Pest Risk Analysis (PRA) of Latikochu in Bangladesh

GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH

Ministry of Agriculture

Tuber Crops Development Project (TCDP)

Department of Agricultural Extension, Dhaka-1215

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Forward

The Tuber Crops Development Project (TCDP), Department of Agriculture Extension (DAE), Ministry of Agriculture conducted the study for "Conducting Pest Risk Analysis (PRA) of Latikochu in Bangladesh" according to the provision of contract agreement signed between TCDP, DAE and Centre for Resource Development Studies Ltd. (CRDS) on 04 January 2022. The PRA study is a five-month assignment commencing from 04 January 2022 under the TCDP, 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 latikochu and evaluate their risk in Bangladesh and to identify risk management options. To carry out the PRA study, the consulting firm conducted field investigations in 30 upazilas under 29 major latikochu growing districts of Bangladesh for listing of pests of latikochu in Bangladesh. The study covered the interview of 600 latikochu growers; 30 FGDs each of which conducted in one Upazila; information from DD of each districts, UAO and two SAAO/SAPPO of each upazila and BARI Researchers of each region; physical inspection and visits of the latikochu fields under sampled districts. The consultants also reviewed secondary sources of information related to PRA of latikochu including CABI & EPPO.

The study findings revealed that in Bangladesh, 11 insect and mite pests, 12 diseases and 41 weeds of latikochu were recorded in Bangladesh. From the analysis 4 insect pests, 3 diseases and 3 weeds were identified as quarantine pests for Bangladesh. 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. The findings also suggested the risk management options for the quarantine pests of latikochu in line with the pre- and post-harvest management and phytosanitary measures. The findings of the PRA study were presented in the National Level Workshop organized by the TCDP, DAE on 13 June 2022. The concerned professionals of agricultural universities of Bangladesh, DAE (Department of Agricultural Extension), research organizations and other relevant personnel from different organizations were attended the workshop. The online version of this report will be published at www.dae.gov.bd.

I would like to congratulate Consultant Team of CRDS for conducting the PRA study successfully and also the concerned TCDP professionals in making the total endeavor a success. I express my heartfelt thanks to the officials of DAE, Ministry of Agriculture, Horetex Foundation, BARI, Agricultural Universities, research organizations and latikochu importer and exporters associations for their assistance and cooperation extended in conducting the PRA study. Thanks are also due to Technical Committee members for their kind review of the report and providing feedbacks improving the quality of the report.

Special thanks to the Secretary and Additional Secretary (Planning Wing) of MoA for their co-operation. I also thanks to the Director General of DAE, Director (Plant Quarantine Wing), Director (Crops) and other high officials of Agriculture, Water Resources and Rural Institution Division in Planning Commission, IMED and Ministry of Agriculture for their presence at the Draft Report presentation workshop and providing valuable suggestions & Feedbacks. Thanks are due to Dr. Md. Azhar Ali, Consultant, TCDP for his advice & guidance. I hope that the report certainly would contribute to enhance the exports and imports of latikochu.

(Mukhlasure Rahaman)
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Preface

This Final Report intends to respond to the requirement of the client according to the provision of contract agreement signed between Project Director of Tuber Crops Development Project (TCDP), Department of Agricultural Extension (DAE) Ministry of Agriculture (MOA), Government of the People's Republic of Bangladesh for "Conducting Pest Risk Analysis (PRA) of Latikochu in Bangladesh". The PRA study is a five-month assignment commencing from January 2022 under the TCDP, DAE.

Consultancy services for "Conducting Pest Risk Analysis (PRA) of Latikochu in Bangladesh" were provided by the Centre for Resource Development Studies Ltd. (CRDS), Bangladesh. The study team consists of six senior level experts, one coordinator, and field and office level support staffs. The major objective of the study is to listing of major and minor pests of Latikochu, identification of pests likely to be associated with pathway, identification of potential for entry, establishment and spread, identification of potential economic and environmental impact, identification of control measures and potential impacts of such measures, assessment of potential loss by the pests, preparation of report on risk analysis of the pests following the relevant ISPMs and make recommendation.

The report includes study design, sampling framework and data collection instruments, guidelines and checklists, details of survey and data collection method, data management and analysis and survey finding as well as the stages of PRA, risk assessment strategies of the pests likely to be associated with the commodity to be imported from the exporting countries and the risk management options as recommendations. The report had been reviewed and discussed thoroughly by the TCDP officials along with other experts and representatives through several discussion meetings. This report was presented in the national level workshop for further comments and suggestions. The consultants have finalized the Report of the PRA study of Latikochu incorporating the comments and suggestions of the client and feedbacks received from the workshop.

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Acknowledgement

It is my pleasure that Tuber Crops Development Project (TCDP), Department of Agricultural Extension (DAE), has entrusted Centre for Resource Development Studies (CRDS) Ltd. to carry out this work **"Conducting Pest Risk Analysis (PRA) of Latikochu in Bangladesh".** The Report has been prepared based on the past four months (January 2017 to April 2017) activities of the survey study in 29 major Latikochu growing districts of Bangladesh as well as on the review of secondary documents. In the process of 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 TCDP-DAE. The Team Leader has prepared the report with inputs from Dr. Md. Abdul Latif, Prof. Dr. Md. Abdul Latif, Prof. Dr. Tuhin Suvra Roy, Prof. Dr. Md. Belal Hossain and Prof. Dr. Shaker Ahmed of the PRA study team. Mrs. Shamsunnahar and Zahin M. Rafid of CRDS provided all facilities and supports for conducting PRA of Latikochu in Bangladesh.

I am grateful to all persons involved in the PRA study. Our special gratitude to Mr. Md. Benojir Alom, Director General, DAE, Bangladesh, who provided his cooperation and gave us an opportunity to meet his Districts-Level officers in connection with the study. Special thanks to Mr. Mukhlasure Rahaman, Project Director, Tuber Crops Development Project (TCDP); Dr. Md. Azhar Ali, Consultant (PRA); Mrs. Ferdousi Easmin, Deputy Project Director, TCDP for their valuable cooperation and suggestions to the study team in line with the activities performed during study and report preparation.

Cordial thanks to Director (PQW), Director (Crops), Deputy Director (Export), Deputy Director (Import), Deputy Director (CPH), Managing Director (Hortex Foundation) and Director (EPB) for providing necessary information of latikocu in Bangladesh.

Active support of the Chairman, Managing Director, Mrs. Shamsunnahar and Zahin M. Rafid of CRDS to co-ordinate the survey team during data collection and monitoring activities is acknowledged with thanks.

(Dr. Hamiz Uddin Ahmed)
Team Leader

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Abbreviations

ADD	**Additional Deputy Director**
BARI	**Bangladesh Agricultural Research Institute**
CABI	**Centre for Agriculture and Biosciences International**
CRDS	**Center for Resource Development Studies Limited**
DAE	**Department of Agricultural Extension**
DD	**Deputy Director**
DPP	**Development Project Proposal**
EPPO	**European and Mediterranean Plant Protection Organization**
IPPC	**International Plant Protection Convention**
ISPM	**International Standard for Phytosanitary Measures**
NGO	**Non-Government Organization**
PC	**Phytosanitary Certificate**
PQW	**Plant Quarantine Wing**
PRA	**Pest Risk Analysis**
PSO	**Principal Scientific Officer**
RARS	**Regional Agricultural Research Station**
SAAO	**Sub-Assistant Agriculture Officer**
SAPPO	**Sub-Assistant Plant Protection Officer**
TCDP	**Tuber Crops Development Project**
TOR	**Terms of Reference**
UAO	**Upazila Agriculture Officer**

Executive Summary

The study on Pest Risk Analysis (PRA) of Latikochu (*Colocasia esculenta*) was undertaken following IPPC Rules and Regulations. Bangladesh exports latikochu in United Kingdom, Italy and other European countries, and Saudi Arabia and some other middle East countries but does not import from any other countries. PRA is the pre-requisite for safe movement of plant and plant products internationally. As a member of IPPC, Bangladesh has to perform PRA for different commodities to arrive at the decision under which category a particular pest will fall and to take appropriate phytosanitary measures to prevent or restrict the movement of the pest. For safe international trade of plant and plant materials and for food security such PRA is needed for all sorts of commodities included in export/import trade. In order to perform this task the Government of Bangladesh awarded a project entitled "Tuber Crops Development Project (TCDP)" to the Department of Agricultural Extension (DAE) under the Ministry of Agriculture. The Project Director of TCDP is executing this task with the assistance of NGO/Private Organizations who has qualified personnel following open bidding process. Center for Resource Development Studies Limited (CRDS), qualifying all requirements has been awarded to conduct the PRA of latikochu in Bangladesh.

In Bangladesh, the acreage of pani and latikochu crop, in 2020-21 cropping year was about 10823 hectares, while the production was about 224988 metric tons. The crop is grown throughout the country starting from kharif 1season. Latikochu is now one of the most important exporting vegetable items which exported to United Kingdom, Italy and other European countries, Saudi Arabia and different countries of the Middle East. A total of 74.013 metric tons of latikochu stolon was exported to United Kingdom, Italy and other European countries in 2021-22. Latikochu is not imported in Bangladesh from any other countries of the world. However, it may introduce in Bangladesh form neighboring countries (India and Myanmar) through personal luggage of human movement.

