, hi'aloa, hibiscus, jacaranda, lychee, mango. Mexican creeper, native cotton, oleander, pikake, plumeria, poinciana, red pepper, sweet potato, ti and wisteria. This is a short list out of over 150 plant hosts listed for hibiscus snow scale and most of the host are more or less common in our country. **b. Economic impact and yield loss** • *P. strachani* is an important occasional pest of several economic crops including Citrus, Hibiscus, palms, coconut, mango, cassava and grapefruits. Gill (1997) reported this species to be commonly encountered in California, USA, on coconut husks and caps in quarantine, and on ti and ginger plants shipped from Hawaii. It is considered a minor pest of coconut in Sri Lanka (Fernando and Kanagaratnam, 1987). This species is commonly found infesting a number of plants in greenhouses. **c. Environmental Impact** • Due to estabilishment of this pest different types of chemical insecticides are used by farmers, which causes a negative effect to our natural environment, hampered natural control system, development of resistence, resurgence and secondary pest outbreak.	**Yes and High**

• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

7.2.8.. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table2.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	**High**	**High**
High	Moderate	High
Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

7.2.9. Risk Management Measures

- Avoid importation of buds and seedlings from countries, where this pest is available.
- In countries where *P. strachani*is not already present, the enforcement of strict phytosanitary regulations as required for *P. strachani*, may help to reduce the risk of this lesser scale becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the pest (OEPP/EPPO, 1990). Particular attention is needed for consignments from countries where certain *A. assectella* are present.

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7.3. Red scale, *Chrysomphalus dictyospermi* (Morgan, 1889)

7.3.1. Hazard identification

Scientific Name: *Chrysomphalus dictyospermi* (Morgan, 1889)
Synonyms:

Aspidiotus (Chrysomphalus) dictyospermi (Morgan) Cockerell, 1897
Aspidiotus agrumicula De Gregorio, 1915
Aspidiotus arecae (Newstead) Cockerell, 1894
Aspidiotus dictyospermi Morgan, 1889
Aspidiotus dictyospermi jamaicensis Cockerell, 1894
Aspidiotus dictyospermi var. arecae Newstead, 1893
Aspidiotus jamaicensis (Cockerell) Ferris, 1941
Aspidiotus mangiferae Cockerell, 1893
Chrisomphalus dictyospermi Yasnosh, 1995
Chrysomphalus arecae (Newstead) Malenotti, 1916
Chrysomphalus castigatus Mamet, 1936
Chrysomphalus dictyospermatis Lindinger, 1949

Common names: dictyosperm scale; Morgan's scale; palm scale;

Taxonomic tree

Domain: Eukaryota
- Kingdom: Metazoa
  - Phylum: Arthropoda
    - Subphylum: Uniramia
      - Class: Insecta
        - Order: Hemiptera
          - Suborder: Sternorrhyncha
            - Superfamily: Coccoidea
              - Family: Diaspididae
                - Genus: Chrysomphalus
                  - Species: *Chrysomphalus dictyospermi*

EPPO Code: CHRYDI
Bangladesh status: Not present in Bangladesh [CIE, 1969; CABI,2015]

7.3.2. Biology

Reproduction is sexual in most *C. dictyospermi* populations. The adult male flies to locate the sessile adult female, and the long genitalia are used to mate with the female beneath her scale cover. It is likely that the male locates an unmated female by smell, although details of the pheromone secretion mechanism are not known. However, both uniparental (parthenogenetic) and biparental (sexual) populations of this species have been recorded in the USA (Brown, 1965). Each female lays 1 to 200 eggs beneath her scale cover, where they are sheltered until they hatch and the first-instar crawlers disperse. *C. dictyospermi* requires warm temperatures and does not multiply much in cold weather. In Egypt, optimal conditions for *C. dictyospermi* were found to be 22 to 25°C, and mean relative humidity of 50 to 58% (Salama, 1970).

7.3.3. Hosts

C. dictyospermi is a highly polyphagous species; Borchsenius (1966) recorded it from hosts belonging to 73 plant families, but its host range is probably wider than this. Favoured hosts are citrus and other trees such as olives (Olea europaea subsp. europaea) and palms. Ebeling (1950) noted that it preferred feeding on leaves.

a) Major hosts: *Albizia julibrissin* (silk tree), Citrus, *Cocos nucifera* (coconut), Musa (banana), Rosa (roses), Zingiber (ginger)

b) Minor hosts:*Vitis vinifera* (grapevine), Pyrus (pears), *Psidium guajava* (guava), *Phoenix* (date palm), *Elaeis guineensis* (African oil palm)

7.3.4. Distribution

C. dictyospermi is probably native to southern China (Longo *et al.,* 1995); it is widespread in tropical and subtropical regions, and occurs under glass in temperate areas (Davidson and Miller, 1990; Gill, 1997). It is distributed predominantly in Mediterranean countries such as Turkey and Syria, and in Middle Eastern countries such as Iran (Lodos, 1982). In Turkey, it is more common in the Aegean region than in the Black Sea and Mediterranean regions (Alkan, 1953). It has a wide distribution in the South Pacific area, and plant quarantine interceptions from the region suggest that it has an even wider distribution there than has been documented (Williams and Watson, 1988). In spite of the record published in Danzig and Pellizzari (1998), *C. dictyospermi* has not been recorded in the UK in recent years and is regarded as absent (CP Malumphy, Central Science Laboratory, UK, personal communication, 2002).

- **Asia:** China (CIE, 1969); **India** (CIE, 1969), Japan, **Malaysia, Myanmar, Philippines**, **Sri Lanka, Thailand** and Turkey (CIE, 1969; Wong, 1999)
- **Africa:** Cameroon, Kenya, Nigeria, Sudan (CIE, 1969; Matile-Ferrero & Oromí, 2001; Amparo Blay Colcoechea, 1993)
- **North America:** Mexico (Schotman, 1989; Miller, 1996; Myartseva & Ruíz-Cancino, 2000; CIE, 1969), USA (Restricted distribution) (CIE,1996)
- **Central America:** Cuba, Costa Rica, Panama (CIE, 1969)
- **South America:** Argentina (Claps & Terán, 2001; CIE, 1969; Claps *et al.*, 2001; Crouzel, 1973), Brazil, Chile (CIE, 1969; Claps *et al.,* 2001)
- **Europe:** France, Italy, Poland, Spain (Longo *et al.,* 1995; CIE, 1969; Danzig & Pellizzari, 1998)
- **Oceania:** Australia, Fiji (Veitch & Greenwood, 1921; Greenwood, 1929; Williams & Watson, 1988; CIE, 1969; Simmonds, 1925; Lever, 1945)

7.3.5. Hazard Identification Conclusion

Considering the facts that *C. dictyospermi* -

- is not known to be present in Bangladesh [CIE, 1969; CABI,2015];
- Is potentially economic important to Bangladesh because it is an important pest of coconut in USA from where young seedlings are imported to Bangladesh.

- *C. dictyospermi* is mentioned on quarantine lists (Burger and Ulenberg, 1990). It could become a serious pest of palms in greenhouses in the USA (Westcott, 1973).
- *C. dictyospermi* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

7.3.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 3.1 – Which of these descriptions best fit of this pest?

Description	Establishment Potential
a. Has this pest been established in several new countries in recent years-No • *C. dictyospermi* is probably native to southern China (Longo *et al.,* 1995); it is widespread in tropical and subtropical regions, and occurs under glass in temperate areas (Davidson and Miller, 1990; Gill, 1997). It is distributed predominantly in Mediterranean countries such as Turkey and Syria, and in Middle Eastern countries such as Iran (Lodos, 1982). In Turkey, it is more common in the Aegean region than in the Black Sea and Mediterranean regions (Alkan, 1953). It has a wide distribution in the South Pacific area, and plant quarantine interceptions from the region suggest that it has an even wider distribution there than has been documented (Williams and Watson, 1988). Moreover, this pest is already established in many Asain countries from where we imported many coconut seedlings. **b. Posibility of survival during transport, storage and transfer? Yes** • *C. dictyospermi* requires warm temperatures and does not multiply much in cold weather. In Egypt, optimal conditions for *C. dictyospermi* were found to be 22 to 25°C, and mean relative humidity of 50 to 58% (Salama, 1970). So, the storage condition is favourable for its growth, reproduction and survival. Besides this, the transport duration of seedlings from exporting countries is about 20 days, which is favourble for their survival. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Pest or symptoms not visible to the naked eye but usually visible under light microscope. So, it is very difficult to detect them during inspection. Moreover, the adults, eggs, nymphs and pupae may enter into imported countries through seedlings, barks, leaves, flowers. • Crawlers are the primary dispersal stage and move to new areas of the plant or are dispersed by wind or animal contact. Mortality due to abiotic factors is high in this stage. • Dispersal of sessile adults and eggs occurs through human transport of infested plant material. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • *C. dictyospermi* is a highly polyphagous species; Borchsenius (1966) recorded it from hosts belonging to 73 plant families, but its host range is probably wider than this. Favoured hosts are citrus and other trees such as olives (Olea europaea subsp. europaea) and palms. Ebeling (1950) noted that it preferred feeding on leaves. Besides this Citrus, *Cocos nucifera* (coconut), Musa (banana), Rosa (roses), Zingiber (ginger), etc are its major hosts. So, the pests can easily estabilished in our country. The climatic condition of exporting countries and our countries is more or less same.	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• **This pest has not established in new countries in recent years** • **The pathway does not appears good for this pest to enter Bangladesh**	Low

and establish, and • **Its hosts are not common in Bangladesh and climate is not similar to places it is established.**	

7.3.7. Determine the Consequence establishment of this pest in Bangladesh
Table 3.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - Yes. • Citrus, *Cocos nucifera* (coconut), Musa (banana), Rosa (roses), Zingiber (ginger), etc are its major hosts. So, the pest can easily estabilished in our country. The pest became a serious pest where they established and the insect established in those countries from where we imported coconut seedlings. So, if the pests enter into our country become a serious pest. **b. Economic impact and yield loss** • *C. dictyospermi* is known mainly as a serious pest of Citrus (Zahradník, 1990). In Spain, Melia (1976) recorded it as one of the arthropods responsible for rejection of 22% of citrus fruits in the sorting and packing house; wastage was highest for Navel oranges (23%) and lowest for blood oranges (9%). Danzig and Pellizzari (1998) referred to *C. dictyospermi* as a dangerous pest in the Palaearctic region. Miller and Gimpel (2004) mentioned it being a most serious pest of citrus in the western Mediterranean Basin, Greece and Iran. Crouzel (1973) recorded *C. dictyospermi* causing damage of economic importance to citrus in Argentina, and Squire (1972) recorded the scale as a pest of citrus and other plants in Bolivia. In the Republic of Georgia, it is the main scale insect pest of citrus (Chkhaidze and Yasnosh, 2001). In Russia, *C. dictyospermi* is a pest of tea (Dzhashi, 1970). It is also known as a minor pest in Mexico and South America (Rosen and DeBach, 1978). Foldi (2001) listed it as an economically important pest in France. • In Turkey, *C. dictyospermi* was most active in citrus plantations in the Aegean region in the past, and even now is often found on citrus trees in gardens, where damage is generally caused by the larvae and is not economically serious; however, never less than 25% of tangerine fruit are heavily infested (Tuncyurek and Oncuer, 1974; Soydanbay, 1977). Infestation decreases plant growth and development and disfigures the fruit, reducing their market value. *C. dictyospermi* is a pest in citrus plantations in the Black Sea region of Russia (Wyniger, 1962) and is the most important scale insect in Greece (De Bach and Argryiou, 1967). In Egypt, it attacks ornamental plants under glass (Nada, 1987). • In the western Mediterranean region and Florida, USA, *C. dictyospermi* is a serious pest of Citrus; it is a minor pest of Citrus, palms and young avocado trees in Mexico and South America (Chua and Wood, 1990; Gill, 1997). The species is of economic importance on several hosts in Brazil, and is regarded as a pest in Argentina, where it occurs on both cultivated and native plants; in Chile it is a primary pest on Citrus and is common on ornamental plants (Claps et al., 2001). *C. dictyospermi* is a pest of olive in Italy, Spain and Turkey (Argyriou, 1990). The species has been reported as a significant pest of Citrus in a number of countries in the South Pacific region; it is also very destructive to rose trees (Williams and Watson, 1988). FAO (1976) recorded *C. dictyospermi* attacking Pinus caribaea and Pinus caribaea var. hondurensis in Fiji.	**Yes and High**

c. Environmental Impact	
• The estabilishment of the insect creats a serious problem in many countries. Farmers use different types of pesticides to control this insect. The excessive use of harmful pesticides cause different type of hazards like development of resistence, resurgence and secondary pest outbread.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

7.3.8.. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 3.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	**High**	**High**
High	Moderate	High
Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

7.3.9. Risk Management Measures

- Avoid importation of coconut and seedlings from countries, where this pest is available.
- In countries where *C. dictyospermi* is not already present, the enforcement of strict phytosanitary regulations as required for *C. dictyospermi*, may help to reduce the risk of this red scale becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the pest (OEPP/EPPO, 1990). Particular attention is needed for consignments from countries where certain *C. dictyospermi* are present.