The major objectives of the project included recording of major and minor insect pests, diseases and weeds oflatikochu crops in Bangladesh and selected twolatikochu exporting countries and listing of quarantine insect pests, diseases and weeds of latikochu. The study also included detail information on pests and pathogens, their entry, establishment and multiplication, climatic and other characters of both exporting and importing countries, etc. The baseline information on insect pests, diseases and weeds, available in Bangladesh were collected from different secondary sources like published papers, books, journals, internet as well as interview with different stakeholders such as farmers, personnel from DAE, experts and professionals. Primary data were collected through field survey. For these 30 upazilas under 29 districts were selected and visited during March-April, 2022. In each upazila, 20 farmers (two blocks and 10 farmers from each block) were selected for data collection. Although the selected 29 districts were used for primary data collection, the entire Bangladesh was considered as the PRA area for latikochu crop, which might be endangered by the introduction of invasive alien pests. The PRA was conducted to identify the hazards for the PRA area.

The pathway and commodity has been described elaborately along with the climatic conditions and cultivation practices followed both in the selected exporting countries such as India and Myanmar as well as Bangladesh. At the same time the geography and climate of the two selected

exporting countries and Bangladesh were also described. The information was used to analyze the performance of the hazard organism(s) in Bangladesh condition if introduced.For identification of potential hazards under insect pests, diseases and weeds, list of insect pests, diseases and weeds in latikochu crops in Bangladesh and four selected countries were made through extensive searches of both national and international sources and internet resources.

Lists of insect pest, diseases and weeds prevailing in Bangladesh have been prepared through field survey, consulting reports and internet searching. In Bangladesh, 10insect and one mite pests of latikochu were recorded. Number of diseases and weeds of latikochu recorded in Bangladesh was 12 and 41 respectively. Separate lists for insect and mite pests, diseases and weeds of India and Myanmar from where latikochumay be introduced in Bangladesh have been made through searching of different sources like books, journal, reports, internet etc. Pest lists of Bangladesh were critically compared with those of exporting countries and the organisms absent in Bangladesh were identified as quarantine pests for Bangladesh. From the analysis four insect pests, three diseases and three weeds were identified as quarantine pests for Bangladesh.

The identified quarantine insect pests, diseases and weeds were taken in consideration for risk analysis process. Risk assessment considering entry, exposure and establishment potential, and consequences on economy, environment or health was done for quarantine pests. Among the identified quarantine pests, four species of insect pests namely banana aphid (*Pentalonia nigronervosa*), taro plant hopper (*Tarophagus colocasiae),* thrips (*Caliothrips indicus*) and white scale insect (*Aspidiella hartii*), three diseases namely spongy black rot (*Botryodiplodia theobromae*), black rot (*Ceratocystis fimbriata*), and alomae and nobone virus (*Two bacilliform viruses*),and three weed species namely wild barley (*Hordeum murinum*), wild oat (*Avena fatua*) and common amaranth (*Amaranthus retroflexus*) were recognized as potential hazards for Bangladesh and prompted discussion and management options for these species. The report included the pest risk management of these 10 quarantine pests of latikochu with specific approaches and methods in detail. Thus it is suggested to follow the recommended quarantine practices while importing latikochu from the aforesaid exporting countries.

1.0 INTRODUCTION

Latikochu, *Colocasia esculenta* is a fast-growing herbaceous plant that originates from a large corm and can grow to 4 ft. (1.5 m) in height. It has been intentionally introduced in many tropical and subtropical regions to be used as a food crop and animal fodder and has subsequently escaped from cultivated areas into natural areas where it becomes invasive. In Bangladesh, the pani and latikochuwere cultivated 10823 hectares land from where 224988 metric tons production was obtained in 2020-21. The crop is grown throughout the country and cultivation season is kharif 1. Many insect pests and diseases cause serious crop damage to latikochu crop during production. So far 11 insect and mite pests, 12 diseases and 41 weeds of latikochuwere recorded in Bangladesh.

Many destructive insects, diseases and weeds are prevailing in the world where Bangladesh is exclusively free from most of these pests. These pests are carried through international trade of agricultural products. We are afraid of maintaining such situations because Bangladesh has to import a huge quantity of plants and plant products every year. Bangladesh is at the highest risk of entering those destructive pests because these pests are usually brought in along with imported Agricultural commodities. On the contrary, Bangladesh has successfully entered into the highly competitive international export market. We are earning a good amount of valuable foreign currency through exporting 10-12 lakhs metric tons of agricultural products. So, to safeguard our agriculture from entering IAS by imported commodities and maintain and develop our market access by fulfilling the importing country's requirement conducting PRA is most essential. Assessment of the potential risk of introduction of any exotic pests and diseases with this commodity to Bangladesh and the probability of their Establishment in Bangladesh condition has not yet been performed.

Bangladesh exports latikochu and other aroids to different countries of the world but not imports. However, latikochu may be carried in Bangladesh with personal luggage from our neighboring countries like India and Myanmar. There is a scope of introducing alien pests of latikochu into Bangladesh which may potentially damage our latikochu and other aroid crops. Moreover, importing countries want to know about the Pest Risk Analysis (PRA) of the product in exporting countries. Pest Risk Analysis (PRA) will contribute to review of existing phytosanitary requirements for introduction of latikochu. Assessment of the potential risk of introduction of any exotic pests and diseases with this commodity to Bangladesh and the probability of their Establishment in Bangladesh condition has not yet been performed. Tuber Crops Development Project (TCDP), Department of Agricultural Extension (DAE) felt that an analysis of the biosecurity risks of latikochu pests is required. Considering this situation, the project will conduct PRA on Ariod (latikochu).The framework of pest risk analysis associated with importation of latikochu includes three stages such as initiation, pest risk assessment and pest risk management. The standard focuses on the initiation stage, gathering information, documentation, risk communication, uncertainty, consistency and management of hazards.

2.0 SCOPE AND METHODOLOGY OF PEST RISK ANALYSIS

2.1 Background

PRA is the process of evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it. The unwanted pests may be introduced into the country through potential carriers such as people, commodities, and conveyances. For excluding foreign pests, recognition of these risks' measures should be reflected in quarantine legislation to control the movement of consignments as a way of protecting plant life and health. All these quarantine policies and risk management measures should be based on risk analysis to minimize the trade barrier. As a contracting party to the International Plant Protection Convention (IPPC), Bangladesh is committed to following the principles and guidelines of the IPPC. One of the main tasks of the contracting party is to conduct pest risk analysis for safeguarding the country's agriculture from entering into the Invasive Alien Species (AS) which is usually destructive pests. The PRA includes a list of pests of specific crops that are usually required for exporting agricultural commodities because based on the presence of pests, climate and other criteria importing countries consider importing agricultural commodities from other countries.

Now more than 300 Destructive Insects and Pests are prevailing in the world where Bangladesh is exclusively free from most of these pests. But we are afraid of maintaining such situations because Bangladesh has to import a huge quantity (about 1 crore MT.) of plants and plant products every year. So, we are at the highest risk of entering those destructive pests because these pests are usually brought in along with imported Agricultural commodities. On the contrary, Bangladesh has successfully entered into the highly competitive international export market. We are earning a good amount of valuable foreign currency through exporting 10-12 lakhs metric tons of agricultural products. So, to safeguard our agriculture from entering IAS by imported commodities and maintain and develop our market access by fulfilling the importing country's requirement conducting PRA is most essential. Considering this situation, the project will conduct PRA on Ariod (latikochu).

Bangladesh exports latikochu and other aroids to different countries of the world but not imports that for many countries. However, latikochu may be carried in Bangladesh with personal luggage from our neighboring countries like India and Myanmar. So, there is a scope of introducing alien pests into Bangladesh which may potentially damage our latikochu and other aroid crops. Moreover, importing countries want to know about the Pest Risk Analysis (PRA) of the product in exporting countries. So, the analysis will contribute to review of existing phytosanitary requirements for introduction of latikochu. However, assessment of the potential risk of introduction of any exotic pests and diseases with this commodity to Bangladesh and the probability of their Establishment in Bangladesh condition has not yet been performed. Recently, Tuber Crop Development Project (TCDP), Department of Agricultural Extension (DAE) felt that an analysis of the biosecurity risks of latikochu pests is required. Hence the present activities were taken up. Here pests are referred to insect pests, diseases and weed of latikochu and whole Bangladesh was considered as PRA areas. However, 30 upazila of 29 districts were selected for the PRA study where latikochu are extensively cultivated (Table 1).

2.2 Scope of the Risk Analysis

The scope of this risk analysis is to determine the presence of insect and mite pests, diseases, weeds and other organisms of Latikochu in Bangladesh and to ascertain the potential hazard organisms associated with Latikochu imported from India and Myanmar. Risk is defined as the likelihood of the entry of the hazards with the pathway or commodity, probability of establishment and the magnitude of the consequences of the hazards on economic, environment or health point of views. The framework of pest risk analysis associated with importation of Latikochu includes three stages such as initiation, pest risk assessment and pest risk management. The standard focuses on the initiation stage, gathering information, documentation, risk communication, uncertainty, consistency and management of hazards.

2.3 Objectives of the PRA of Latikochu

The objective of this consulting service is to provide technical assistance to do Pest Risk Analysis of Ariod (Latikochu) in the Tuber Crops Development Project as identified hereto in the scope of work detailed in the subsequent sections. Specifically, the consulting service must achieve the following objectives:

i. To conduct Pest Risk Analysis on Ariod (latikochu) and categorize risk as high, medium, low and minimum;
ii. To determination an organism as a pest;
iii. To create lists of regulated pests of the above-mentioned commodities for import regulation;
iv. To recommend appropriate pest risk management and assessment options.

Specific Objectives of the recruitment of a Pest Risk Analysis Consulting Firm are (according to ISPM 11 in the framework of ISPM-2):

1. Listing of major and minor pests mentioning plant parts affected (Prepare a pest list);
2. Listing of regulated pests (Quarantine and Non-Quarantine Pests);
3. Identification and categorization of pests likely to be associated with a pathway;
4. Determination of pests up to species level;
5. Identification of potentials for entry, establishment, and spread of regulated pests;
6. Identification of probability of survival during transport or storage & transfer of hosts;
7. Nature of damage;
8. Identification of probability of pest surviving existing pest management procedures;
9. Identification of availability of suitable hosts, alternate hosts, and vectors in the PRA areas;
10. Identification of potential economic and environmental impacts;
11. Assessment of potential loss by the pests;
12. Analysis of uncertainties;
13. Identification of management options for control of regulated pests;
14. Preparation of report on risk analysis of the pests following the relevant ISPMs;
15. Identification of host plants and more damaging host plant species if present;
16. Identification of Risk management options.
17. To detect pests, it is recommended to follow relevant ISPMs where procedures are being described;
18. Perform pest risk analysis and other responsibilities assigned by PD of TCDP.

2.4 Process of PRA

Pest risk analysis (PRA) is a science-based process that provides the rationale for determining appropriate phytosanitary measures for a specified PRA area. It is a process that evaluates technical, scientific, and economic evidence to determine whether an organism is a potential pest of plants and, if so, how it should be managed. Under the IPPC, the term plant pest refers to all organisms harmful to plants or plant products including other plants, bacteria, fungi, insects and other animals, mites, mollusks, nematodes, and viruses. Pests can be either regulated or not, and the IPPC recognizes and defines two categories of regulated pests of plants: quarantine pests and regulated, non-quarantine pests. PRA assists with determining whether a pest fits either of these two categories and the strength of phytosanitary measures, if and, that should be taken in response to it.

Pest risk analysis is a process consisting of three stages (1) initiation of the PRA through identification of a pest or pathway, or review or revision of an existing phytosanitary policy, (2) Pest risk assessment, and (3) pest risk management. Risk communication is an integral component that occurs throughout each step. The schematic diagram of Pest Risk Analysis (PRA) of Latikachu is shown in Figure 1.

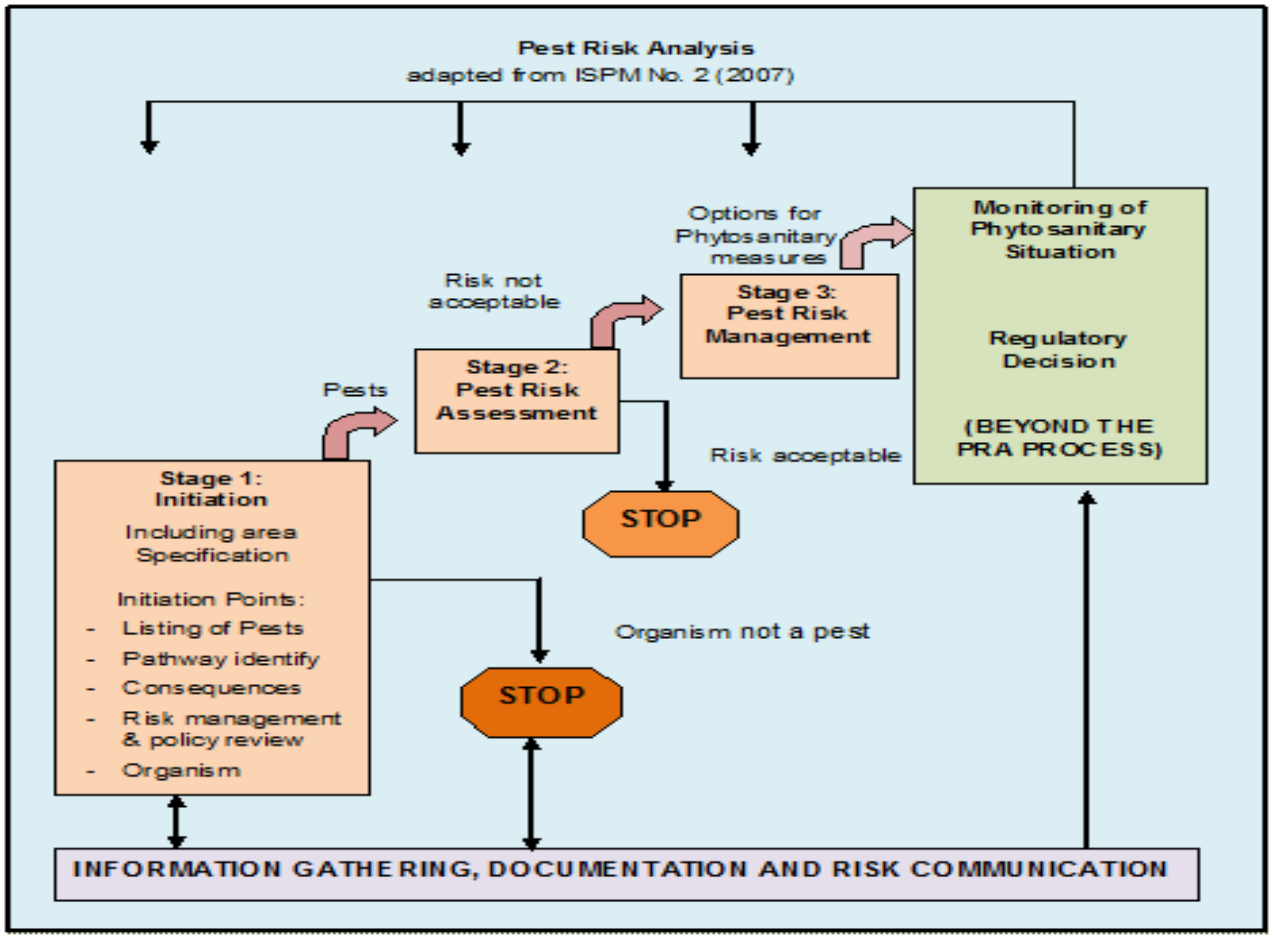

Figure 1.Schematic Diagram of Pest Risk Analysis.

2.5 Methodology

This section includes a discussion on the collection of data from the study area, study population and its selection procedures, instruments to be used, implementation strategy, quality control procedure and data management, etc. Considering the objectives of the study, time, and types of respondents under the study, both qualitative and quantitative research methods were applied in the study conforming to the objectives as stated in the TOR.

2.5.1 Collection of Documents and Review

To be familiar with the study, the review of relevant literature and the collection of secondary data is necessary. The review of literature will include the relevant project documents i.e. Project Proforma (PP), project reports, information on records of insect pests, diseases and weeds of Latikochu available at DAE / other concerned agencies, through Internet searching and from other sources. Secondary data, either qualitative or quantitative, have been collected from the available related reports and literatures in TCDP, Plant Protection Wing (PPW) and Plant Quarantine Wing (PQW) of DAE, Teachers of different universities, related scientists of Tuber Crops Research Center of BARI and Journals, Hortex Foundation, Export Processing Bureau, Research Reports, CABI reports, IPPC similar reports, Internet searching, and other sources.

2.5.2 Discussion with Experts in the Discipline

The Project Director (PD) holds a key position and will select an intensively grown area of the crop. The PD along with the PRA Consultant of TCDP being highly knowledgeable will be the source of information and guidance from time to time. The study team will meet him at the early stage of the commencement of study to apprise him of the approach to the work and guidelines from him. The assignment is highly technical and specific to the subject and substantial information may be given to the experts in the discipline. The team will meet with experts of the Plant Protection Wing of DAE and BARI and others places.

2.5.3 Selection of Potential PRA Area

The districts with upazilas have been listed in the ToR. But Latikochu is not cultivated in all places with the same intensity. The potential area, block, and the number of farmers in each block will be identified in consultation with the PD of TCDP, DAE and scrutinizing secondary information. The list of the districts and Upazilas are given in Table 1 and for this assignment (PRA of Latikochu). The selected districts are also shown in Figure 2.

The expert workers of the consulting firms have been collected survey data from areas where Aroid crops [Ariod (latikochu)] grow and areas specified by PD, TCDP. The raw data is required to share nearer Agricultural related offices or Institutes. Data were collected from 30 Upazilas; 28 Upazilas from 28 districts and two Upazilas from Rangpur District. Two-Block were selected from each Upazila and 10 farmers were interviewed from each Block using the structured questionnaire. Data were also collected from one Latikochu field from each upazila and as such 30 production fields from 29 districts.