7.3.10. References

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7.4. Spiked mealybug, *Nipaecoccus nipae (Maskell, 1893)*

7.4.1. Hazard Identification

Scientific Name: *Nipaecoccus nipae* (Maskell, 1893)
Synonyms:

*Ceroputo nipae (*Maskell), Lindinger, 1904

Dactylopius dubia Maxwell-Lefroy, 1903

Dactylopius nipae Maskell, 1893

Common names: Spiked mealybug, Spiked mealybug,
Taxonomic tree

- Domain: Eukaryota
- Kingdom: Metazoa
  - Phylum: Arthropoda
    - Subphylum: Uniramia
      - Class: Insecta
        - Order: Hemiptera
          - Suborder: Sternorrhyncha
            - Superfamily: Coccoidea
              - Family: Pseudococcidae
                - Genus: Nipaecoccus
                  - Species: *Nipaecoccus nipae*

EPPO Code: NIPANI.
Bangladesh status: Not present in Bangladesh [APPPC, 1987; CABI/EPPO, 2005]

7.4.2. Biology

N. nipae is sexually reproductive but its biology and ecology are poorly known. Males and females cannot be readily distinguished from each other during the first two instars, but the third instar female begins to resemble the adult. When present, immature males change within a pupal cocoon during the third instar prior to emerging as a winged adult

7.4.3. Hosts

N. nipae is polyphagous and attacks 80 genera of plants belonging to 43 families (Ben-Dov, 1994). It is recorded feeding on a wide range of economically important plants, mostly fruit crops and ornamentals, including avocados, bananas, citrus, cocoa, coconuts, custard apples (*Annona reticulata*), edible figs, **guavas**, mangoes, oil palm, orchids, pawpaws, pineapples, seaside grapes and soursop (*Annona muricata*). *N. nipae* seems to prefer palms, such as species of Areca, Cocos, Kentia, Kentiopsis and Sabal. In temperate regions in Europe and North America, *N. nipae* often attacks ornamental palms grown under glass.

a) Major host:*Annona squamosa* (sugar apple), *Artocarpus altilis* (breadfruit), *Cajanus cajan* (pigeon pea), ***Cocos nucifera* (coconut)**, *Ficus carica* (fig), *Ficus elastica* (rubber plant), *Ipomoea batatas* (sweet potato), *Mangifera indica* (mango), Musa (banana), *Psidium guajava* (guava)

7.4.4. Distribution

N. nipae is found in Europe, Asia, Africa, North, Central and South America and Oceania (Ben-Dov, 1994; CABI/EPPO, 2005).
Asia: China (Ben-Dov, 1994), India (Josephrajkumar *et al.,*2012), Indonesia (CABI/EPPO, 2005), Korea, Republic of (CABI/EPPO, 2005), Philippines (Caasi-Lit *et al.,* 2012), Turkey (CABI/EPPO, 2005)
Africa: Morocco (CABI/EPPO, 2005), South Africa (CABI/EPPO, 2005)
North America: Mexico and USA (CABI/EPPO, 2005)
South Amrica: Brazil, Chile, Argentina, Peru, Colombia (Ben-Dov, 1994; CABI/EPPO, 2005)
Europe: Belgium, Italy, Portugal, Russian federation, Spain, UK (Ben-Dov, 1994; CABI/EPPO, 2005)
Ocenia: Fiji (Hodgson & Agowska, 2011)

7.4.5. Hazard Identification Conclusion

Considering the facts that *N. nipae* -

- is not known to be present in Bangladesh [APPPC, 1987; CABI/EPPO, 2005];
- will be potentially economic important to Bangladesh because it is a major pest of several crops, fruits and ornamental plants like avocados, bananas, citrus, cocoa, coconuts, custard apples, edible figs, guavas, mangoes, oil palm, orchids, pawpaws, pineapples, seaside grapes etc which are also important crops in our country.
- The degree of polyphagy of *P. solenopsis* its numerous economically important host-plants, and the rapid escalation of international trade in fresh plant material and produce, mean that this species presents a high risk of introduction.
- *P. solenopsis* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

7.4.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 4.1 – Which of these descriptions best fit of this pest?

Description	Establishment Potential
A. **Has this pest been established in several new countries in recent years-Yes**, • In recent years *N. nipae* been established in different country especially in Asian countries like China, **India**, Indonesia, Korea, **Philippines,** Turkey. Guav and other fruits are mainly imported from thesre countries. **B. Possibility of survival during transport, storage and transfer? No** • Due to lack of information about their biology, we can't predict about their survival during transport, storage and transfer.	**YES and**

C. Does the pathway appear good for this pest to enter Bangladesh and establishment and spread? - Yes, • The pathway appear good for this pest to enter into Bangladesh and establishment because the adults, eggs, nymphs and pupae may transport through flowers, inflorescence, fruits, leaves, roots and stems. Different type of vegetables, fruits, crops, seeds, flowers, plant parts are imported in our country from different country in where the pest is already established. So, this insect can enter in our country through any of this imported material. • Immature and adult female *N. nipae* are readily carried on plants and plant produce and may be injurious when introduced to new geographical areas where they have no natural enemies. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • *N. nipae* is polyphagous and attacks 80 genera of plants belonging to 43 families (Ben-Dov, 1994). It is recorded feeding on a wide range of economically important plants, mostly fruit crops and ornamentals, including bananas, citrus, cocoa, coconuts, custard apples (*Annona reticulata*), edible figs, guavas, mangoes, oil palm, orchids, pawpaws, pineapples, most of them are important plants in our country • These climatic conditions of these countries where this pest has already estabilished are more or less similar with the climatic condition of **Bangladesh**.	**Moderate**
• NOT AS ABOVE OR BELOW	**Moderate**
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.4.7. Determine the Consequence establishment of this pest in Bangladesh

Table 4.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • Because it is a major pest of several economically important plants, mostly fruit crops and ornamentals, including bananas, citrus, cocoa, coconuts, custard apples (Annona reticulata), edible figs, guavas, mangoes, oil palm, orchids, pawpaws, pineapples etc which are also important crops in our country. **b. Economic impact and yield loss** • *N. nipae* is generally of little economic importance, but it has become a pest of avocados and guavas in Hawaii, Bermuda and Puerto Rico (see Ben-Dov, 1994 for further references). Ant-attended infestations of *N. nipae* have been recorded causing damage to coconut plantations in Guyana, together with the coconut scale Aspidiotus destructor (Raj, 1977). *N. nipae* is also a pest of ornamental palms. The damage caused by *N. nipae* may result in ornamental plants, fruit, cut flowers and foliage losing their market value. **c. Environmental Impact** • The grower is required to implement chemical applications to save the crop, resulting in increased expenses in production as well as the potential of	**Yes and Moderate**

chemical contamination of soil and water. • The excessive use of toxic chemical insecticides have a negative impact to our environment, natural life, wild life, even aquatic life and disrupting the natural control system in the field.	
• Not as above or below	**Moderate**
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

7.4.8. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 4.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	High	High
High	Moderate	High
Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	**Moderate**	**Moderate**
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – Moderate

7.4.9. Risk Management Measures

- Avoid importation of cocnut and other fruits from countries, where this pest is available.
- In countries where *N. nipae* not already present, the enforcement of strict phytosanitary regulations as required for *N. nipae* may help to reduce the risk of this mealybug becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the pest (OEPP/EPPO, 1990). Particular attention is needed for consignments from countries where certain *N. nipae* present.

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7.5. Long-tailed mealybug, *Pseudococcus longispinus*

7.5.1. Hazard identification

Scientific Name: *Pseudococcus longispinus* Targioni Tozzetti
Synonyms:

*Boisduvalia lauri (*Boisduval) Signoret

Coccus adonidum various authors (not Linnaeus)

Coccus laurinus Boisduval

*Dactylopius adonidum (*Linnaeus)

Dactylopius longifilis Comstock

Common names: Long-tailed mealybug
Taxonomic tree

- Domain: Eukaryota
- Kingdom: Metazoa
  - Phylum: Arthropoda
    - Subphylum: Uniramia
      - Class: Insecta
        - Order: Hemiptera
          - Suborder: Sternorrhyncha
            - Superfamily: Coccoidea
              - Family: Pseudococcidae
                - Genus: Pseudococcus
                  - Species: *Pseudococcus longispinus*

EPPO Code: PSECAD.
Bangladesh status: Not present in Bangladesh [CABI,2017]

7.5.2.Biology

The female lays 75-200 eggs (dependent on the host plant) and a generation is completed in about six weeks at 26ºC. Third-stage nymphs may also be inseminated, but oviposit only after having molted to females. Pest numbers peak in early summer, declining in autumn and winter. First instar nymphs may disperse by becoming wind-borne. Large populations are often attended by ants, which do not seem to affect the numbers of *P. longispinus* but hinder its natural enemies.

7.5.3.Hosts

The longtailed mealybug has a relatively wide host range that includes many economically important crops, such as avocado, citrus, grapes, pear, persimmon, and pineapple (Faber *et al*. 2007, Furness 1976, Dentener *et al*. 1997, Williams and Watson 1988). Valuable ornamental plants, especially those adapted to tropical and subtropical environments are also hosts. These include species of cycads (Culbert 1995) and orchids (Kot *et al*. 2015, Ray and Hoy 2014). Plants kept inside homes or in greenhouses seem to be especially at risk for mealybug infestation, due to the relatively stable temperature and humidity of these environments (Blumberg and Van Driesche 2001).

a) **Major host:***Albizia julibrissin* (silk tree), Citrus, *Colocasia esculenta* (taro), *Diospyros kaki* (persimmon), *Persea americana* (avocado),***Cocos nucifera* (coconut),** *Psidium guajava* (guava), *Pyrus communis* (European pear), *Solanum melongena* (aubergine), *Vitis vinifera* (grapevine)

b) **Minor host:***Alpinia purpurata* (red ginger), *Ananas comosus* (pineapple), , Coffea (coffee), *Malus domestica* (apple), *Manihot esculenta* (cassava),*Prunus domestica* (plum), *Solanum tuberosum* (potato) etc.

7.5.4. Distribution

Longtailed mealybug is widespread throughout the world. It is found outdoors in the warmer parts of America, Europe, and Africa. In northern latitudes it occurs in greenhouses (McKenzie 1967). First collected in Hawaii before 1900, it is present on the six major Islands (Zimmerman 1948, Hawaiian Terrestrial Arthropod Chlecklist 1992).

- **Asia:** China (CIE, 1984), **India** (Ben-Dov, 1994), **Indonesia** (Ben-Dov, 1994), Iran (CIE, 1984), Japan (Ben-Dov, 1994), **Malaysia** (CIE, 1984), **Philippines** (Lit & Calilung, 1994), Singapore (AVA, 2001), **Sri Lanka** (CIE, 1984), Taiwan (CIE, 1984), Turkey (CIE, 1984), Vietnam (CIE, 1984)
- **Africa:** Egypt (CIE, 1984), Cameron (CIE, 1984), Ghana (CIE, 1984), Zimbabwe (CIE, 1984)
- **North America:** Canada (CIE, 1984), Mexico (Ben-Dov, 1994) and USA (CIE, 1984)
- **South Amrica**: Brazil (Culik *et al.,* 2009), Chile (CIE, 1984), Argentina (CIE, 1984), Uruguay (CIE, 1984)
- **Europe:** Netherlands, Belgium, Denmark, Finland, France, Sweden, UK, Germany, Greece, Italy (CIE, 1984), Russian Federation (Ben-Dov, 1994)
- **Ocenia:** Australia (CIE, 1984), Fiji (CIE, 1984), New Zealand (CIE, 1984)

7.5.5. Hazard Identification Conclusion

Considering the facts that *P. longispinus* -

- is not known to be present in Bangladesh [CABI,2017];
- The longtailed mealybug has a relatively wide host range that includes many economically important fruits, such as guava, avocado, citrus, grapes, pear, persimmon, and pineapple.
- Valuable ornamental plants, especially those adapted to tropical and subtropical environments are also hosts. These include species of cycads and orchids. Plants kept inside homes or in greenhouses seem to be especially at risk for mealybug infestation, due to the relatively stable temperature and humidity of these environments
- will be potentially economic important to Bangladesh because it is a major pest of several crops like okra, cotton, sunflower, china-rose, tobacco, sesame, tomato, aubergine etc which are also important crops in our country.

- The degree of polyphagy of *P. longispinus* its numerous economically important host-plants, and the rapid escalation of international trade in fresh plant material and produce, mean that this species presents a high risk of introduction.
- *P. longispinus* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

7.5.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 5.1 – Which of these descriptions best fit of this pest?

Description	Establishment Potential
A. **Has this pest been established in several new countries in recent years-Yes**, • Longtailed mealybug is widespread throughout the world. It is found outdoors in the warmer parts of America, Europe, Asia and Africa. • In recent years *P. longispinus* been established in different country especially in Asian countries like China, India, Sri-Lanka, Japan, Malaysia, Philippines, Singapore, Vietnam and Turkey. This mealybug species has the ability to increase rapidly in population size and spread to cover vast areas where host plants occur, in a relatively short period of time. **B. Possibility of survival during transport, storage and transfer? Yes** • The female lays 75-200 eggs (dependent on the host plant) and a generation is completed in about six weeks at 26ºC. The transport, storage and transfer duration from exporting countries to our country is about 20 days, so the duration is favorable for its survival and the storage environment is also favorable for its survival. **C. Does the pathway appear good for this pest to enter Bangladesh and establishment and spread? - Yes,** • The pathway appear good for this pest to enter into Bangladesh and establishment because pest or symptoms not visible to the naked eye but usually visible under light microscope so it is very difficult to detect them. The adults, eggs, nymphs and pupae may transport through fruits, leaves, roots and stems. Different type of vegetables, fruits, crops, seeds, flowers, plant parts are imported in our country from different country in where the pest is already established. So, this insect can enter in our country through any of this imported material... **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • *P. longispinus* is a major pest of several fruit crops like Avocado, citrus, guava, grapevine, European pear, aubergine, silk tree, taro, persimmon etc, most of the crops are cultivated in our country. Besides this, They also imported from different countries. • *P. longispinus* ia a minor pest of red ginger, pineapple, coconut, coffee, apple, cassava, plum, potato etc. Most of which are common in our country,	**YES and High**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.5.7. Determine the Consequence establishment of this pest in Bangladesh

Table 5.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • Because it is a major pest of several fruit crops like Avocado, citrus, guava, grapevine, European pear, aubergine, silk tree, taro, persimmon etc. Most of fruits are common in our county, Beside the cultivation the fruits are also imported from countries where the pest is already established. So, if the pest enter into our country became a serious pest. **b. Economic impact and yield loss** • Mealybugs and other insects with piercing-sucking mouthparts, like aphids, feed directly from the host plant vascular system. This food source is plentiful but somewhat dilute, meaning the insect must take in an abundance of plant sap to get adequate nutrition. • Honeydew, a sugary substance periodically excreted from the insect's body, is a waste product of this feeding behavior. Honeydew itself is not harmful to the plant, but can coat the leaves and nearby objects and encourage growth of a fungus known as sooty mold. Sooty mold, like honeydew, is not directly injurious to the plant, but it is unsightly, hard to remove, and can diminish the plant's photosynthetic capabilities. It also reduces or eliminates the economic value of fruits grown for fresh consumption and plants grown for ornamental value. • Sometimes honeydew-producing insects are first noticed because of the presence of another insect species taking advantage of their sugary excretions. Colonies of longtailed mealybug have been observed being tended by white-footed ants, *Technomyrmex difficilis* Forel (Warner *et al.* 2002). • In addition to typical feeding damage*, Pseudococcus longispinus,* as well as several related mealybug species, is an efficient vector of Grapevine leafroll-associated virus 3 (GLRaV-3), a major causal agent of Grapevine leafroll disease (Douglas and Krüger 2008). The causal agents of Grapevine leafroll disease are distributed worldwide and this disease reduces yield and quality of grapes used for juice, wine, and table consumption (Maree *et al.* 2013). **c. Environmental Impact** • The grower is required to implement chemical applications to save the crop, resulting in increased expenses in production as well as the potential of chemical contamination of soil and water. • The extreme use of harmful chemical insecticides may harm to natural environment, disrupting the natural control system in our crop field and may causes resistance, resurgence and upset.	**Yes and High**
• Not as above or below	**Moderate**
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

7.5.7. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 5.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	**High**	**High**
High	Moderate	High
Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

7.5.9. Risk Management Measures

- Avoid importation of infested material from countries, where this pest is available.
- In countries where *Phenacoccus solenopsis* not already present, the enforcement of strict phytosanitary regulations as required for *P. solenopsis* may help to reduce the risk of this mealybug becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the pest (OEPP/EPPO, 1990). Particular attention is needed for consignments from countries where certain *P. solenopsis* present.