Table 1. Selected districts and upazilas for PRA of Latikochu in Bangladesh

Sl. No.	District	Upazila	Sl. No.	District	Upazila
01.	Dhaka	Savar	16.	Nogaon	Raninagar
02.	Gazipur	Shripur	17.	Bogra	Shajahanpur
03.	Narsingdi	Shibpur	18.	Rangpur	Mitahapukur
04.	Manikgonj	Singair			Gangachara
05.	Rajbari	Sadar	19.	Panchagohr	Boda
06.	Cumilla	Barura	20.	Khulna	Dumuria
07.	Tangail	Modhupur	21.	Sunamgonj	Bishawmvapur
08.	Sherpur	Nalitabari	22.	Sylhet	Golapgonj
09.	Jamalpur	Madargonj	23.	Habigonj	Nabigonj
10.	Kishorgonj	Kuliarchar	24.	B.Baria	Nabinagor
11.	Mymenshingh	Trishal	25.	Noakhali	Companigonj
12.	Jhenaidah	Sadar	26.	Chattogram	Boalkhali
13.	Joypurhat	Panchbibi	27.	Patuakhali	Kolapara
14.	Madaripur	Kalkini	28.	Barishal	Ujirpur
15.	Chuadanga	Sadar	29.	Shariotpur	Jajira

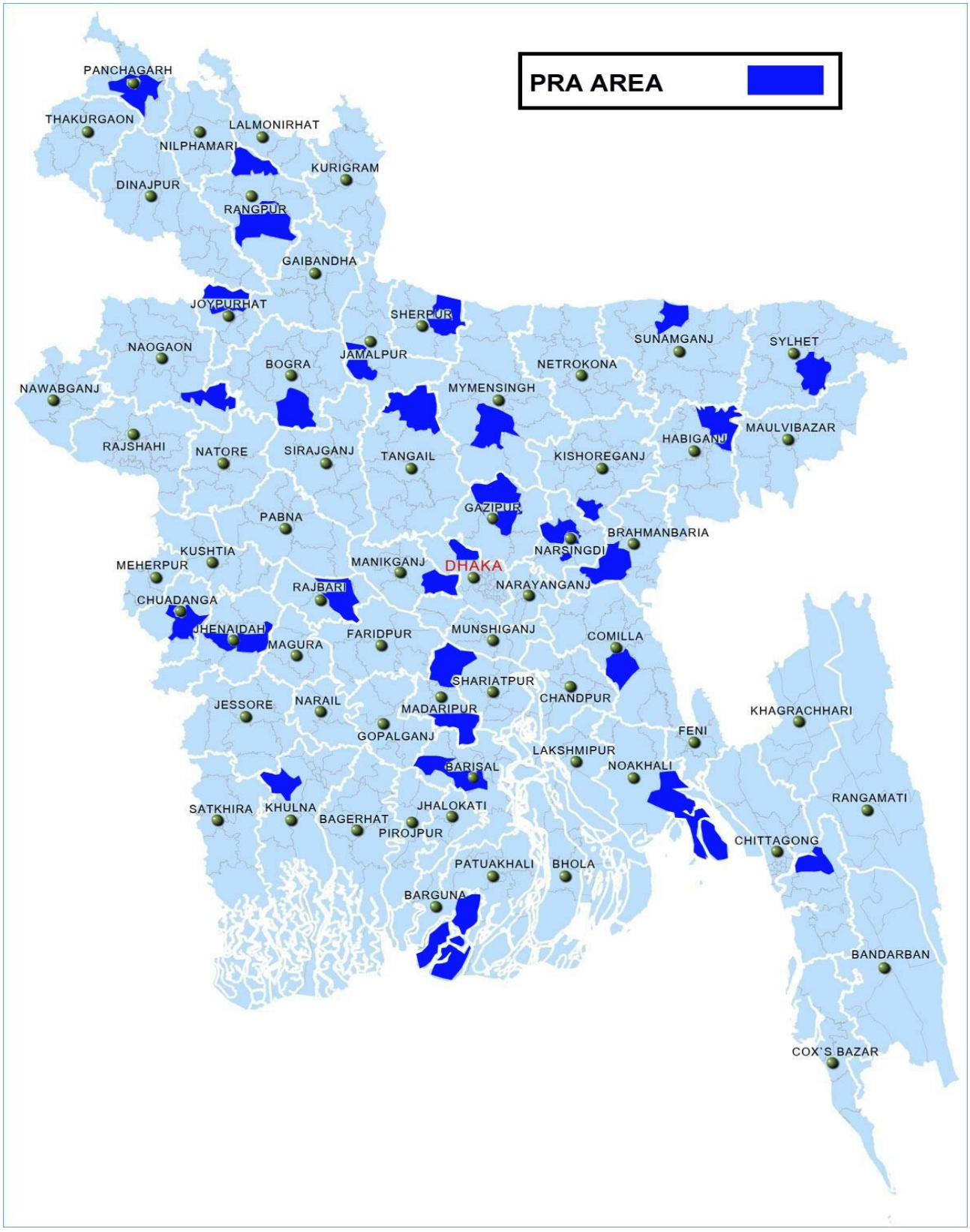

Figure 2. Study Area of Pest Risk Analysis of Latikochu Showing in Bangladesh Map.

2.5.4 Development of field survey plan

The survey includes both qualitative and quantitative surveys. The stages of data collection are depicted in Figure 3. The field plan was made according to the location of the sample farms in sample blocks in the project Upazila.

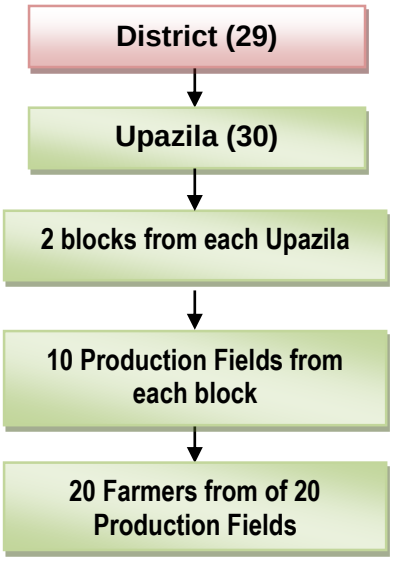

Figure 3. Survey plan for PRA of latikochu in Bangladesh.

2.5.5 Determination of sample size

It has been specified in the Minutes of the meeting held on 31 October 2021 that 02 Blocks from each Upazila were selected and 10 farmers were selected from each Block. Thus 20 farmers were interviewed from each Upazila.

2.5.6 Recruitment and training of enumerators

For field-level data collection, 04 supervisors and 06 field researchers was recruited from amongst the panel of qualified and experienced field workers maintained at CRDS office in Dhaka. The minimum qualification for field researchers is a bachelor's degree in agriculture having 2/3 years of relevant field experience, while four supervisors supervised the field data collectors. Before their recruitment, the advertisement was hung on CRDS, agricultural universities, and the client's notice board. A Board consisting of Team Leader and Consultants selected the enumerators. After recruitment, two days training were organized for enumerators; one day classroom training in the training room of CRDS and one day field training at Savar, Dhaka.

Classroom training firstly included lectures on the objectives of the survey, the logic of the checklist prepared and determining sample UPs and respondents. The methods of communication and properly eliciting information thoroughly discussed. In the second stage, the trainees were trained how to record data and code them. In the third stage, the interviewers were conducted a

demonstration interview and the inconsistencies reviewed and corrective lessons imparted. In the fourth stage, the interviewers were played the role of respondents, and the difficulties if encountered in eliciting responses were overcome. Some photographs of training of enumerators are shown in Plate 1.

2.5.7 Primary/field data collection

The enumerators were sent to the desired destination according to the prepared programme. The field data collection included both quantitative and qualitative data. Focus group discussion (FGD) and key informant interviews (KII) and in-depth interviews with open deliberation as well as structured issues. The distribution of data collection is shown in Table 2.

Table 2. Distribution of Samples for PRA of Latikochu in Bangladesh

Tools to be used	Sample Size				Total Sample Size
	Per Upazila	Per District	Number of Upazila	Number of Districts	
Farmers Interview	20	20.	30	29	600
Focus Group Discussion (FGD)	1	1	30	29	29
Key Informant Interviews (KII)	1	1	30	29	29

For pest risk analysis of Latikochu, data on pests, diseases and weeds were collected from the various sources. Various sources of data are shown in Figure 4.

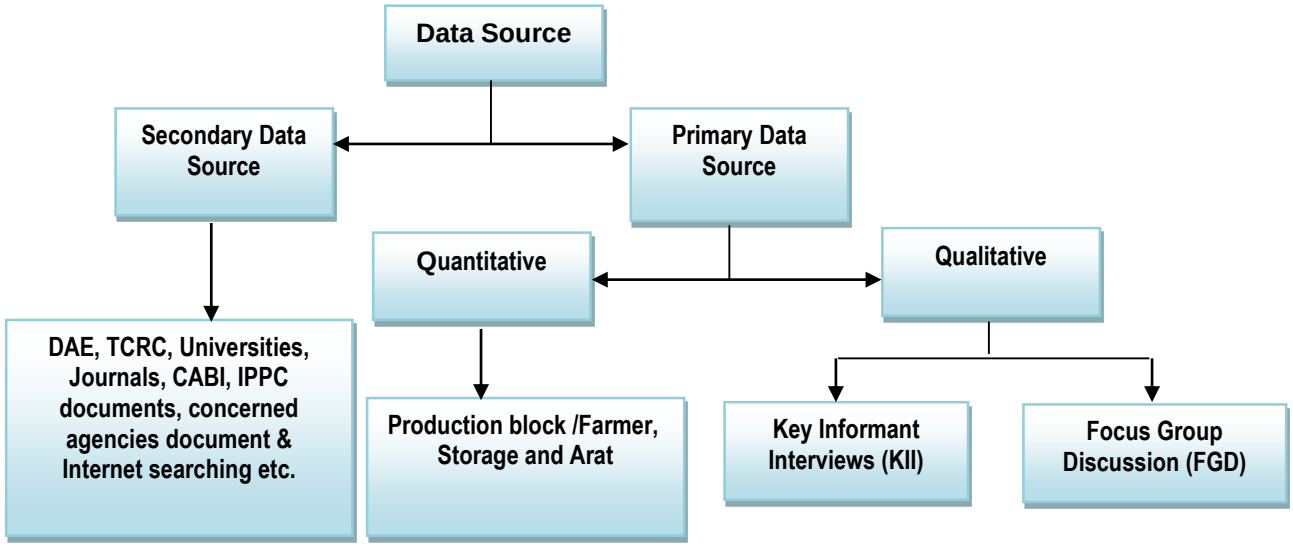

Figure 4. Sources of data for pest risk analysis of Latikochu.

Plate 1. Photographs of training of enumerators for PRA of latikochu.

2.5.8 Quantitative data collection

2.5.8.1 Farmhouse level survey

The sample survey was based on a pre-defined questionnaire. As already discussed above, 600 farmers from the production field were interviewed with structured questionnaires. The questionnaires captured quantitative data related to the study requirement, project goal, objectives, and indicators stated in the project description. Through sample survey, the data included the pest, the listing of pests & diseases, identification of location-specific pests and diseases, hazards identification, attacking stage in terms of seasonal variation and age of the plant, etc.

The data were collected by one-to-one interviews. The field researchers were collected the necessary information from the respective production field under selected block at Upazila level (Plate 2). This production field and blocks were selected with the help of the Upazila Agricultural Officer or Sub Assistant Agricultural Officer. The field researchers were collected data according to the set survey schedule which was supplied previously to the Project Director prior to the survey. The collected data were handed over daily to the supervisor, who in turn will check consistency and arrange a proper listing. The expert team members were also checked the filled-in questionnaires as well as supervised the activities of the supervisors and field researchers. Some photo graphs of field survey are shown in Plate 3.


Plate 2. Interview of growers of latikochu for PRA.



Plate 3. Data collection from latikochu field for PRA.

2.5.8.2 Qualitative data collection

2.5.8.2.1 Focus Group Discussions (FGDs)

A total of 29 FGDs were conducted under this study. A checklist was developed for conducting FGD to collect information on occurrence, frequency of occurrence, severity, pathway, time of the attack and plant age, establishment & spread, the magnitude of potential economic & environmental impact, risk management options, etc. Here stakeholders like prominent farm houses were involved in the production, the Agricultural staff at upazila level, etc. Each session was continued for 1-2 hours with 8-16 participants. Some photographs of FGD are shown in Plate 4.

2.5.8.2.2 Key Informant Interviews (KII)

We conducted 59 KII, of which 29 from selected 29 districts with Deputy Director or representative and another 30 from 30 upazila with UAO or representative. All 59 Key Informant Interviews (KIIs) were conducted under this assignment at the field level. In addition, information have been collected from TCDP officials, Deputy Director (PPW, PQW) of DAE, Deputy Directors of land and seaport, Deputy Director of Plant Quarantine Center, Central Packing House, Managing Director of Hortex Foundation, respective scientists of BARI, respective professors of university and a few numbers with sector experts. The Key Informant Interviews (KII) focused on insect pests, diseases, weeds of Latikochu, their nature of damage, steps for risk assessment & measures to be taken for risk management, behavior, and control of identified pests, diseases, and weeds of Latikochu in Bangladesh. Some photographs of KII are shown in Plate 5.






Plate 4. FGD for PRA of latikochu.

Plate 5. Key Informant Interview (KII) for PRA of latikochu.

2.5.9 Secondary data collection

Secondary data, either qualitative or quantitative, were collected from the available related reports and literatures in TCDP and Plant Protection Wing of DAE, Scientists from Tuber Crops Research Center (TCRC) of BARI, Teachers of different Universities, Journals, Books, and other published reports, CABI report, IPPC similar reports, Internet searching, and other sources. Secondary data helped determine similarities and differences due to communication, technical, institutional, financial, socio-cultural, and environmental differences and to study the project framework and focus on specific issues as well as the methodology and implementation analysis.

2.5.10 Interpretation of results

The collected information on insect and mite pests, diseases and weeds of Latikochu from different locations were analyzed and interpreted with the aim to find out variations in order to know the incidence and status of each pest against the location. The most vulnerable stage of plant growth for insect pests and disease attack was also determined based on both primary and secondary data. Finally, a check list was prepared based on locally available insect and mite pests, diseases and weeds of Latikochu in Bangladesh in comparison with four exporting countries.

2.6 Methodology of risk analysis

The process and methodology for undertaking import risk analyses need to collect the information on insect pests, diseases and weeds of the particular commodity in the importing country, the primary data collection and secondary data collection from relevant persons, published reports, journal article or books as well as from internet resources. Prepare a separate pest list of importing country as well as each of exporting countries hereinafter will be called as country of origin. Compare the lists critically to identify the potential destructive exotic pests.The diagram below illustrates the risk analysis process [Figure 5].

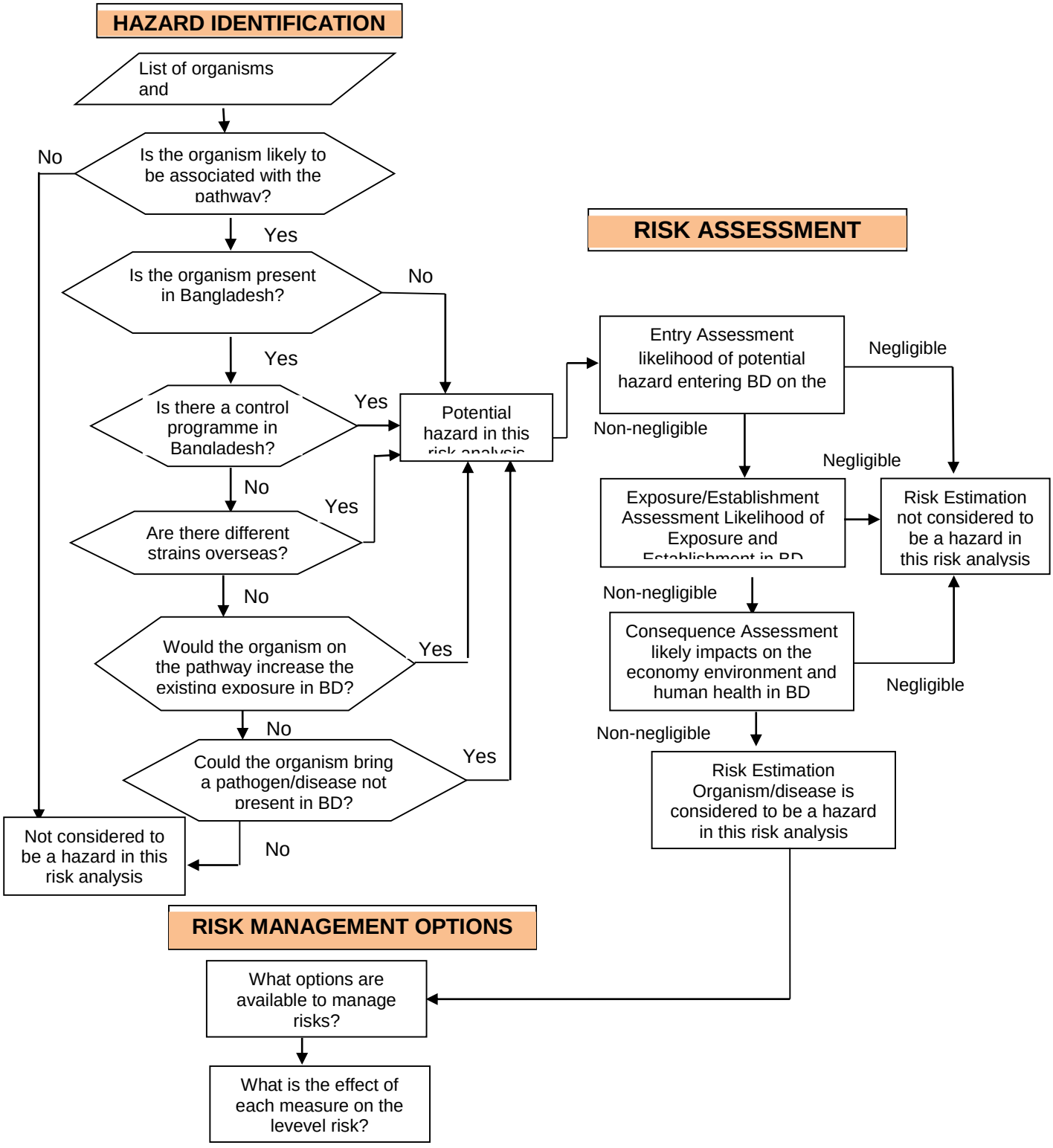

Figure 5. Diagram of the risk analysis process. The three main aspects of analysis include: hazard identification, risk assessment, and risk management.

2.6.1 Commodity and pathway description

The first step in the risk analysis process is to describe the commodity and entry pathway of the commodity. This includes relevant information on:

1. The country of origin, including geographic and climatic condition, relevant crop growing practices, pest management systems;
2. Pre-export processing and transport systems;
3. Export and transit conditions, including packaging, mode and method of shipping;
4. Nature and method of transport and storage on arrival in Bangladesh;
5. Characteristics of Bangladesh climate, and relevant agricultural practices.

This information provides context for the assessment of the potential hazard organisms.

2.6.2 Hazard identification

For any risk assessment the first step is to identify the hazard as the risk is related to hazard. Hazards are the unwanted insect and mite pests, diseases (pathogen)or weeds which could be introduced into Bangladesh by risk goods, in this case selected Latikochu is potentially capable of causing harm to Latikochu production in Bangladesh, must be identified. This process begins with the collation of a list of organisms that might be associated with the commodity in the country of origin. Such list is compared with the existing pests present in Bangladesh to prepare a list of exotic pests harmful for Bangladesh if introduced.

This list is to be 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. Diagrammatic representation of hazard identification is shown in Figure 6.