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7.6. Black tea thrips, *Heliothrips haemorrhoidalis* Bouché

7.6.1. Hazard identification

Scientific Name: *Heliothrips haemorrhoidalis* Bouché
Synonyms:

Dinurothrips rufiventris Girault

Heliothrips adonium Haliday

Heliothrips ceylonicus

Heliothrips haemorrhoidalis var. *abdominalis* Reuter

Heliothrips haemorrhoidalis var. *andustior* Priesner

Heliothrips haemorrhoidalis var. *ceylonicus* Schmutz

Heliothrips semiaureus Girault

Heterothrips haemorrhoidalis

Thrips haemorrhoidalis Bouché

Common names:Black tea thrips, black glasshouse thrips; greenhouse thrips

Taxonomic tree

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Thysanoptera
Family: Thripidae
Genus: Heliothrips
Species: *Heliothrips haemorrhoidalis*

EPPO Code: HELTHA
Bangladesh status: Not present in Bangladesh [CABI,2015]

7.6.2.Biology

There have only been a few brief accounts of the biology and ecology of *H. haemorrhoidalis* in recent years, although some detailed studies were carried out in earlier years (Russell, 1909; Rivnay, 1934, 1935a, b).

Males of *H. haemorrhoidalis* are rare, chiefly known from Brazil, and reproduction is parthenogenetic and thelyotokus. The female takes 4-6 days to start oviposition after emergence and produces up to 47 eggs on average at 21-28°C during her lifetime of about 1 month. The eggs are laid singly in the epidermis of the under surface of the leaf and each egg is covered with an excretory droplet. The larvae emerge in about 14-15 days at an optimal temperature of 26-28°C, and 16-22 days at 21-25°C. They carry a large excretory droplet between the anal setae at the end of the abdomen, which is raised and lowered at intervals to deposit the droplet. The first and second instars occupy 9-11 days at 26-28°C, and 10-16 days at 21-25°C, followed by the prepupal and pupal stages which lasting for 3-4 days at 26-28°C and 4-6 days at 21-25°C. The adult lives for up to 35 days at 25-27°C. The complete life cycle of *H. haemorrhoidalis* occurs on the leaves of the host. This thrip may produce about seven generations under temperate weather conditions and more than 12 under tropical conditions.

Both adults and larvae feed mostly on leaves and fruits in concentrated colonies; the youngest or oldest leaves are rarely preferred. The colonies gather mainly on the under surfaces of the leaves; they do not live on the tops of the leaves and fruits until the tissue becomes unsuitable for feeding and oviposition.

The biology of *H. haemorrhoidalis* on the fern Polypodium phegopteris was studied in India (Daniel and Chandrasekar, 1986). The thrip was mostly restricted to mature fronds of the fern and mating was evident, in contrast to parthenogenetic reproduction on coffee leaves. The male:female ratio was 3:25, and the life cycle ranged from 20-30 days. This thrips-fern association was observed only at altitudes above 1900 m. The mature fronds preferred by *H. haemorrhoidalis* had 1.5 times the lipid content of young fronds. There was little variation in other chemical compounds between the young and mature fronds. A higher concentration of protein and nitrogen in P. phegopteris, compared with other fern hosts, appeared to attract and enhance the survival and growth of *H. haemorrhoidalis*.

7.7. Hosts

H. haemorrhoidalis is highly polyphagous, and has been recorded with certainty from more than 100 plant species, including some ferns (Daniel and Chandrasekar, 1986) and conifers (Ananthakrishnan, 1971; Zondag, 1977; Cerda, 1980). Seriously damaged cultivated crops include avocado, coconut, kiwifruit, persimmon, citrus, tea, croton, pine and cyclamen.

a) Major host:*Camellia sinensis* (tea) , ***Cocos nucifera* (coconut)**, Coffea (coffee), *Mangifera indica* (mango), *Manihot esculenta* (cassava), *Psidium guajava* (guava), Schinus (pepper tree) *Vitis vinifera* (grapevine)

b) Minor host:*Alpinia purpurata* (red ginger), *Ananas comosus* (pineapple), , Coffea (coffee), *Malus domestica* (apple), *Manihot esculenta* (cassava),*Prunus domestica* (plum), *Solanum tuberosum* (potato) etc.

7.6.4. Distribution

H. haemorrhoidalis is widely distributed in the tropics and subtropics; it also occurs in greenhouses of temperate areas as it was first described from specimens collected in a greenhouse in Berlin. *H. haemorrhoidalis* is presumed to have originated in tropical America, probably Brazil. It has been introduced to various parts of the world by man and has become naturalized in those areas.

- **Asia:** China (CIE, 1951, Zhang & Tong, 1993), India (Bhatti, 1990; CIE, 1961), Indonesia (Waterhouse, 1993; CIE, 1961; zur Strassen, 1994), Iran (CIE, 1984), Japan (Kudô, 1992; CIE, 1961), Malaysia (Kudô, 1995), Philippines (Reyes, 1994; Kudô, 1995), Singapore (AVA, 2001), Sri Lanka (CIE, 1961), Thailand (Waterhouse, 1993; Kudô, 1980), Taiwan (CIE, 1984), Turkey (CIE, 1984), Vietnam (CIE, 1984)
- **Africa:** Egypt (CIE, 1961), Cameron (CIE, 1961), Ghana (CIE, 1961), Zimbabwe (CIE, 1961)
- **North America:** Canada (CIE, 1961), Mexico (CIE, 1961) and USA (CIE, 1961)
- **South Amrica**: Brazil (Culik *et al.,* 2009), Chile (CIE, 1984), Argentina (CIE, 1984), Uruguay (CIE, 1984)
- **Europe:** Netherlands, Belgium, Denmark, Finland, France, Sweden, UK, Germany, Greece, Italy (CIE, 1961),
- **Ocenia:** Australia (CIE, 1961), Fiji, New Zealand

7.6.5. Hazard Identification Conclusion

Considering the facts that *H. haemorrhoidalis* -

- is not known to be present in Bangladesh [CABI,2015];
- *H. haemorrhoidalis* is highly polyphagous, and has been recorded with certainty from more than 100 plant species, including some ferns (Daniel and Chandrasekar, 1986) and conifers (Ananthakrishnan, 1971; Zondag, 1977; Cerda, 1980). Seriously damaged cultivated crops include avocado, coconut, kiwifruit, persimmon, citrus, tea, croton, pine and cyclamen.
- Crop losses, caused by H. haemorrhoidalis, are difficult to assess and there have been few critical studies despite the importance of this pest on many crops.
- *H. haemorrhoidalis* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

7.6.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 6.1 – Which of these descriptions best fit of this pest?

Description	**Establish ment Potential**
A. **Has this pest been established in several new countries in recent years-Yes**, • *H. haemorrhoidalis* is widespread throughout the world. It is found outdoors in the warmer parts of America, Europe, Asia and Africa. • In recent years *H. haemorrhoidalis* been established in different country especially in Asian countries like Thailand, China, India, Sri-Lanka, Japan, Malaysia, Philippines, Singapore, Vietnam and Turkey. This mealybug species has the ability to increase rapidly in population size and spread to	**YES**

cover vast areas where host plants occur, in a relatively short period of time. **B. Possibility of survival during transport, storage and transfer? Yes** • The female takes 4-6 days to start oviposition after emergence and produces up to 47 eggs on average at 21-28°C during her lifetime of about 1 month. The eggs are laid singly in the epidermis of the under surface of the leaf and each egg is covered with an excretory droplet. The larvae emerge in about 14-15 days at an optimal temperature of 26-28°C, and 16-22 days at 21-25°C. The transport, storage and transfer duration from exporting countries to our country is about 20 days, so the duration is favorable for its survival and the storage environment is also favorable for its survival. **C. Does the pathway appear good for this pest to enter Bangladesh and establishment and spread? - Yes,** • The pathway appear good for this pest to enter into Bangladesh and establishment because both adult and immature stages are detected by examining the under surfaces of leaves and the surfaces of the fruits. Chlorotic spots, brown patches and necrotic lesions are apparent. Microscope preparations should be made for identification; it is necessary to examine thrips under a compound microscope. Different type of vegetables, fruits, crops, seeds, flowers, plant parts are imported in our country from different country in where the pest is already established. So, this insect can enter in our country through any of this imported material... **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • *H. haemorrhoidalis* is highly polyphagous, and has been recorded with certainty from more than 100 plant species, including some ferns (Daniel and Chandrasekar, 1986) and conifers (Ananthakrishnan, 1971; Zondag, 1977; Cerda, 1980). Seriously damaged cultivated crops include avocado, coconut, kiwifruit, persimmon, citrus, tea, croton, pine and cyclamen. • The main hosts are tea, coconut, mango, cassava, guava, pepper and grapevine.Most are very important fruits and cash crops in Bangladesh. • Moreover, the climatic conditions of the estabilishment of this pest is more or less similar with the exporting countries, where they are estabilished.	**and High**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.6.7. Determine the Consequence establishment of this pest in Bangladesh

Table 6.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • Because it is a major pest of several fruit crops like *Camellia sinensis* (tea) , ***Cocos nucifera* (coconut)**, Coffea (coffee), *Mangifera indica* (mango), *Manihot esculenta* (cassava), *Psidium guajava* (guava), Schinus (pepper tree) *Vitis vinifera* (grapevine) etc. Most of fruits are common in our county, Beside the cultivation the fruits are also imported from countries where the	**Yes and High**

pest is already established. So, if the pest enter into our country became a serious pest. **b. Economic impact and yield loss** • Crop losses, caused by *H. haemorrhoidalis*, are difficult to assess and there have been few critical studies despite the importance of this pest on many crops. • *H. haemorrhoidalis* was found to be one of five important pests on avocado fruits in South Africa (the others were *Pseudotheraptus wayi, Selenothrips rubrocinctus, Pterandrus rosa [Ceratitis rosa]* and *Nezara viridula)* in a packhouse survey. *H. haemorrhoidalis* together with *S. rubrocinctus* caused 2.1% (potentially up to 80%) cull of the fruits by lesions and crack (Dennill and Erasmus, 1992a). H. haemorrhoidalis caused considerable mortality in up to 3-year-old Pinus radiata on warm sites, both in the nursery and in the forest in New Zealand (Zondag, 1977). **c. Environmental Impact** • The grower is required to implement chemical applications to save the crop, resulting in increased expenses in production as well as the potential of chemical contamination of soil and water. • The extreme use of harmful chemical insecticides may harm to natural environment, disrupting the natural control system in our crop field and may causes resistance, resurgence and upset.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

7.6.7. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 6.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	**High**	**High**
High	Moderate	High
Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

7.6.9. Risk Management Measures

- Avoid importation of infested material from countries, where this pest is available.
- In countries where *H. haemorrhoidalis* not already present, the enforcement of strict phytosanitary regulations as required for *H. haemorrhoidalis* may help to reduce the risk of this mealybug becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the pest (OEPP/EPPO, 1990). Particular attention is needed for consignments from countries where certain *H. haemorrhoidalis* present.

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7.7. Coconut leaf roller, *Omiodes blackburni*

7.7.1. Hazard identification

Scientific Name: *Omiodes blackburni*
Synonyms:

- *Botys blackburni* Butler, 1877
- *Hedylepta blackburni*
- *Nacoleia blackburni*
- *Lamprosema blackburni*
- *Phostria blackburni*

Common names: Coconut leaf roller

Taxonomic tree
Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Lepidoptera
Family: Crambidae
Genus: *Omiodes*
Species: *Omiodes blackburni*

EPPO Code:
Bangladesh status: Not present in Bangladesh [Wikipedia, 2016]

7.7.2. Biology

Young larvae feed gregariously on the underside of the leaf of their host plant, protected by a thin web of silk. Larvae are full-grown in about four weeks from hatching. Full-grown larvae are 32–35 mm long and dull greenish, with two dorsal whitish lines. Pupation takes place in a slight cocoon in the caterpillar's retreat. The pupa is 15–19 mm long and light to dark brown according. The pupal period lasts 11–13 days.

7.7. Hosts

Recorded food plants include *Cocos nucifera*, but it occasionally also feeds on *Pritchardia* (including *Pritchardia pacifica*), banana and introduced palms.

7.7.4. Distribution

North America: United States (Wikipedia, 2016).

7.7.5. Hazard Identification Conclusion

Considering the facts that *Omiodes blackburni* -

- is not known to be present in Bangladesh [Wikipedia, 2016];
- Is potentially less economic important to Bangladesh because it is an important pest of coconut in USA from where young seedlings are not imported to Bangladesh.
- *Omiodes blackburni* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

7.7.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 7.1 – Which of these descriptions best fit of this pest?

Description	Establishment Potential
a. Has this pest been established in several new countries in recent years-No • There are no studies about the newly establishment of *Omiodes blackburni* in any other countries in the world. **b. Posibility of survival during transport, storage and transfer? Yes** • Though young seedlings of coconut are imported to Bangladesh. This pest lay eggs under side of the leaf and this eggs remain dormant at low temperature. So this pest can survive during transport due to their overwintering characteristics at low temperature. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • The coconuts are imported into Bangladesh from USA. *Omiodes blackburni* is a common problem in such countries. So, the pathway appear good for this pest to entire in Bangladesh. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • The host range of *Omiodes blackburni* is common in Bangladesh and the climate in Bangladesh is also suitable for establishment of *Omiodes blackburni* in Bangladesh.	**YES and Medium**
• NOT AS ABOVE OR BELOW	Moderate
• **This pest has not established in new countries in recent years** • **The pathway does not appears good for this pest to enter Bangladesh and establish, and** • **Its hosts are not common in Bangladesh and climate is not similar to places it is established.**	Low

5.3.2.7. Determine the Consequence establishment of this pest in Bangladesh

Table 1.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • Coconut leaf roller is a serious pest of coconut, banana. Which are major fruits crops in our country. So, if the pest enter into our country become a serious pest for our fruits industries. **b. Economic impact and yield loss** • Due to lack of information we can not predict about the economic impact of this pest. **c. Environmental Impact** • Due to lack of information we can not predict about the economic impact of this pest.	**Low**
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

7.7.8.. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 7.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	High	High
High	Moderate	High
Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	**Low**	**Low**
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – Low

7.7.9. Risk Management Measures

- Avoid importation of buds and seedlings from countries, where this pest is available.
- In countries where *Omiodes blackburni* is not already present, the enforcement of strict phytosanitary regulations as required for *Omiodes blackburni* may help to reduce the risk of this leaf roller becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the pest (OEPP/EPPO, 1990). Particular attention is needed for consignments from countries where certain ***A. assectella*** are present.

7.7.10. References

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7.8. Coconut hispine beetle, *Brontispa longissima*

7.8.1. Hazard identification

Scientific Name: *Brontispa longissima*
Synonyms:

- *Brontispa castanea* Lea
- *Brontispa froggatti* Sharp
- *Brontispa longissima var. javana* Weise
- *Brontispa longissima var. selebensis* Gestro
- *Brontispa reicherti* Uhmann
- *Brontispa simmondsi* Maulik
- *Oxycephala longipennis* Gestro
- *Oxycephala longissima* Gestro

Common names: Coconut hispine beetle
Taxonomic tree

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Coleoptera
Family: Chrysomelidae
Genus: *Brontispa*
Species: *Brontispa longissima*

EPPO Code: BRONLO.
Bangladesh status: Not present in Bangladesh [EPPO, 2014]

7.8.2. Biology

The eggs are laid in groups of one to four, end to end, in a furrow chewed in the leaf by the adult, between or inside the tightly folded leaflets. The beetle covers each egg with excreta. The eggs hatch after an incubation period of about 5 days. The newly hatched larva begins to feed between and inside unopened leaflets. The number of instars varies from five to six. The larvae are fairly sedentary and avoid light. The larval period is 30-40 days, followed by a prepupal period of 3 days and a pupal period of 6 days. The pupa lies freely between the apposed surfaces of the developing folded leaflets. The development from egg to adult takes 5-7 weeks. The beetles, which also seem to avoid light, are nocturnal and fly well (Kalshoven, 1981). The adults feed among the young unopened leaflets and, since they live up to 220 days, their cumulative damage greatly exceeds that of the larvae. There is a preoviposition period of 1-2 months and 100 or more eggs may be laid. There are about three overlapping generations per year (Waterhouse and Norris, 1987; Maulik, 1938; O'Connor, 1940; Froggatt and O'Connor, 1941; Smee, 1965; Maddison, 1983; Kalshoven, 1981 and Franssen and Mo, 1952).

7.8.3. Hosts

The host range of *B. longissima* includes various Palmae [Arecaceae]. In Papua New Guinea, coconut, sago palms, areca or betel palm (*Areca catechu*), royal palms (*Roystonea regia*), oil palm and ornamental palms are attacked. In northern Australia, hosts include areca palms (*A. catechu*), nicobar palm (*Bentinckia nicobarica*), carpentaria palm (*Carpentaria acuminata*) and fish tail palm (*Caryota mitis*). In Hong Kong, it is also reported from ivory nut palm (*Phytelephas*), petticoat palm (*Washingtonia robusta*), king palm (*Archontophoenix alexandrae*) and dwarf date palm (*Phoenix roebelenii*) (CSK Lau, 1991).

7.8.4. Distribution

Africa: Madagascar (EPPO, 2014), Mauritius (EPPO, 2014), Seychelles (EPPO, 2014).
Asia: Cambodia (Rethinam & Singh, 2007), China (EPPO, 2014), Indonesia (Rethinam & Singh, 2007), Japan (EPPO, 2014), Laos (Rethinam & Singh, 2007), Malaysia (EPPO, 2014), Maldives (EPPO, 2014), Myanmar (Rethinam & Singh, 2007), Philippines (EPPO, 2014), Singapore (EPPO, 2014), Taiwan (EPPO, 2014), Thailand (Rethinam & Singh, 2007) and Vietnam (Rethinam & Singh, 2007).
Oceania: Australia (EPPO, 2014), Papua New Guinea (EPPO, 2014), Samoa (EPPO, 2014), Solmon Islands (EPPO, 2014).

7.8.5. Hazard Identification Conclusion

Considering the facts that *B. longissima*-

- is not known to be present in Bangladesh [EPPO, 2014];
- is potentially economic important to Bangladesh because it is an important pest of coconut in Asia including China, Indonesia, **Japan**, Philippines, Malaysia, Maldives, Myanmar, Singapore, Taiwan, Thailand and Vietnam [EPPO, 2014] from where seedlings of coconut are imported to Bangladesh.
- *B. longissima* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

7.8.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 8.1 – Which of these descriptions best fit of this pest?

Description	Establishment Potential
a. Has this pest been established in several new countries in recent years-Yes, • Recently, *B. longissima* has spread to Singapore, Vietnam, Nauru, Cambodia, Laos, Thailand, Maldives, Myanmar and Hainan Island, China (Rethinam and Singh, 2007). It is feared that it will spread from the Maldives to Sri Lanka and southern parts of India. **b. Posibility of survival during transport, storage and transfer? Yes** • The beetle is only capable of weak flight, so new infestations spread slowly, unless aided by human activity (Maddison, 1983). **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Young coconut palms should be inspected for eggs between or inside the tightly folded leaflets and early feeding damage of the larvae between and inside unopened leaflets, where browning and death of the surrounding tissues can be seen. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • This pest can become establish in Bangladesh through imports of the seedlings of coconut.*B. longissima* host range is restricted to plants belonging to Palmae [Arecaceae] which is mostly common in Bangladesh. • Dry periods favour the development of *Brontispa* populations. This conclusion is based on the number of damaged leaves in coconut crowns, which represents the extent of infestation to the central axis (Kalshoven, 1981). Strong monsoon winds reduce the influence of parasitic wasps. No damage occurred in regions of West Java with high rainfall, although the beetle has been found in these areas (Kalshoven, 1981).	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.8.7. Determine the Consequence establishment of this pest in Bangladesh

Table 8.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • *B. longissima*favoure dry season for developing their life cycle. And Bangladesh has this season which is comfortable for the establishment of this pest. • This is a fairly serious pest of coconutfor Bangladesh.	**Yes and High**

b. Economic impact and yield loss • *Brontispa* attacks palms of all ages, although it is most damaging to young palms in nurseries and for the first 4-5 years after planting out in the field, especially in dry areas. Neglected palms are more heavily attacked than those kept free from undergrowth (Froggatt and O'Connor, 1941; Maddison, 1983). • Outbreaks of *Brontispa* occur quite regularly in east Java, especially near Blitar, where about 55,000 trees were damaged in three districts during the dry season of 1940. *Brontispa* is also a regular pest in Besuka, especially north of Banjuwangi (near Giri) where the climate is rather dry. Outbreaks have also been reported from Madura (Kalshoven, 1981). *B. longissima* causes widespread and serious damage to unopened leaves of coconut in Java (Mo, 1965). • *B. longissima* is the most serious pest of young palms in the Solomon Islands; at a time when considerable areas of young palms existed, it was estimated that damage to the value of £65,000 had been suffered in less than 10 years on Lever's Estates alone (Tothill, 1929). In extreme cases, damage can completely arrest the development of young palms and may even kill them (Brown and Green, 1958). Only occasionally are mature palms attacked on a large enough scale in the Solomon Islands to cause serious damage. **c. Environmental Impact** • In 1936, Adonaria Island, east of Flores, Indonesia, became a focus for *Brontispa* attacks, from which the pest migrated to Flores in later years causing particular damage to coconuts in valleys under humid conditions. • Coconut plantations in South Sulawesi, Indonesia, which were in poor condition due to poor soil conditions, infestations by aleurodids and inadequate maintenance, were more susceptible to attack by *B. longissima*. Severe *Brontispa* attacks were reported in nearly all regions of south-east Sulawesi in 1929 (Kalshoven, 1981).	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

7.8.8.. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 8.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	**High**	**High**
High	Moderate	High
Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

7.8.9. Risk Management Measures

- Avoid importation of seedlings of coconut from countries, where this pest is available.
- In countries where *B. longissima*is not already present, the enforcement of strict phytosanitary regulations as required for *B. longissima*, may help to reduce the risk of this hispine beetle becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the pest (EPPO, 2014). Particular attention is needed for consignments from countries where certain *B. longissima* are present.

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7.9. Nettle caterpillar, *Darna trima* (Moore)

7.9.1. Hazard identification

Scientific Name: *Darna trima* (Moore)
Synonyms:
Darna trima ajavana Holloway
Orthocraspeda trima Moore
Common names: Nettle caterpillar
Taxonomic tree
Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Lepidoptera
Family: Limacodidae
Genus: *Darna*
Species: *Darna trima*
EPPO Code: DARNTR.
Bangladesh status: Not present in Bangladesh [CABI, 2014]

7.9.2. Biology

Eggs are flat, scale-like, translucent and ovoid; dimensions range from 0.7 x 0.5 mm (Desmier de Chenon, 1982) to 1.5 x 1.0 mm (Tiong and Munroe, 1977). Newly hatched larvae are 1.3 x 0.5 mm in size and are cream-coloured with distinct lateral setae (Tiong and Munroe, 1977). Description of mature larvae collected from oil palm in Peninsular Malaysia: size 15 x 5 mm; first thoracic segment dark brown, rest of body dark with a conspicuous yellow lateral marking (Holloway *et al.,* 1987). Pupation takes place within cocoons which are globular or slightly ovoid, brown and 6 mm in diameter (Tiong and Munroe, 1977). Males 8-9 mm, females 9-12 mm (Holloway *et al.,* 1987).

7.9.3. Hosts

D. trima has a very wide host range covering many plant families. Among these host plants coconut, tea, oilo palm, sago palm, cocoa etc. are the main host (CABI, 2014).

7.9.4. Distribution

- ***Asia**:* Indonesia (APPPC, 1987; Kalshoven & van, 1981; Waterhouse, 1993).
- ***Europe:*** Netherlands (IPPC, 2006).

7.9.5. Hazard Identification Conclusion

Considering the facts that *D. trima* -

- is not known to be present in Bangladesh [CABI, 2014];
- is potentially economic important to Bangladesh because it is an important pest of coconut in Asia including **Indonesia** (APPPC, 1987; Kalshoven & van, 1981; Waterhouse, 1993) from where bulb and seed are imported to Bangladesh.

7.9.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 9.1 – Which of these descriptions best fit of this pest?

Description	Establishment Potential
• **Has this pest been established in several new countries in recent years-Yes**, • Establishment of *D. trima* has been recorded in recent years in Netherlands (IPPC, 2006). • **Posibility of survival during transport, storage and transfer? Yes** • The life cycle of *D. trima* has been reported as follows: eggs 2-3 days, larvae 30-33 days, pupae 12-14 days and adults 7-10 days (Tiong and Munroe, 1977). So larvae can servive into the midrib of coconut leaves at the time of transport, storage and transfer. • **Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • *D. trima* lay eggs under the leaflet and eggs are hatched within 2-3 days. So first inster larvae inter into the midrib of the leaf which can not detact by nacked eyes. For this reason the pathway appear good for *D. trima* to enter Bangladesh and established. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • This pest can become establish in Bangladesh through imports of seedlings of coconut.*D. trima*was mainly known as a pest of coconut in tropical and subtropical countries. *D. trima* host range is wide. The main hosts of this pest is common in Bangladesh. • The climatic requirements for growth and development of*D. trima*are more or less similar with the climatic condition of **Bangladesh**.	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.9.7. Determine the Consequence establishment of this pest in Bangladesh

Table 9.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • *D. trima* is largely polyphagous insect. So most reported outbreaks occur on palm trees like coconut (Wood, 1987) and sago palms (Kimura, 1979). • Main hosts of *D. trima* are available in Bangladesh. So it can be a serious pest of Bangladesh. **b. Economic impact and yield loss** • *D. trima* is the commonest found in outbreaks (Holloway *et al.,* 1987). Young plantings are more severely attacked, but mature palms are also defoliated. In one outbreak it was reported that as many as 2000 larvae per frond were found and the leaf area of some palms was reduced up to 60% (Young, 1971). It has been estimated that a single larva consumes 20 cm^2 of leaf tissue over its entire life (Kimura, 1974).	**Yes and High**

• Defoliation of oil palm by leaf-eating caterpillars can have a drastic effect on yield. In a trial in which palms were artificially defoliated, there was a 43% drop in yield a year after 50% defoliation of the upper part of the crown, followed by a 17% drop in the year after that (Wood *et al.,* 1973a). The main effect was expressed 4-6 months after defoliation and complete recovery took some years (Wood, 1982). Even limited damage can lead to some crop loss and remedial action is beneficial, provided that measures taken are well-timed and selective in action (Wood, 1987). In immature palms the effect of artificial defoliation was less marked. • Outbreaks of *D. trima* have been reported on cocoa in Java, Indonesia and West Malaysia (Entwistle, 1972). **c. Environmental Impact** • Rainfall is believed to play an important role in the population dynamics of many tropical insects. Increases in the populations of insect pests of oil palm are often associated with periods of low rainfall. Rainfall may help to regulate oil palm pests by making conditions conducive for the promotion of certain pathogens, e.g. non-occluded virus in *D. trima* (Syed and Shah, 1977).	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

7.9.8. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 9.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	**High**	**High**
High	Moderate	High
Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

7.9.9. Risk Management Measures

- Avoid importation of coconut seedlings from countries, where this pest is available.
- In countries where *D. trima*is not already present, the enforcement of strict phytosanitary regulations as required for *D. trima*, may help to reduce the risk of this pest becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the pest (OEPP/EPPO, 1990). Particular attention is needed for consignments from countries where *D. trima*pests are not present.