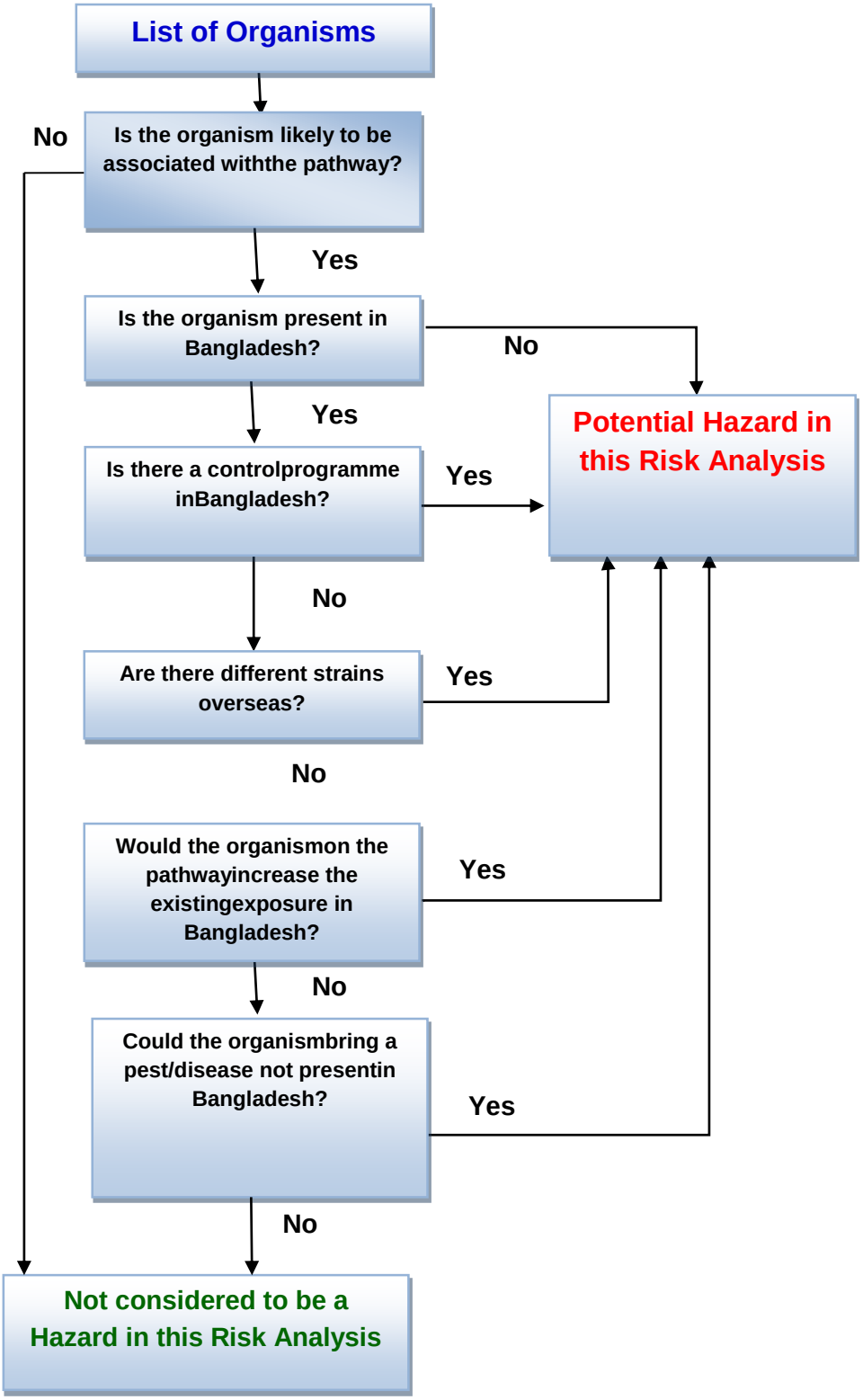

Figure 6. Diagrammatic representation of hazard identification.

2.6.3 Risk assessment of potential hazards

Risk assessment is the evaluation of the likelihood of entry, exposure and establishment of 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 consequences
- Risk estimation.

In this risk analysis hazards have been grouped to avoid unnecessary duplication of effort in the assessment stage of the project. Where there is more than one species in a genus for example, the most common or potentially damaging species is researched and analyzed in detail and used as an example to cover major biological traits within the group. Any specific differences between congeners are highlighted in individual analyses.

2.6.4 Methodology of risk assessment

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. Descriptors are used in assessing the likelihood of entry, exposure and establishment, and the economic, environmental, social and human health consequences. 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. Diagrammatic representation of risk assessment and risk management is shown in Figure 7.

2.6.5 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.

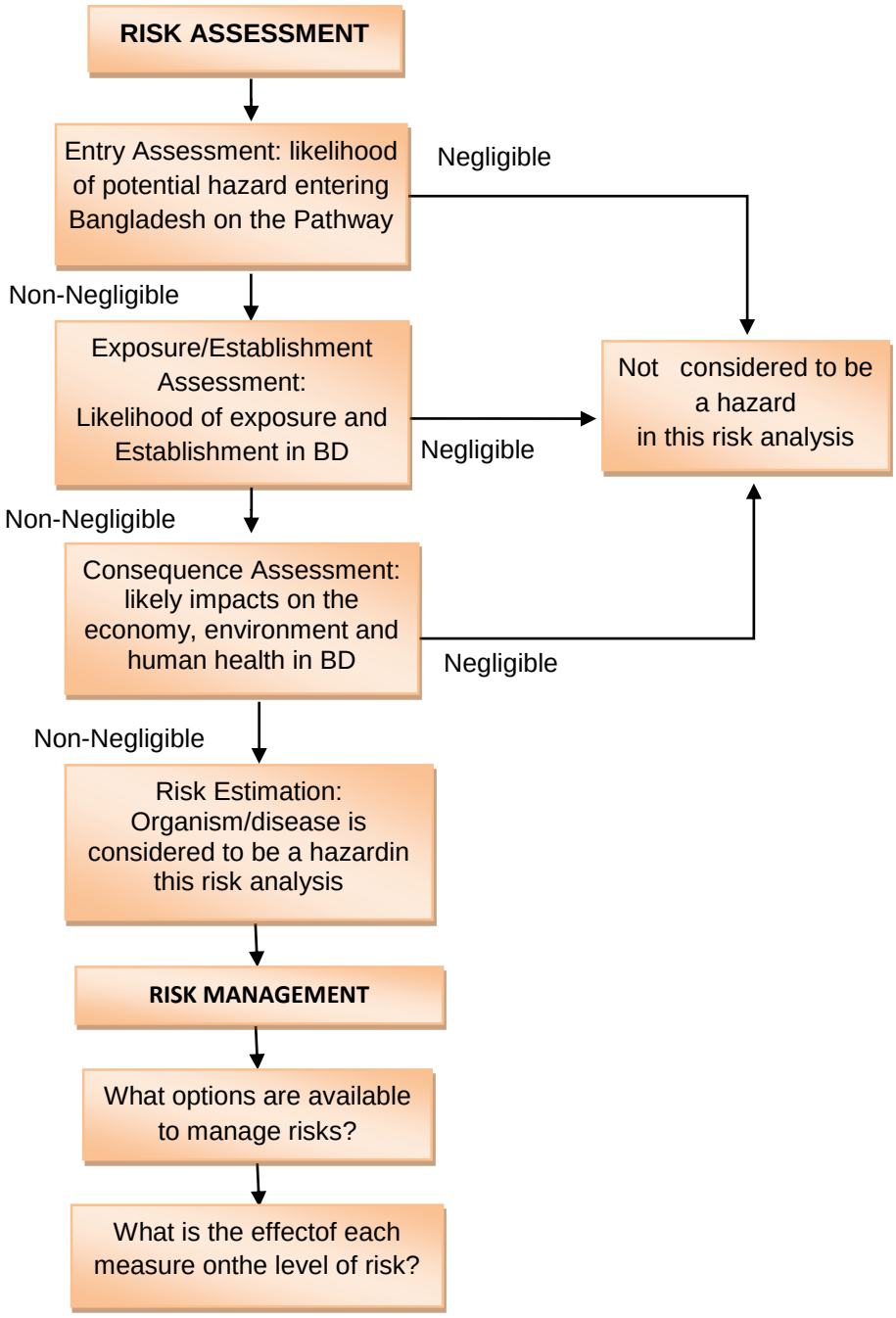

Figure 7. Diagrammatic representation of the process followed for risk assessment and management.

2.6.6 Analysis of measures to mitigate biosecurity risks

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 framework in section 5.

2.6.7 Risk evaluation

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

2.6.8 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 four established pathways (China, India, Myanmar and Vietnam) for Latikochu coming 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.

2.6.9 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 from Bangladesh. 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.

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 insect pests, diseases or weeds potentially associated with the commodity, Latikochu in the present context. It also provides information of the commodity including history, morphological characteristics, climate requirement, cultivation and harvest and post harvest operations especially in the country of origin. Separate lists of insect pests, diseases and weeds are prepared for the selected exporting countries as well as for Bangladesh. After critical evaluation of the lists the quarantine pests for Bangladesh and their distribution among the exporting countries were identified. Information on latikochu production and climate in Bangladesh is also enumerated. Information on climate, geography and pest control strategies of the country of origin as well as in Bangladesh is collated and presented for assessing the likelihood of establishment and spread of potential hazard organism(s) when enter and exposed to Bangladesh environment.

3.2 Identification of pathways

The pathways for conducting present PRA including latikochu (*Colocasia esculenta)* imported from India and Myanmar.