7.9.10. References

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7.10. Red palm mite, *Raoiella indica* Hirst (1924)

7.10.1. Hazard identification

Scientific Name: *Raoiella indica* Hirst (1924)
Common names: Red palm mite;
Coconut red mite;
Leaflet false spider mite
Taxonomic tree
Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Chelicerata
Class: Arachnida
Subclass: Acari
Superorder: Acariformes
Suborder: Prostigmata
Family: Tenuipalpidae
Genus: *Raoiella*
Species: *Raoiella indica*
EPPO Code: RAOIIN.
Bangladesh status: Not present in Bangladesh [CABI/EPPO, 2007; EPPO, 2014]

7.10.2. Biology

The original description by Hirst (1924) stated that the length of the adult female (including palpi) is 0.29-0.30 mm and the male is 0.21 mm. Redescriptions have quoted the length of the adult female as between 267-300 µm and the width between 178 and 215 µm (Hirst, 1924; Taher Sayed, 1942; Sadana, 1997). The eggs are approximately 0.117 mm long, red/orange and smooth and shiny in appearance (Moutia, 1958) and are found attached to the leaf by a stipe that is roughly twice as long as the egg (Kane and Ochoa, 2006). Zaher *et al*. (1969) stated that the length of the larva was 125 µm long and 93 µm wide, the protonymph 210 µm long and 159 µm wide, and the deutonymph 272 µm long and 179 µm wide. Welbourn (2006) stated that the dorsal and lateral setae of nymphs are distinctly shorter than those of the adult, and dorsal setae are not set in tubercules (projecting setal bases). The eggs are laid in groups, often near the midrib or depressions in the leaflet, and on hatching, the larvae emerge and start feeding on leaf tissue. Moutia (1958) recorded that on average, 28.1 eggs were laid on leaf discs during the average adult female life span of 27 days. As the larvae and nymphs pass through each stage, they enter a quiescent stage for 36-48 hours, whereby they enter ecdysis and withdraw posteriorly from the exuviae (Zaher *et al.,* 1969). The duration of each stage on coconut in Mauritius was egg: 4-6 days; larva: 6-8 days; protonymph: 4-7 days; deutonymph: 4-5 days.

7.10.3. Hosts

R. indica is a polyphagous pest which main hosts are coconut, betlenut palm, hellconia, banana, date palm (Cocco and Hoy, 2009; Goldsmith, 2009).

7.10.4. Distribution

- **Asia**: Cambodia (EPPO, 2014), India (CABI/EPPO, 2007; EPPO, 2014), Iran (CABI/EPPO, 2007; EPPO, 2014), Israel (CABI/EPPO, 2007; EPPO, 2014), Oman (CABI/EPPO, 2007; EPPO, 2014), Pakistan (CABI/EPPO, 2007; EPPO, 2014), Philippines (CABI/EPPO, 2007; EPPO, 2014), Saudi Arabia (CABI/EPPO, 2007; EPPO, 2014), Sri Lanka (CABI/EPPO, 2007; EPPO, 2014), Thailand (Kane *et al*., 2005), United Arab Emirates (CABI/EPPO, 2007; EPPO, 2014).
- **Africa:** Egypt (CABI/EPPO, 2007; EPPO, 2014), Sudan (CABI/EPPO, 2007; EPPO, 2014), Tanzania (Zannou *et al.,* 2010)
- **North America:** Mexico (Estrada-Venegas *et al.,* 2010), USA (Smith & Dixon, 2008).
- **South America:** Brazil, Colombia, Venezuela (Rodrigues & Antony, 2011; Carrillo *et al.,* 2011).
- **Europe:** Russian Federation (EPPO, 2014).

7.10.5. Hazard Identification Conclusion

Considering the facts that *R. indica* -

- is not known to be present in Bangladesh [CABI/EPPO, 2007; EPPO, 2014];
- In Asia, *R. indica* is present in India, Iran, Pakistan, Philippines, Sri Lanka, and Thailand from where coconut seedlings are imported.
- *R. indica* also present in Brazil, USA, and Russian Federation.

7.10.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 10.1 – Which of these descriptions best fit of this pest?

Description	**Establishment Potential**
a. Has this pest been established in several new countries in recent years-Yes, • Establishment of *R. indica* has been recorded in recent years in Iran, Israel, Pakistan, Philippines, Thailand, Mexico, USA, Brazil and Russian Federation. **b. Posibility of survival during transport, storage and transfer? Yes** • *R. indica* can survive at 15^{o}C temperature then the duration of the life cycle become long. • *R. indica* lay eggs under side of the leaves at midrib. So the larvae can insert into the leaves and can stay there at the time of transporting and storage. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? – Yes** • Though the neighboring country has present *R. indica* at coconut plant and Bangladesh can import coconut seedlings from this country, so it seems	**YES and HIGH**

the good pathway for this pest to enter Bangladesh. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • The host range of *R. indica* are fairly common in Bangladesh. • The favourable temperature is 24.2^{o}C for *R. indica*, which is more or less similar in Bangladesh. • So, the host ranges of *R. indica* are fairly common in Bangladesh and the climate is more or less similar for establishment of this pest in Bangladesh.	
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.10.7. Determine the Consequence establishment of this pest in Bangladesh

Table 10.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - Yes • Though the climatic condition and the host range for *R. indica* are similar in Bangladesh, so it can be a serious pest in Bangladesh. **b. Economic impact and yield loss** • Little empirical data has been gathered on the economic impact of the introduction of *R. indica* to the Caribbean, USA and South America. Peña *et al*. (2009) quoted that coconut [*Cocos nucifera*] growers have reported a 70% drop in coconut production since the introduction of the mite and FAO figures have shown a drop to date in coconut production from Caribbean countries since 2004, when the mite was first identified in the region. Empirical studies are required to confirm these figures/correlations; however, officials are concerned that this may lead to job losses and major socio-economic problems. In Florida, it was feared possible economical impacts could come from quarantine restrictions if *R. indica* was detected in palm nurseries. However, Bronson (2009) stated that *R. indica* population levels were lower than expected in Florida and quarantine would not to be enforced unless infestation levels were found to be high. Extra costs for implementing regulatory actions in Florida have been quoted to be as much as half a million US dollars extra per year for palm nursery producers (Peña *et al.,* 2009). **c. Environmental Impact** • The amenity value of many ornamental plants and palms is severely affected by the yellowing that the mite causes.	**Yes and High**
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

7.10.8.. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table10.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	**High**	**High**
High	Moderate	High
Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

7.10.9. Risk Management Measures

- Avoid importation of coconut seedlings from countries, where this pest is available.
- In countries where *R. indica* is not already present, the enforcement of strict phytosanitary regulations as required *R. indica*, may help to reduce the risk of this mite becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the pest (OEPP/EPPO, 1990).

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7.11. Lethal yellowing of coconut, Candidatus Phytoplasma palmae

7.11.1. Hazard identification

Scientific Name: *Candidatus Phytoplasma palmae*
Synonyms:

Candidatus Phytoplasma palmae-related strains.
Coconut lethal yellowing mycoplasma-like organism
Coconut lethal yellowing phytoplasma
Palm lethal yellowing phytoplasma

Common names: Lethal yellowing of coconut

Taxonomic tree

Domain: Bacteria

Phylum: Firmicutes

Class: Mollicutes

Order: Acholeplasmatales

Family: Acholeplasmataceae

Genus: *Candidatus Phytoplasma*

Species: *Candidatus Phytoplasma palmae*

EPPO Code: PHYP56. EPPO A1 list No. 159.

Bangladesh status: Not present in Bangladesh [CABI/EPPO &, 1998a]

7.11.2. Biology

Phytoplasmas are cell wall-less prokaryotes, too small in size to be resolved adequately by light microscopy methods. By transmission electron microscopy of ultrathin sections, phytoplasmas appear to consist of rounded to filamentous bodies bounded by a trilaminar unit membrane. These bodies contain granules the size of ribosomes and strands of DNA that apparently condense during specimen preparation (Thomas, 1979; Thomas and Norris, 1980). In phloem sieve tube elements of coconut palms, cells of the LY phytoplasma are generally 142-295 nm in diameter and may vary from 1 to 16 µm in length (Waters and Hunt, 1980).

7.11.3. Hosts

Plant host range for LY phytoplasma (16SrIV-A) includes: *Aiphanes lindeniana* (Ruffle palm), *Allagoptera arenaria* (Kutze seashore palm), *Caryota mitis* (Burmese or clustering fishtail palm), *C. rumphiana* (Giant fishtail palm), *Chelyocarpus chuco* (Round leaf palm), *Copernicia alba* (Caranday palm), *Corypha taliera* (Buri palm), *Crysophila warsecewiczii* (Rootspine palm), *Cyphophoenix nucele* (Lifou palm), *Dypsis cabadae* (Cabada palm), *D. decaryi* (Triangle palm), *Gaussia attenuata* (Puerto Rican Gaussia palm), *Howea belmoreana* (Belmore Sentry palm), *H. forsteriana* (Kentia or Sentry palm), *Hyophorbe verschaffeltii* (Spindle palm), *Latania lontaroides* (Latan palm), *Livistona chinensis* (Chinese fan palm), *L. rotundifolia* (Footstool palm), *Nannorrhops ritchieana* (Mazari palm), *Phoenix canariensis* (Canary Island date palm), *P. dactylifera* (Date palm), *P. reclinata* (Senegal date palm), *P. rupicola* (Cliff date palm), *P. sylvestris* (Silver date palm), *Pritchardia maideniana* (Kona palm), *P. pacifica* (Fiji Island fan palm), *P. remota* (Remota loulu palm), *P. thurstonii* (Thurston palm), *Ravenea hildebrantii* (Hildebrants palm), *Syagrus schizophylla* (Arikury palm), *Veitchia arecina* (Montgomerys palm) and *V. merrillii* (McCoy *et al.,* 1983; Eden-Green, 1997; Harrison and Jones, 2004; Harrison and Oropeza, 2008).

7.11.4. Distribution

- **Africa:** Ghana (CABI/EPPO &, 1998a), Kenya (CABI/EPPO &, 1998a), Nigeria (CABI/EPPO &, 1998a).
- **North America:** Mexico (McCoy *et al.,* 1982; CABI/EPPO &, 1998a; EPPO, 2014), USA (CABI/EPPO &, 1998a; EPPO, 2014).
- **South America:** Guyana (EPPO, 2014).
- **Oceania:** Australia (EPPO, 2014).
- **Europe:** Netherlands (NPPO of the Netherlands, 2013).

7.11.5. Hazard Identification Conclusion

Considering the facts that *Candidatus Phytoplasma palmae*-

- is not known to be present in Bangladesh [CABI/EPPO &, 1998a];
- *Candidatus Phytoplasma palmae*is present in USA, Australia, and Netherlands from where coconut seedlings are imported to Bangladesh.
- It has been recently seen in Texas that an outbreak of palm lethal yellowing can occur in a non-coconut-growing area (McCoy *et al*., 1980). The risk to date palm prompted the

following proposal by Carpenter (1977): 'In Florida, lethal yellowing has been identified in P. dactylifera, P. canariensis and P. reclinata as well as in coconut and several other species of palms.

- *Candidatus Phytoplasma palmae*is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

7.11.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 11.1 – Which of these descriptions best fit of this pest?

Description	Establishment Potential
a. Has this pest been established in several new countries in recent years-Yes, • Establishment of *Candidatus Phytoplasma palmae*has been recorded in Antigua and Barbuda, Guatemala, Netherlands Antilles, Saint Kitts and Nevis, Guyana, Netherlands and Australia. • *Candidatus Phytoplasma palmae*has also been established in many countries from where coconut seedlings are imported in Bangladesh like USA (EPPO, 2014). **b. Posibility of survival during transport, storage and transfer? Yes** • *Candidatus Phytoplasma palmae*can survive into the coconut leaves at low temperature (till 5^{o}C). • The time from primary infection to appearance of overt visible symptoms on young, non-bearing coconut palms has been estimated at between 112 and 262 days (Dabek, 1975). • So, there is possibility to survive during transport, storage and transfer to Bangladesh. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? – Yes** • The pathway for *Candidatus Phytoplasma palmae*to enter Bangladesgh is appear good from the treading countries. • *Candidatus Phytoplasma palmae*is transported through coconut leaves. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • The host range of *Candidatus Phytoplasma palmae*is limited but available in Bangladesh.	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.11.7. Determine the Consequence establishment of this pest in Bangladesh

Table 11.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • The main host of *Candidatus Phytoplasma palmae* is coconut, which is available in Bangladesh and also the climatic factors are favourable for establishing *Candidatus Phytoplasma palmae.* • So, *Candidatus Phytoplasma palmae* can be the serious pest of Bangladesh.	**Yes and High**

b. Economic impact and yield loss • The Atlantic tall, the most prevalent coconut ecotype throughout the Caribbean region and Atlantic coast of the Americas (Harries, 1978a), is highly susceptible to LY disease. During the past three decades, at least 50% of Florida's estimated one million coconut palms and over 80% of Jamaica's five million coconut palms have been eliminated by LY (McCoy *et al.,* 1983). Similar epidemic losses of coconut to LY continued along the Atlantic coasts of southern Mexico and Honduras (Oropeza and Zizumbo, 1997). Although rarely affecting palms less than 5 years old, the disease prevents any re-establishment of highly susceptible coconut ecotypes in LY-endemic locations such as Florida and Jamaica. **c. Environmental Impact** • Due to entry of the pytoplasma different type of bacteriside used by the farmers which have negative effect on our environment.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

7.11.8. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table11.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	**High**	**High**
High	Moderate	High
Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

7.11.9. Risk Management Measures

- Lethal yellowing and related diseases pose a significant threat to global coconut production (Harries, 1978b).
- Avoid importation of coconut seedlings from countries, where this pathogen is available.
- In countries where *Candidatus Phytoplasma palmae*is not already present, the enforcement of strict phytosanitary regulations as required *Candidatus Phytoplasma palmae*, may help to reduce the risk of this pathogen becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the pathogen (OEPP/EPPO, 1990).

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7.12. Red ring nematode, *Bursaphelenchus cocophilus*

7.12.1. Hazard identification

Scientific Name: *Bursaphelenchus cocophilus*
Synonyms:
Aphelenchoides cocophilus (Cobb, 1919) Goodey, 1933
Aphelenchus cocophilus Cobb, 1919*;*
Rhadinaphelenchus cocophilus (Cobb, 1919) Goodey, 1960
Chitinoaphelenchus cocophilus (Cobb, 1919) Chitwood in Corbett, 1959
Common names: Red ring nematode;

Taxonomic tree

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Nematoda
Order: Aphelenchida
Family: Aphelenchoididae
Genus: *Rhadinaphelenchus*
Species: *Rhadinaphelenchus cocophilus*

EPPO Code: RHAACO.
Bangladesh status: Not present in Bangladesh [CABI & EPPO, 1999; EPPO, 2014]

7.12.2. Biology

Body of female nematode is about 1 mm long and very slender (a=60-96), arcuate to nearly straight when relaxed; cuticle thin, marked with transverse striae 0.6-1 µm apart; lateral fields with four incisures and a faint median line suggesting a fifth incisure, occupying 0.25 of body-width (Goodey, 1960); deirids and phasmids absent. Tail elongate sub-cylindrical with a rounded, unstriated terminus, 10-17 anal body-widths long. Body of male nematode is ventrally arcuate, more strongly curved in tail region. Head, spear and oespohagus as in female. Testis single, anteriorly outstretched, with spermatogonia in a row. Spicules paired, small; dorsal limb 9-11 µm long with an elongated rounded apex. Larvae have high, dome-shaped heads, not offset from body. Tails of second- and third-stage larvae have conoid or sharply mucronate tips, and those of fourth-stage larvae have dimorphic tips: in female larvae they are rounded as in the female, and in male larvae sharply drawn out (CIH, 1975).

7.12.3. Hosts

R. cocophilus is a parasite of palms only.

7.12.4. Distribution

- **North America:** Mexico (CABI & EPPO, 1999; EPPO, 2014).
- **South America:** Brazil (CABI & EPPO, 1999; EPPO, 2014), Peru (CABI & EPPO, 1999; EPPO, 2014), Colombia (CABI & EPPO, 1999; EPPO, 2014), Venezuela (CABI & EPPO, 1999; EPPO, 2014).

7.12.5. Hazard Identification Conclusion

Considering the facts that *R. cocophilus* -

- is not known to be present in Bangladesh [CABI & EPPO, 1999; EPPO, 2014];
- is present in countries from where Bangladesh import coconut seedlings. So there is a chance for establishment of *R. cocophilus*in Bangladesh.

7.12.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 12.1 – Which of these descriptions best fit of this pest?

Description	Establishment Potential
a. Has this pest been established in several new countries in recent years- No • *R. cocophilus* has not been established in any countries in recent years. **b. Posibility of survival during transport, storage and transfer? Yes** • In host plant body *R. cocophilus* can servive up to 90 days. So during transport, storage and transfer *R. cocophilus* can servive in host plant body. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? – Yes** • The only confirmed vector of *R. cocophilus*is *Rhynchophorus palmarum*.	**YES and Moderate**

• Spread through infected plants for planting (CABI, 2016). This nematode is not known to be seed borne. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • *R. cocophilus* is considered an imminent threat that could be introduced into the imported coconut seedlings. • *R. cocophilus*has only one host. And coconut plant is available in Bangladesh.	
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.12.7. Determine the Consequence establishment of this pest in Bangladesh

Table 12.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - Yes. • *R. cocophilus* attacks young and old coconut plants. And it can kill coconut plants. So it can be a serious pest for coconut in Bangladesh. **b. Economic impact and yield loss** • In Trinidad, red ring disease can kill 35% of young coconut trees. In Venezuela, 35% of oil palms (*Elaeis spp*.) were killed by red ring disease over a 10 year period (Brammer and Crow, 2002). Chinchilla (1991) states that losses of 5 to 15% in oil and coconut palm plantations as a result of *B. cocophilus* is common in several countries in Central and South America. • *B. cocophilus* most often attacks *Cocos nucifera* trees that are four-to-seven years old. These trees usually die six to eight weeks after symptoms appear. Older trees may last up to 20 weeks after symptom expression (Esser and Meredith, 1987). **c. Environmental Impact** • *R. cocophilus* causes major crop loss of coconut plantations in its restricted area of distribution. It can also seriously damage oil palms. The percentage loss can vary from a few percent to complete destruction of young coconuts. Young coconut palms easily succumb to *R. cocophilus* attack. There is no record of any tree, once affected, having recovered. The heaviest losses due to *R. cocophilus* occur at the end of the wet season and in the first 2-3 months of the dry season (December to March) in Trinidad.	**Yes and High**
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

7.12.8. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 12.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	High	High
High	Moderate	High
Moderate	**High**	**High**
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – high

7.12.9. Risk Management Measures

- Avoid importation of coconut seedlings from countries, where this nematod is available.
- In countries where *R. cocophilus*is not already present, the enforcement of strict phytosanitary regulations as required*R. cocophilus*, may help to reduce the risk of this nematod becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the nematod (OEPP/EPPO, 1990).

7.12.10. References

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7.13. Burrowing nematode, *Radopholus similis* (Cobb, 1893)

7.13.1. Hazard identification

Scientific Name: *Radopholus similis* (Cobb, 1893) Thorne, 1949
Synonyms:

Anguillulina biformis (Cobb, 1909) Goodey, 1932;
Radopholus acutocaudatus (Zimmermann, 1898) Siddiqi, 1986;
Rotylenchus similis;
Tetylenchus granulosus (Cobb, 1893) Filipjev, 1936;
Tylenchus biformis Cobb, 1909.

Common names: Burrowing nematode;
Nematode root rot;
Slow wilt nematode.

Taxonomic tree

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Nematoda
Family: Pratylenchidae
Genus: *Radopholus*
Species: *Radopholus similis*

EPPO Code: RADOCI.

Bangladesh status: Not present in Bangladesh [CABI/EPPO, 1999; EPPO, 2014]

7.13.2. Biology

Body of female nematode is straight to slightly arcuate ventrally; cuticle distinctly annulated. Lateral field with 4 incisures, not areolated except towards extremities, arising from near median oesophageal bulb and ending near tail terminus. Tail somewhat elongate-conoid with a narrow rounded or indented terminus. In male nematode oesophagus and spear degenerate; median bulb and valvular apparatus indistinct, spear without distinct knobs. Lip region elevated, 4-lobed, with lateral lips considerably reduced, not strongly sclerotized, with 3-5 annules posteriorly (Orton Williams and Siddiqi, 1973).

7.13.3. Hosts

Radopholus similis (sensu lato) is very polyphagous. Its host major are pineapple, groundnut, betelnut, tea, citrus, coconut, coffee, turmeric, carrot, yam, banana, avocado, black pepper, pears, sugarcane, tomato and ginger.

7.13.4. Distribution

- **Asia**: China (CABI/EPPO, 1999; EPPO, 2014), India (CABI/EPPO, 1999; EPPO, 2014), Indonesia (CABI/EPPO, 1999; EPPO, 2014), Israel (CABI/EPPO, 1999; EPPO, 2014), Japan (CABI/EPPO, 1999; EPPO, 2014), Malaysia (CABI/EPPO, 1999; EPPO, 2014), Pakistan (Shahina & Maqbool, 1992), Philippines (CABI/EPPO, 1999; EPPO, 2014), Sri Lanka (Gnanapragasam *et al.,* 1991), Taiwan (CABI/EPPO, 1999; EPPO, 2014), Thailand (CABI/EPPO, 1999; EPPO, 2014) and Turkey (EPPO, 2014).
- **Africa**: Egypt (CABI/EPPO, 1999; EPPO, 2014), South Africa (CABI/EPPO, 1999; EPPO, 2014).
- **North America:** Canada (CABI/EPPO, 1999; EPPO, 2014), USA (CABI/EPPO, 1999; EPPO, 2014).
- **South America:** Argentina (CABI/EPPO, 1999; EPPO, 2014), Brazil (Zem & Lordello, 1983).
- **Oceania:** Australia (Blake, 1972).
- **Europe:** Belgium (CABI/EPPO, 1999; EPPO, 2014), France (CABI/EPPO, 1999; EPPO, 2014), Italy (CABI/EPPO, 1999; EPPO, 2014), Spain (CABI/EPPO, 1999; EPPO, 2014).

7.13.5. Hazard Identification Conclusion

Considering the facts that *R. similis* -

- is not known to be present in Bangladesh [CABI & EPPO, 1999; EPPO, 2014];
- is present in countries from where Bangladesh import coconut seedlings. So there is a chance for establishment of *R. similis* in Bangladesh.

7.13.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 13.1 – Which of these descriptions best fit of this pest?

Description	Establishment Potential
a. Has this pest been established in several new countries in recent years- Yes • *R. similis* has been introduced in India, Indonesia, Japan, Singapore, Taiwan, Turkey, Benin, Canada, Argentina, Austria, Italy, UK and New Caledonia (CABI/EPPO, 1999; EPPO, 2014). **b. Posibility of survival during transport, storage and transfer? Yes** • In host plant body *R. similis* can survive up to 90 days. So during transport, storage and transfer *R. similis* can survive in host plant body. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? – Yes** • Spread through infected plants for planting. This nematode is not known to be seed borne. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • *R. similis* is considered an imminent threat that could be introduced into the imported coconut seedlings. • *R. similis* has only one host. And coconut plant is available in Bangladesh.	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.13.7. Determine the Consequence establishment of this pest in Bangladesh

Table 13.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • *R. similis* attacks young and old coconut plants. And it can kill coconut plants. So it can be a serious pest for coconut in Bangladesh **b. Economic impact and yield loss** • *R. similis* causes non-specific general decline symptoms on coconut such as stunting, yellowing, reduction in number and size of leaves and leaflets, delay in flowering, button shedding and reduced yield (Griffith and Koshy, 1990; Koshy *et al.,* 1991). In pot experiments, soil population levels of 100 nematodes per seedling cause a 35% reduction in height and a 14% reduction in girth of coconut palms over a five year period (Koshy and Sosamma, 1987). In large field tanks (microplots) in India after seven years, an initial inoculum level of 1000 nematodes per seedling (10 nematodes per 35 640 cm^3 of soil) gave reductions of 17, 14 and 35% over uninoculated control in height, number of leaves and girth of stem, respectively (Koshy *et al.,* 1991). **c. Environmental Impact** • *R. similis* is sensitive to cold and favours warm temperatures and moist soil conditions. In very wet or dry soil, populations of the nematode are found to decline (Gnanapragasam, 1993). • In coconut, *R. similis* takes about 25 days at 25-28°C to complete its life	**Yes and High**

cycle. Most juveniles and adults, including gravid females, infest healthy, succulent root tips. In the field, the nematode can survive for 6 months in moist soil (27-36°C) and only 1 month in dry soil (29-39°C). Under glasshouse conditions it survives for longer periods: 15 months in moist soil (25.5-28.5°C) and 3 months in dry soil (27-31°C) (Griffith and Koshy, 1990).	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

7.13.8. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 13.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	**High**	**High**
High	Moderate	High
Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

7.13.9. Risk Management Measures

- Avoid importation of coconut seedlings from countries, where this nematode is available.
- In countries where *R. similis* is not already present, the enforcement of strict phytosanitary regulations as required *R. similis*, may help to reduce the risk of this nematode becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the nematode (OEPP/EPPO, 1990).

7.13.10. References

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7.14. Cadang cadang disease, *Coconut cadang-cadang viroid*

7.14.1. Hazard identification

Scientific Name: *Coconut cadang-cadang viroid*
Common names: Cadang cadang disease;
Yellow mottling disease.
Taxonomic tree
Domain: Virus
Group: Viroids
Family: Pospiviroidae
Genus: Cocadviroid
Species: *Coconut cadang-cadang viroid*
EPPO Code: CCCVD0.
Bangladesh status: Not present in Bangladesh [EPPO, 2014]

7.14.2. Biology

CCCVd (246-nucleotide form) is the smallest known viroid, as well as the smallest known infectious pathogen. Cadang-cadang affected coconut palms (*Cocos nucifera*) contain linear and circular viroid molecules, and there are numerous variants of the basic 246 nt sequence (Imperial *et al.,* 1981; Mohamed *et al.,* 1982; Haseloff *et al.,* 1982) including mutants of these (Rodriguez, 1993; Rodriguez and Randles, 1993). For example, there are two monomeric 'fast' ($CCCVd_{246}$ and $CCCVd_{247}$) and 'slow' ($CCCVd_{296}$ and $CCCVd_{297}$) electrophoretic forms as well as dimeric forms of each monomer (Randles, 1985). $CCCVd_{247}$ differs from $CCCVd_{246}$ by the insertion of a cytosine at position 197 and $CCCVd_{297}$ from $CCCVd_{296}$ are the corresponding 'slow' forms. The 'slow' RNAs are directly derived from the corresponding 'fast' forms by a partial duplication of the right-hand terminus (TR) of the molecule (Haseloff *et al.,* 1982). There are additional slow forms due to the reiteration of 41, 50 or 55 nt in the TR, producing viroid RNAs between 287 and 301 nt (Haseloff *et al.,* 1982). Coconut palms with a 'brooming' phenotype contain single mutations (Rodriguez and Randles, 1993). Variants of CCCVd (270, 293 and 297 nt variants of the viroid) have been detected in oil palm in low concentrations and had a high sequence similarity with $CCCVd_{296}$ but none were identical to previously described forms of CCCVd (Vadamalai *et al.,* 2006). Physical properties and melting profile of CCCVd are similar to those of Potato spindle tuber viroid (PSTVd) (Randles *et al.,* 1982). CCCVd is the only viroid known to show 'programmed' molecular changes during disease progression. The order of appearance is normally the 246, 247 nucleotide forms at early stage disease then increasing amounts of the 296, 297 nucleotide forms at the medium and late stages as the small forms disappear (Imperial and Rodriguez, 1983; Randles, 1985, 1987). Associated dimeric forms follow the same pattern.