3.2.1 Commodity description- Latikochu

Introduction

Latikochu, *Colocasia esculenta* is a fast-growing herbaceous plant that originates from a large corm and can grow to 4 ft. (1.5 m) in height. It has been intentionally introduced in many tropical and subtropical regions to be used as a food crop and animal fodder [14, 15] and has subsequently escaped from cultivated areas into natural areas where it becomes invasive [11]. It is widely cultivated in some of these and other Pacific Islands. It is also viewed as an invasive species or aggressive weed in parts of the Caribbean and Americas.*C. esculenta* has several adaptations and it has the ability to reproduce both sexually by seeds and vegetatively by corms, tubers, and root suckers, and it is adapted to grow in a great variety of substrates and habitats ranging from full sun to deep shaded areas [15].

C. esculenta, commonly known in its crop form as taro, is mainly cultivated for its starchy stem tubers and corms. These corms are eaten boiled, fried or roasted as a side dish or are used to produce starch and flour. Taro corm puree makes an easily digested, low-allergenic baby food. In times of scarcity, this species is used as a famine food and in some regions leaves are used for food after cooking. Waste leaves, corms and peel can be cooked or fermented into silage for animal feed. Most taro in South-East Asia is consumed by humans, but it also has uses in religious festivals and in folk medicines and is fed to livestock, primarily pigs.

Stolon, stem and rhizome are the main edible organs of Latikochu, and though they are primary for stolon, the rhizomes which are not of good quality may be considered for some other uses. The stolon, emerging continuously from the base of the developing sucker corms, is highly acceptable as vegetable due to its non-acridity and taste [13]. Latikochu is famous for the production of good quality stolon. It is highly nutritious and palatable. Stolon contains 1.12 g iron, 38 mg calcium, 500 IU vitamin A, 38 mg vitamin C and 35 kilocalorie food energy under 100 g edible portion [4]. Generally, it is harvested throughout the kharif season, when vegetables are deficit in the market.

So, it can easily meet up the demand of vegetables at that time. It can grow easily with less care and input. Moreover, disease and insect infestations are less in case of Latikochu. Thus, there is a great opportunity to improve its production and quality through nutrient management [13]. Cultivation of latikochu (taro stolon) has gained popularity amongst farmers of Bangladesh as it is more profitable than paddy or other crops. Latikochu is very popular in Bangladesh and delicious dishes are prepared with mustard, shrimp, Hilisha head, pulses and hot washed rice in different ways in different parts of our country.Alongside men, many women are engaged in latikochu farming. The men extract the loti and take them home. Women then clean them and put them into bundles to sell to local traders. In addition, latikochu is now one of the most important vegetables items which is exported in Malaysia, United Kingdom, Italy and other European countries, Saudi Arabia and different countries of the Middle East.

3.2.1.2 History

Latikochu, *Colocasia esculenta*, is native to tropical Asia [8] originating in South-East or southern Central Asia, where it was probably cultivated before rice. It has been actively cultivated throughout tropical and subtropical regions. It was carried by early Polynesians throughout Oceania, where it became a staple food. It is an ancient crop in Asia, being introduced into Japan more than 2500 years ago. Today it is grown throughout the West Indies and in West and North Africa. In Asia, it is widely planted in south and central China and is grown to a lesser extent in India. It is now a staple food in many islands of the Pacific including Papua New Guinea, where it has prestigious as well as economic value, playing an important role in traditional gift-giving and ceremonies. It also has great cultural importance in Hawaii, where growing the crop was not merely an activity of food production but was strongly bound to the people's culture and beliefs about creation [7].

C. esculenta is thought to have been domesticated in northern India, but independent domestication in New Guinea has also been suggested [15]. Domestication is believed to have taken place at a very early date, even before the domestication of rice. Archaeological evidence suggests human use of the plants 28,000 years ago in the Solomon Islands [12]. It was spread by human settlers eastward to New Guinea and the Pacific over 2000 years ago, where it became one of the most important food plants economically and culturally. It was one of the first crops introduced to Hawaii by Polynesians around 900 to 1000 AD, most likely in multiple arrivals [7].Distribution to China and via Arabia to Egypt and East Africa also occurred at least 2000 years ago. From there *C. esculenta* was introduced by Arab people to West Africa. It was introduced into Europe from Egypt [9].

During the seventeenth century, *C. esculenta* was introduced from Africa to the Americas as a food crop for slaves by Spaniard, Portuguese, and British slave traders [9]. For example, as early as 1647, taro was cultivated in Barbados as a slave dietary staple [6]. Later, by 1864, it was reported as "naturalized" in Jamaica and St. Kitts and widely cultivated in most islands in the West Indies [10]. In Puerto Rico, the first report of this species was made by Bello in 1883. In the southeastern United States, it was introduced in 1910 by the Department of Agriculture as a substitute crop for potatoes [9, 11].

3.2.1.3 Identity of Latikochu

Common name: Taro

Scientific name: *Colocasia esculenta* (L.) Schott (1832)

Taxonomic tree

Domain: Eukaryota
Kingdom: Plantae
Phylum: Spermatophyta
Subphylum: Angiospermae
Class: Monocotyledonae
Order: Arales
Family: Araceae
Genus: Colocasia
Species: *Colocasia esculenta*

3.2.1.4 Growth cycleand yield of latikochu

Latikochu (taro) is a perennial, glabrous, herb growing to a height of about 1.0 m with a massive, fleshy corm at the base, and lateral, thick, edible runners. Root system is adventitious, fibrous, and shallow. Latikochuis erect, long and deep green. Its stolon is dominant than stem, leaf green, upper portion of joint of leaf and petiole may be red colour which is an identifying characteristics of latiraj variety. The stolon, emerging continuously from the base of the developing sucker corms, is highly acceptable as vegetable due to its non-acridity and taste [13]. Crop duration is 80-127 days. Stolon is tall 90-100 cm, slight flat, light pink color having comparatively lower calcium oxalate than other taro. Lati is usually boiled homogenously and free from acidity. It is widely cultivated all regions of Bangladesh. Transplanting time is kharif 1 during February to March. Lati harvesting starts two month after transplantation and may becontinued up to seven months. Average stolon yield is 25-30 t ha^{-1} and that of the rhizome is 15-20 t ha^{-1}.

3.2.1.5 Environmental requirements for latikochu

Partly because of their large transpiring surfaces, taro plants have a high requirement for moisture for their production. Normally, rainfall or irrigation of 1,500- 2,000mm is required for optimum yields. Latikochu (*C. esculenta*) is best suited to tropical lowland areas with annual precipitation greater than 2000 mm, and evenly distributed, although there are many upland varieties with water requirement of much less than 2000 mm. Taro thrives best under very wet or flooded conditions. Dry conditions result in reduced corm yields. Corms produced under dry conditions also tend to have a dumb-bell shape; the constrictions reflect periods of reduced growth during drought. It also grows well in wetlands including paddies with a continuous supply of flowing water, furrow-irrigated fields, and raised beds in poorly drained swamps. Taro requires an average daily temperature above 21^0C for normal production. It is well adapted to high temperatures (20-35°C) and shaded conditions and for that reason it is common to find it growing under coconut, cocoa or coffee plantations: when cultivated, it is often grown as an intercrop with such tree crops.

It cannot tolerate frosty conditions. Partly because of its temperature sensitivity, taro is essentially a lowland crop. Yields at high altitudes tend to be poor. The highest yields for taro are obtained under full intensity sunlight. However, they appear to be more shade-tolerant than most other crops. This means that reasonable yields can be obtained even in shade conditions where other crops might fail completely.Taro is able to tolerate heavy soils on which flooding and waterlogging can occur. Indeed, the dasheen type of taro does best when grown in such soils. It seems that under flooded or reducing soil conditions, taro plants are able to transport oxygen (through their spongy petioles) from the aerial parts down to the roots. This enables the roots to respireand grow normally even if the surrounding soil is flooded and deficient in oxygen. In practice, however, flooded taro fields must be aired periodically in order to avoid iron and manganese toxicity under the reducing soil conditions. Taro does best in soil of pH 5.5-6.5. It is able to form beneficial associations with vesicular-arbuscularmycorrhizae, which therefore facilitate nutrient absorption. One particularly useful characteristic of taro is that some cultivars are able to tolerate salinity.

3.3 Latikochu production and export in Bangladesh

In Bangladesh, Latikochu and other taro are grown in all over Bangladesh. The stolon producing Latikochu occupies an area ofabout 6,777 hectares, with a total production of 41521 metric tons of stolon, and an average yield of 6.13 metric tons per hectare in 2018-19 [4]. Area and production of pani and Latikochu in Bangladesh from 2019 to 2022 are shown in Figure 8[1]. It is observed that both area (ha) and production (metric ton) are gradually increasing during this period which indicates that Latikochu cultivation is becoming popular in Bangladesh day by day.

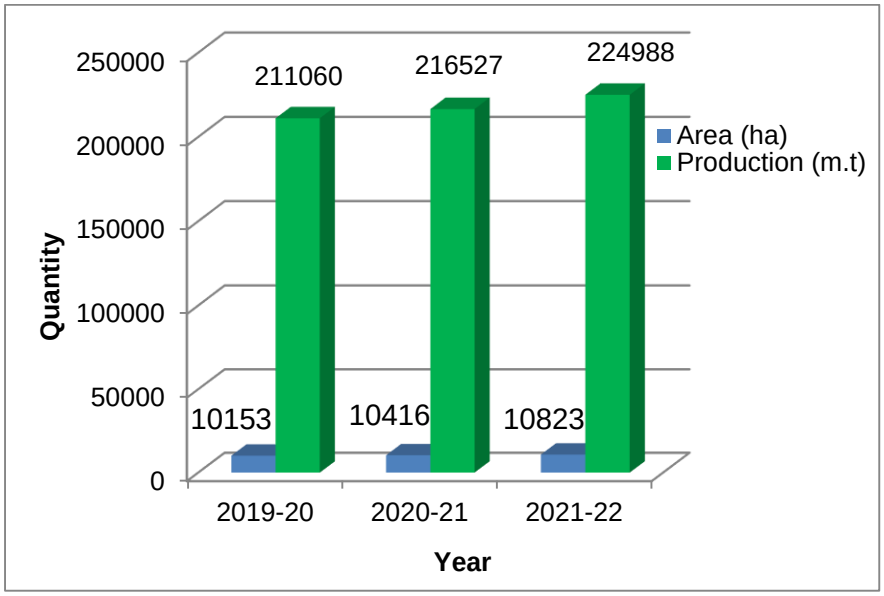

Figure 8. Area and production of pani and latikochu in Bangladesh during three years.