7.14.3. Hosts

There is natural infection of all commercial cultivars of *Cocos nucifera* (coconut palm) in the Philippines. Related viroid-like RNA sequences were also detected naturally in *Elaeis guineensis* (oil palm) and *Corypha elata* (buri palm) in the Philippines although some hybridization was also seen in palms with no symptoms (Randles *et al.,* 1980). Experimental hosts susceptible to mechanical inoculation with partially purified CCCVd include a wide range of Arecaceae including oil palm, betelnut palm (*Areca catechu*), date palm, royal palm and golden cane palm (Randles *et al.,* 1980; Imperial *et al.,* 1985; Randles, 1987) and possibly *Maranta* species. Related viroid-like RNA sequences have also been found naturally in members of the Arecaceae and Pandanaceae, as well as herbaceous monocotyledons including Zingiberaceae, Marantaceae and Commelinaceae (Hanold and Randles, 1991a, b; Rodriguez, 1993). Related viroid-like RNA has also been detected in a limited sample of coconuts in Sri Lanka (Vadamalai *et al.,* 2009).

7.14.4. Distribution

- **Asia**: Malaysia (EPPO, 2014), Philippines (Randles & Rodriguez, 2003; Randles & Imperial, 1984), Sri Lanka (EPPO, 2014).
- **Oceania:**Guam (EPPO, 2014), Solomon Islands (EPPO, 2014).

7.14.5. Hazard Identification Conclusion

Considering the facts that CCCVd -

- It is not known to be present in Bangladesh [EPPO, 2014];
- CCCVd has present in Malaysia, Philippines and Sri Lanka (EPPO, 2014) from which coconut seedlings are imported in Bangladesh.

7.14.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 14.1 – Which of these descriptions best fit of this pest?

Description	**Establishment Potential**
a. Has this pest been established in several new countries in recent years- Yes • CCCVd has been established in Malaysia, Sri Lanka, Guam and Solomon Islands (EPPO, 2014) in recent years. **b. Posibility of survival during transport, storage and transfer? Yes** • In host plant body CCCVd can survive for long duration. So during transport, storage and transfer CCCVd can survive in host plant body. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? – Yes** • Spread through infected plants for planting. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • CCCVd is considered an imminent threat that could be introduced into the imported coconut seedlings. • CCCVd has wide range of host plants. Coconut plant is the major host for CCCVd which is available in Bangladesh.	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.14.7. Determine the Consequence establishment of this pest in Bangladesh

Table 14.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - Yes. • Coconut (*Cocos nucifera*) is both a vital subsistence and major cash crop in developing countries, and most coconut products are supplied by smallholders. CCCVd is considered to be a serious economic threat (Hanold and Randles, 1991a) and both local and international quarantines are in place to prevent the movement of coconut material from the area of incidence in the Philippines. • It was estimated in 1980 that since cadang-cadang was first recorded it had killed more than 30 million coconut palms. This would have amounted to a loss of produce worth US$ 2400-3000 million at the rate of US$ 80-100 (depending on copra prices) for each planting (palm) site. Annual yield loss of about 22,000 t of copra has been attributed to this disease in the Philippines (Zelazny *et al.,* 1982). Estimated average losses of ca. 300,000 palms per annum since 1980 means that total losses until 2007 probably exceed 40 million palms. **b. Economic impact and yield loss** • Infection leads to cessation of coconut production, followed by decline and death of diseased palms. About 40 million palms are estimated to have died from cadang-cadang in the Philippines with a loss of about US$100 per infected palm due to lost production and delay in replacement (Randles and Rodriguez, 2003). • Oil palms with both GOS symptoms and infected with CCCVd-related RNA show significantly reduced growth (Hanold and Randles, 1998). **c. Environmental Impact** • In areas of high incidence the ecosystem is radically altered due to large scale death of palms.	**Yes and High**
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

7.14.8. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 14.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	**High**	**High**
High	Moderate	High
Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

7.14.9. Risk Management Measures

- Avoid importation of coconut seedlings from countries, where this virous is available.
- In countries where CCCVdis not already present, the enforcement of strict phytosanitary regulations as requiredCCCVd, may help to reduce the risk of this virous becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the virous (OEPP/EPPO, 1990).

7.14.10. References

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7.15. Coconut foliar decay, *Coconut foliar decay virus*

7.15.1. Hazard identification

Scientific Name: *Coconut foliar decay virus*
Other scientific Names:
CCoconut foliar decay nanavirus
Common names: Coconut foliar decay
New Hebrides coconut disease

Taxonomic tree
Domain: Virus
Group: "ssDNA viruses"
Group: "DNA viruses"
Family: Nanoviridae
Genus: Nanovirus
Species: *Coconut foliar decay virus*

EPPO Code: CFDV00.
Bangladesh status: Not present in Bangladesh [EPPO, 2014]

7.15.2. Biology

Virions isometric; 20 nm in diameter; angular in profile; without a conspicuous capsomere arrangement. Density 1.21-1.25 g/ml in Nycodenz; 1.30 g/ml in CS_2SO_4. Genome consists of DNA; single-stranded; circular. Total genome size 1.29 kb. Genome possibly unipartite; largest (or only) genome part 1.29 kb (Randles and Hanold, 1989).

7.15.3. Hosts

Only one host of CFDV is coconut.

7.15.4. Distribution

- **Oceania:**Vanuatu(Julia, 1982; EPPO, 2014).

7.15.5. Hazard Identification Conclusion

Considering the facts that CFDV -
- It is not known to be present in Bangladesh [EPPO, 2014];
- CFDV has present in Vanuatu.

7.15.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 15.1 – Which of these descriptions best fit of this pest?

Description	Establishment Potential
a. Has this pest been established in several new countries in recent years- NO • There is no record of establishment of CFDV recent years. **b. Posibility of survival during transport, storage and transfer? No** • Virus not transmitted by mechanical inoculation; not transmitted by grafting (coconuts will not graft) (Calvez *et al.*, 1980). **c. Does the pathway appear good for this pest to enter Bangladesh and establish? – No** • Transmitted by a vector; an insect; Cixiidae: *Myndus crudus*; an unusual insect group. Transmitted in a semi-persistent manner, or in a persistent manner (Calvez *et al.*, 1980). • So the pathway does not appear good for transmition of CFDV to enter Bangladesh. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • The host range of CFDV in Bangladesh is available. • And the environmental condition also suitable for growth and development of CFDV.	**Low**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.15.7. Determine the Consequence establishment of this pest in Bangladesh

Table 15.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - No. • Though the host of CFDV is common in Bangladesh, so CFDV can be a serious pest in Bangladesh. **b. Economic impact and yield loss** • The disease is important in Vanuatu, not because it affects the local varieties grown in all the islands, but because it affects improvements to the coconut industry based on high-yielding hybrids. Local tall and dwarf varieties are low yielding compared to the hybrid varieties of commerce, e.g., Malayan Yellow Dwarf x Rennell Island Tall, Malayan Yellow Dwarf x West African Tall, and Cameroon Red Dwarf x Rennell Island Tall. **c. Environmental Impact** • After estabilishment of this virus, farmers used insecticide to control its vector causes serious problem to the environment.	**Low**
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

7.15.8. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 15.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	High	High
High	Moderate	High
Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	**Low**	**Low**

Calculated Risk Rating – Low

7.15.9. Risk Management Measures

- Avoid importation of coconut seedlings from countries, where this virous is available.
- In countries where CFDVis not already present, the enforcement of strict phytosanitary regulations as requiredCFDV, may help to reduce the risk of this virous becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the virous (OEPP/EPPO, 1990).

7.15.10. References

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7.16. Parthenium weed;*Parthenium hysterophorus*

7.16.1 Hazard Identification

Scientific name: *Parthenium hysterophorus* L.

Synonyms: *Parthenium hysterophorus* var. *lyratum* A.Gray
Argyrochaeta bipinnatifida Cav.
Argyrochaeta parviflora Cav.
Echetrosis pentasperma Phil.
Parthenium glomeratum Rollins,
Parthenium lobatum Buckley,
Parthenium pinnatifidum Stokes,
Villanova bipinnatifida Ortega

Common names: Parthenium weed, bitter weed, bitter-broom, bitterweed, carrot grass, congress grass, false camomile, false ragweed, feverfew, parthenium, parthenium weed, ragweed, ragweed parthenium, Santa Maria, Santa Maria feverfew, white top, whitehead, whitetop

Taxonomic tree

Kingdom: Plantae

Family: Asteraceae

Genus: *Parthnium*

Species: *Parthenium hysterophorus*

EPPO Code: PTNHY. This pest has been included in EPPO A2 list: No. 383

Bangladesh status: Present in restricted areas of Bangladesh possibly introduced from India.

7.16.2. Biology

P. hysterophorus reproduces only by seeds and is known to be highly prolific, as a single plant produces 15 000 seeds on average and up to 100 000 seeds (GISD Database, Global Invasive Species Database, 2010). Seed viability is high, 85% or higher (Navie et al., 1998). Buried seeds have been found to last longer than seeds on the soil surface, and a significant proportion can still germinate after 8–10 years. Freshly produced seeds demonstrate a degree of dormancy (up to several months) (Navie et al., 1998). In addition, the species is an opportunistic germinator. Seeds can germinate at any time of the year provided moisture is available but they require bare soil to do so (Parsons & Cuthbertson, 1992). The plant flowers 4 – 8 weeks after germination and flowering continue until drought or frost kills the plant. Under favourable conditions, 2 – 3 life cycles can be completed per year (Fatimah & Ahmad, 2009).

7.16.3. Hosts or habitats

- *P. hysterophorus* grows in a wide range of habitats, including degraded and disturbed lands and streams and rivers. It is a pioneer species that can invade grazing land and degraded pastures, crops, orchards, summer crops, disturbed and cultivated areas, forests, railway tracks and roadsides, recreation areas, as well as river banks and floodplains (Navie*et al*. 1996a).
- According to the Corine Land Cover nomenclature, the following habitats are invaded: arable land, permanent crops (e.g. vineyards, fruit tree and berry plantations, olive), pastures, riverbanks / canalsides (dry river beds), road and rail networks and associated land, other artificial surfaces (wastelands).
- 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, coconut, 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; Anwar et al. 2012).

7.16.4. Geographical distribution

Native distribution: *P. hysterophorus* is native to the area bordering the Gulf of Mexico, and has spread throughout southern USA, the Caribbean and Brazil.

- **North America**: Bermuda, Mexico, USA (Alabama, Arkansas, Connecticut, Delaware, District of Columbia, Florida, Hawaii, Illinois, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Missouri, Mississippi, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, South Carolina, Texas, Virginia).
- **Central America and Caribbean**: Belize, Costa Rica, Cuba, Dominican Republic, Guadeloupe, Guatemala, Haiti, Honduras, Jamaica, Martinique, Netherlands Antilles, Nicaragua, Puerto Rico, Saint Barthelemy, Republic of Panama, Trinidad, Trinidad and Tobago.
- **South America**: Argentina, Bolivia, Brazil, Chile, Ecuador, French Guiana, Guyana, Peru, Paraguay, Suriname, Uruguay, Venezuela.

Exoticdistribution

- **EPPO region**: Israel.
- **Africa:** Comores, Egypt, Eritrea, Ethiopia, Kenya, Madagascar, Mauritius, Mauritius, Mayotte, Mozambique, Reunion, Seychelles, Somalia,South Africa, Swaziland, Tanzania, Uganda and Zimbabwe.
- **Asia:** Bangladesh,Bhutan, China (south of country), India, Oman and Yemen, Israel, Nepal, Pakistan, Sri Lanka, Japan, Republic of Korea, Taiwan and Vietnam.
- **Oceania:** Australia (Queensland, New South Wales, Northern Territory, Western Australia), French Polynesia, several Pacific islands including Bermuda, New Caledonia, Vanuatu and Christmas island.

7.16.5. Hazard identification conclusion

Considering the facts that *P. hysterophorus*-

- is not known to be present in all areas of Bangladesh;
- is potentially economic important to Bangladesh because it is an important pest of flowers and foliages in Asia including China, India, Nepal, Pakistan, **Japan** [EPPO, 2014; CABI/EPPO, 1999] from where agricultural crops and flowers are imported to Bangladesh.
- can become established in Bangladesh through the transportation of agricultural equipment and imports of the agricultural planting materials including flowers and foliages.
- *Parthenium hysterophorus* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

7.16.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 16.1. – Which of these descriptions best fit of this pest?

Description	Establishment Potential
A. Has this pest been established in several new countries in recent years?-Yes, • 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 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, and Fournet and Hammerton (1991) indicate that it occurs in 'probably all islands' of the Lesser Antilles. • Since its accidental introduction into Australia and India in the 1950s, probably as a	**YES**

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. • Because *P. hysterophorus* has shown invasive behaviour where it has been introduced elsewhere in the world and has a highly restricted distribution in the EPPO region, it can be considered an emerging invader in the EPPO region (EPPO, 2012). **b. Posibility of survival during transport, storage and transfer? Yes** • *P. hysterophorus* reproduces only by seeds and is known to be highly prolific, as a single plant produces 15000 seeds on average and up to 100000 seeds (GISD Database, Global Invasive Species Database, 2010). Seed viability is high, 85% or higher (Navie et al., 1998). Buried seeds have been found to last longer than seeds on the soil surface, and a significant proportion can still germinate after 8–10 years. Freshly produced seeds demonstrate a degree of dormancy (up to several months) (Navie et al., 1998). In addition, the species is an opportunistic germinator. Seeds can germinate at any time of the year provided moisture is available but they require bare soil to do so (Parsons & Cuthbertson, 1992). Therefore, the seeds of this weed can survive during transport, storage and transfer of the commodity. c. **Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Entries as a contaminant of agricultural produce and machinery have historically been important pathways for the introduction of *P. hysterophorus* in new regions. • **Contaminant of used machinery:** *P. hysterophorus* can enter new territories as a contaminant of used machinery, either as seeds, e.g. lodged on the radiators and grills of automobiles, or as seeds in soil attached to machinery, such as harvesters, road construction and maintenance machinery, military equipment and other vehicles. Vehicles and harvesters may circulate quite frequently across EPPO countries. The release of seeds of *P. hysterophorus* from the vehicles on the roads networks may facilitate its transfer to other unintended habitats connected by roads. • **Contaminant of grain:** *P. hysterophorus* was accidentally introduced into Israel in 1980 most likely through import of contaminated grains from the USA for fishponds (Dafni& Heller 1982). Wheat and other cereals were reported for the introduction of *P. hysterophorus* in India (Sushilkumar&Varshney, 2010), and sorghum is also reported to be infested in Ethiopia (Tamado*et al*., 2002). • **Contaminant of seed:** - Pasture seeds (grass) from Texas into central Queensland (Everist, 1976), as well as in Egypt from Texas in the 1960s (Boulos& El-Hadidi, 1984); - Cereal seed from the United States in Africa, Asia and Oceania (Bhomik&Sarkar, 2005); - Soybean seed from the USA in the Shandong Province in China in 2004 (Li &Gao, 2012). **d.Are the host(s) and habitats of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • *P. hysterophorus* grows in a wide range of habitats, including degraded and disturbed lands and streams and rivers. It is a pioneer species that can invade grazing land and degraded pastures, crops, orchards, summer crops, disturbed and cultivated areas, forests, railway tracks and roadsides, recreation areas, as well as river banks and floodplains (Navie*et al*. 1996a). • *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	**and** **HIGH**

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). • Where climatic conditions are appropriate (e.g. Mediterranean area, Black Sea, Eastern Asia, the warmest temperate area) there are numerous suitable habitats. Consequently, for these areas, the probability of establishment is high with low uncertainty. • Therefore, the hosts and habitats as well as climatic requirements for this weeds are mostly common in Bangladesh.	
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter your country and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	Low

7.16.7. Determine the Consequence establishment of this pest in Bangladesh

Table 16.2 – Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • *P.hysterophorus*is a major pestinpastures and crops in its exotic range, and has major detrimental impact on human and animal health through allergies and dermatitis. • If introduced in the area of potential establishment, eradication or containment would be unlikely to be successful due to its high reproductive potential and high spread capacity through human activities. • • This is a **fairly serious pest** of several important crops and human health rather than flowers for Bangladesh. **b. Economic impact and yield loss** • 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 after *Digitaria abyssinica* (Tamado and Milberg, 2000) and sorghum grain yield was reduced from 40 to 97% depending on the year and location (Tamado, 2001). • Although *P. hysterophorus* is not yet considered to be a major crop weed in Australia (Navie *et al.,* 1996), it has started to spread into sorghum, sugarcane and sunflower growing areas and negatively affect yields (Parsons and Cuthbertson, 1992). 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. **c. Environmental Impact** • Parthenium weed lacks predators, and cattle and livestock usually do not feed on it.	**Yes and High**

As a result, the food chain is disturbed and the trophic structure changes, leading to an ecological imbalance in the invaded area. • 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 nitrifyingbacteria. • 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. Batish et al. (2005) recorded 39 plant types in a *Parthenium*-free area, but only 14 were present in an infested area, and very little or sometimes no vegetation can be seen in some *Parthenium*-dominated areas (Kohli, 1992). 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).	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in your country.	Low

7.16.8. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 16.3 – Calculating risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	**High**	**High**
High	Moderate	High
Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

7.16.9. Risk Management Measures

a. Contaminant of used machinery

- Cleaning or disinfection of machinery/vehicles in combination with internal surveillance and/or eradication or containment campaign.

b. Contaminant of grain: Measures related to the crop or to places of production:

- Pest-free area
- Pest-free place of production/production site consist in the following combination of measures: visual inspection at the place of production, specified treatment of the crop, testing of the commodity, internal surveillance and/or eradication or containment campaign.
- Certification scheme

- Import under special licence/permit and specified restrictions (for grain which is aimed to be crushed or transformed).

c. Contaminant of seeds: Measures related to the crop or to places of production:

- Pest-free area
- Pest-free place of production/production site consist in the following combination of measures: visual inspection at the place of production, specified treatment of the crop, testing of the commodity, internal surveillance and/or eradication or containment campaign.
- Certification scheme for seeds.

d. Contaminant of growing media adherent to plants for planting: Measures related to the crop or to places of production:

- Pest-free area
- Pest-free place of production/production site consist in the following combination of measures: visual inspection at the place of production, specified treatment, growing in glasshouses and in sterilized soil, internal surveillance and/or eradication or containment campaign.
- Certification scheme for plants for planting
- Removal of the growing medium from plants for planting.

e. Contaminant of travelers (tourists, migrants, etc.) and their clothes, shoes and luggage

Systems approach:

- Publicity to enhance public awareness on pest risks
- Internal surveillance and/or eradication or containment campaign.

7.16.10. References

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7.B. 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 CAB Internation (2007) and EPPO (European and Mediterranean Plant Protection Organization) (1997).

From the quantitatively risk analysts of quarantine pests likely to be associated and follow the coconut pathway to Bangladesh from Sri Lanka, Vietnam, India, Thailand, Malaysia, Myanmar and other exporting countries, out 16 potential hazard organisms, 13 hazard organisms were identified with high risk potential, 1 moderate and 2 low wereidentified with moderate risk potential.

The overall pest risk potential ratings of 16 quarantine pests of coconut for Bangladesh have been included in the following Table 11:

Table 11: The Overall Pest Risk Potential Rating

Sl. No.	Potential Hazard Organism	Scientific name	Family	Order	Pest Risk Potential
Insect pests					
1	Coconut bug	*Pseudotheraptus wayi*	Coreidae	Homoptera	**High**
2	lesser snow scale	*Pinnaspis strachani*	Diaspididae	Homoptera	**High**
3	Red scale	*Chrysomphalus dictyospermi*	Diaspididae	Hemiptera	**High**
4	Spiked mealybug	*Nipaecoccus nipae*	Pseudococcidae	Hemiptera	**Moderate**
5	long-tailed mealybug	*Pseudococcus longispinus*	Pseudococcidae	Hemiptera	**High**
6	Black tea thrips	*Heliothrips haemorrhoidalis*	Thripidae	Thysanoptera	**High**
7	Coconut leaf roller	*Omiodes blackburni*	Crambidae	Lepidoptera	**Low**
8	coconut hispine beetle	*Brontispa longissima*	Chrysomelidae	Coleoptera	**High**
9	Nettle caterpillar	*Darna trima (Moore)*	Limacodidae	Lepidoptera	**High**
Mite					
10	Red palm mite	*Raoiella indica* Hirst	Tenuipalpidae	Acarina	**High**
Bacteria					
11	Lethal yellowing of coconut	*Candidatus Phytoplasma palmae (PLY)*	Acholeplasmataceae	Acholeplasmatales	**High**
Nematode					
12	Red ring nematode (Coconut palm nematode)	*Bursaphelenchus cocophilus*	Aphelenchoididae	Aphelenchida	**High**
13	Burrowing nematode	*Radopholus similis*	Pratylenchidae	Acarina	**High**
Virus					
14	Cadang-cadang	*Coconut cadang-cadang viroid (CCCVd)*	Pospiviroidae		**High**
15	Coconut foliar decay	*Coconut foliar decay virus (CFDV)*	Nanoviridae	Group: DNA viruses	**Low**
Weed					
16	Parthenium weed	*Parthenium hysterophorus*	Asteraceae	Asterales	**High**

Uncertainity

The quarentine pest species those remain uncertainitry as potential hazards due to lack of their detail information. Such uncertain species were saddle back caterpillar (*Acharia stimulea*), bag worm (*Scoriodyta* spp.), thanjavur wilt (*Ganoderma lucidum*), leaf scorch (*Fusarium* sp.), leaf rot (*Cholletotrichum* Sp.), tatipaka (*Phytoplasma* spp.) and root wilt (*Mycoplasma like organism*). The taxonomic identity of this uncertain species is given in the table 12.

Table 12: Quarantine pest species for Bangladesh likely to be associated with host plants during importation from exporting countries, but remained as uncertain hazards due to lack of detail information

Sl. No.	Common name	Scientific name	Family	Order
01.	Saddle back caterpillar	*Acharia stimulea*	Limacodidae	Lepidoptera
02.	Bag worm	*Scoriodyta* spp.	Psychidae	Lepidoptera
03.	Thanjavur wilt	*Ganoderma lucidum*	Ganodermataceae	Polyporales
04.	Leaf scorch	*Fusarium* sp.	Nectriaceae	Hypocreales
05.	Leaf rot	*Cholletotrichum* Sp.	Glomerellaceae	Glomerellales
06.	Tatipaka	*Phytoplasma* spp.	Acholeplasmataceae	Acholeplasmatales
07.	Root wilt	*Mycoplasma like organism*	Mycoplasmataceae	Mycoplasmatales

CHAPTER 8

RISK MANAGEMENT

8.1. Risk Management Optionsand 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 coconutfrom India, China, Japan, Thailand, Taiwan, Vietnam, Philippines, Indonesia, U.S.A, Australia, France, Germany, Italy, Netherlands, Belgium, Brazil, and Chile or any other countries of coconutexport (i.e. produced under standard cultivation, harvesting and packing activities). Plant Quarantine Wing of Bangladesh will consider the risk management measures proposed below is commensurate with the identified risks.

8.1.1. Pre-harvest Management Options

i. **Use of pest resistant varieties**: The use of resistant varieties is a common and effective component in reducing pest risk.

ii. **Chemical spray program**: Pre-harvest chemical sprays may be used to control pests within production fields, for example, the use of nematicides to control the root knot nematode.

iii. **Crop rotation**: Certain coconut diseases can survive from season to season in the field. Depending on the type of pathogen, it may survive in the resting form either in the soil or in coconut plant debris, or in a living form in surviving fallen fruit. On occasion, diseased fruitsare the sources of contamination for the current season crops. Therefore, acrop rotation to minimize soil disease problems is recommended.

iv. **Control of Insects**: Sucking and chewing insects may transmit many diseases. For example the *Cucumber mosail virus*t disease was found to be transmitted by the aphids (EPPO, 1997). The control of these insects and the rouging of infected parts of plants as early as possible may prevent spread of diseases in the field.

v. **Irrigation practices and soil type**: A well drained soil is recommended for planting of coconut as this make conditions less favourable to disease infection (Johnson, 1969). Over irrigation and a poorly drained soil increases the susceptibility to diseases such as powdery mildew, scab etc. The type of irrigation system may also aid in the transmission of some diseases.

vi. **Pre-harvest Inspection**: The relevant officers and inspectors from the importing country should inspect and verify the cleaning and disinfecting of equipment and storage used in coconut production. Laboratory testing should be done periodically. Quarantine restrictions may be used to limit spread of diseases detected.

8.1.2. Post-harvest Management Options

i. **Sanitization of equipment and material**: All machinery, transport and storage surfaces that the coconutseed will contact should be cleaned and disinfected prior to receiving new coconut seeds. Since most disinfectants are inactivated by soil and plant debris, it is essential that this material be removed by thoroughly cleaning the equipment and storage with a pressure washer or steam cleaner before the disinfectant is applied.

ii. **Disposal of infected fruits**: All infected fruits should be discarded away from production site (Rowe *et. al*).

iii. **Seedlingand fruit grading**: The class and variety of coconut fruits and seedlings must be kept separate through harvesting, grading and storage. Grading must be done according to class, variety and disease tolerance. The class of coconut must clearly identifiable and labeled.

8.1.3. Phytosanitary Measures

i. **Pest free areas**: As a sole mitigation measure, the establishment of pest-free areas or pest-free places of production may be completely effective in satisfying an importing country's appropriate level of phytosanitary protection (IPPC, 1996b, 1999).Establishment and maintenance of pest-free areas or production sites should be in compliance with international standards (*e.g.*, IPPC, 1996b, 1999, 2006).

ii. **Stipulated commercial grade for coconut fruits**: This ensures a certain level of quality and cleanliness which results from commercial handling. This is a significant measure for pests that affect quality or associated with contaminants (eg. soil). Bangladesh should therefore make request for a certain grade of cocconut that reflects the acceptable tolerance level of the country.

iii. **Accept only certified coconut seedlings for crop production**: This measure is highly effective in mitigating pest risk, because it ensures the absence of specific pests, particularly pathogens, or a defined low prevalence of pests at planting. The main components of seedling certification include: sampling and testing of production areas to ensure free from viruses; approval of land and seed to be multiplied; inspection of crops for variety purity and crop health; inspection of coconut fruit samples; and sealing and labeling of certified seedling. Coconut seedlings to be imported from the exporting countries should be sourced from an officially recognized seed certification system.

iv. **Shipments traceable to place of origin in exporting countries**: A requirement that coconut seeds and fruits be packed in containers with identification labels indicating the place of origin, variety and grade is necessary to ensure traceability to each production site.

v. **Pre export inspection and treatment:** The NPPOs of exporting countries will inspect all consignments in accordance with official procedures in order to confirm those consignments are satisfied with import requirements on phytosanitary of Bangladesh.If quarantine fruitflieswith high risk potential are found during inspection, the phytosanitary procedures should maintained:

- Consignments of fruits from countries where these pests occur should be inspected for symptoms of infestation and those suspected should be cut open in order to look for larvae. EPPO recommends (OEPP/EPPO, 1990) that such fruits should come from an area where fruit fliesdo not occur and where routine intensive control measures are applied.
- Fruits may also be treated in transit by cold treatment (e.g. 13 or 14 days at 0.0 or 0.6°C,, respectively) or, for certain types of fruits, by vapour heat (e.g. keeping at 43-44°C for 6-9 h, according to commodity) (FAO, 1983) or hot water treatment.
- Ethylene dibromide was previously widely used as a fumigant but is now generally withdrawn because of its carcinogenicity; methyl bromide is less satisfactory, damaging many fruits and reducing their shelf life, although treatment schedules are available for specific cases (FAO, 1983; Armstrong & Couey, 1989).

vi. **Requirement of phytosanitary certification from country of origin:** The phytopathological service of the country of origin should ensure the coconut seeds and fruits from which the consignment is derived was not grown in the vicinity of unhealthy coconuttrees and was inspected by a duly authorized official/phytopathological service and the coconutseedlings have been produced in areas within the country free from all pests and diseases.

vii. **Port-of-entry inspection and treatment**: Upon arrival in Bangladesh, each consignment of coconut should be inspected to detect pests, with export phytosanitary certificate and seed certificate. Sampling of coconut seedlings and fruits consignments at port-of-entry in Bangladesh should combine visual inspection and laboratory testing. Visual inspection is useful to verify that certain phytosanitary certification requirements have been met and consignment is generally free of contaminants. The efficacy of this measure depends on the statistical level of sampling and the ability to detect the pests or article of concern (eg. soil). Laboratory testing requires that a portion of each sample taken for inspection be subjected to laboratory analysis for the detection of pathogens.

The consignment could re-export or destroy if quarantine pests or regulated articles with high risk potential are found during an inspection.

8.2 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.

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