Latikochu is now one of the most important exporting vegetable items which exported to United Kingdom, Italy and other European countries, Saudi Arabia and different countries of the Middle East. A total of 74.013 metric tons of Latikochu stolon was exported to United Kingdom, Italy and other European countries in 2021-22 (Figure 9) [2]. However, quantity of Latikochu export was decreased during 2019-20 fiscal year (Figure 10) [3] due to several reasons. Latikochu is not imported in Bangladesh from any other countries of the world. However, may introduce in Bangladesh form neighboring countries (India and Myanmar) through personal luggage of human movement.

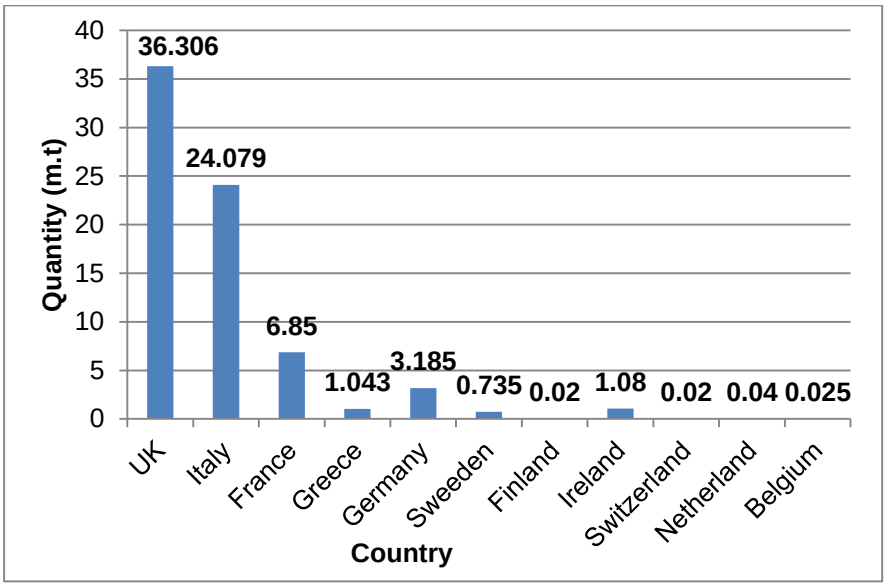

Figure 9. National export of latikochu stolon in UK and European countries during 2021-2022.

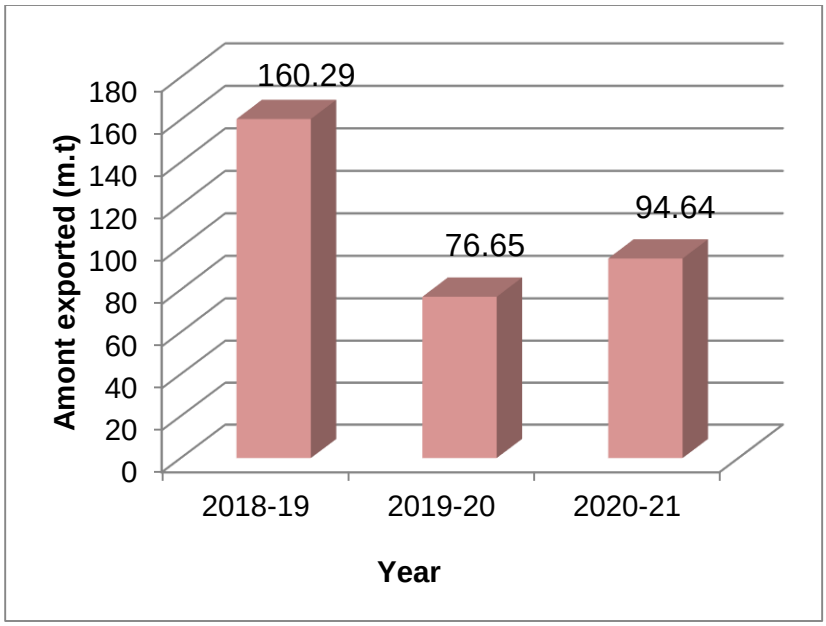

Figure 10. Latikochu stolon export from Bangladesh during last three years.

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3.4 Background information of exporting countries

3.4.1 India

Taro (*Colocasia esculenta*) is an important vegetable grown in many areas particularly in fertile wet areas of India. The major taro production states in India are Assam, Manipur, Himachal Pradesh, Karnataka, Gujarat, Tamilnadu, Maharashtra, Kerala, Andhrapradesh, Telanagana, Uttarakhand, Orissa, Bihar, and West Bengal.It is grown as mono crop (in Andhra Pradesh, Madhya Pradesh and Orissa) as well as intercrop (in Uttar Pradesh and Andhra Pradesh) [8]. Taro is available in different states throughout the year either from local production or procured from other states due to differences in planting time. The underground corm is harvested and eaten after cooking, besides leaves and petioles of leaves are used for many purposes [7].

3.4.1.1 Geography

India is situated north of the equator between 8°4' north (the mainland) to 37°6' north latitude and 68°7' east to 97°25' east longitude [3]. It is the seventh-largest country in the world, with a total area of 3,287,263 square kilometres (1,269,219 sq mi) [3, 4, 5]. India measures 3,214 km (1,997 mi) from north to south and 2,933 km (1,822 mi) from east to west. It has a land frontier of 15,200 km (9,445 mi) and a coastline of 7,516.6 km (4,671 mi) [1].

On the south, India projects into and is bounded by the Indian Ocean—in particular, by the Arabian Sea on the west, the Lakshadweep Sea to the southwest, the Bay of Bengal on the east, and the Indian Ocean proper to the south. The Palk Strait and Gulf of Mannar separate India from Sri Lanka to its immediate southeast, and the Maldives are some 125 kilometres (78 mi) to the south of India's Lakshadweep Islands across the Eight Degree Channel. India's Andaman and Nicobar Islands, some 1,200 kilometres (750 mi) southeast of the mainland, share maritime borders with Myanmar, Thailand and Indonesia. The southernmost tip of the Indian mainland (8°4′38″N, 77°31′56″E) is just south of Kanyakumari, while the southernmost point in India is Indira Point on Great Nicobar Island. The northernmost point which is under Indian administration is Indira Col, Siachen Glacier [6]. India's territorial waters extend into the sea to a distance of 12 nautical miles (13.8 mi; 22.2 km) from the coast baseline. India has the 18th largest Exclusive Economic Zone of 2,305,143 km^2 (890,021 sq mi).

The northern frontiers of India are defined largely by the Himalayan mountain range, where the country borders China, Bhutan, and Nepal. Its western border with Pakistan lies in the Karakoram and Western Himalayan ranges, Punjab Plains, the Thar Desert and the Rann of Kutch salt marshes. In the far northeast, the Chin Hills and Kachin Hills, deeply forested mountainous regions, separate India from Burma. On the east, its border with Bangladesh is largely defined by the Khasi Hills and Mizo Hills, and the watershed region of the Indo-Gangetic Plain.

3.4.1.2 Climate

The climate of India consists of a wide range of weather conditions across a vast geographic scale and varied topography, making generalizations difficult. Also, based on the Köppen system, India hosts six major climatic sub types, ranging from arid deserts in the west, alpine tundra and glaciers in the north, and humid tropical regions supporting rain forests in the southwest and the island territories. Many regions have starkly different microclimates, making it one of the most climatically diverse countries in the world. The country's meteorological department follows the international standard of four seasons with some local adjustments: winter (January and

February), summer (March, April and May), monsoon (rainy) season (July to September), and a post-monsoon period (October to December) [10].

India's geography and geology are climatically pivotal: the Thar Desert in the northwest and the Himalayas in the north work in tandem to create a culturally and economically important monsoonal regime. As Earth's highest and most massive mountain range, the Himalayas bar the influx of frigid katabatic winds from the icy Tibetan Plateau and northerly Central Asia. Most of North India is thus kept warm or is only mildly chilly or cold during winter; the same thermal dam keeps most regions in India hot in summer. Climate in South India is generally hotter and more humid due to its coasts [10].

Though the Tropic of Cancer—the boundary that is between the tropics and subtropics—passes through the middle of India, the bulk of the country can be regarded as climatically tropical. As in much of the tropics, monsoonal and other weather patterns in India can be strongly variable: epochal droughts, heat waves, floods, cyclones, and other natural disasters are sporadic, but have displaced or ended millions of human lives. Such climatic events are likely to change in frequency and severity as a consequence of human-induced climate change. Ongoing and future vegetative changes, sea level rise and inundation of India's low-lying coastal areas are also attributed to global warming [10].

3.4.2 Myanmar

3.4.2.1 Geography

Myanmar is a republic in South-East Asia. The official name of Myanmar is the Union of Myanmar with a total area of 678,500 square kilometers (262,000 sq mi). It lies between latitudes 9° and 29°N, and longitudes 92° and 102°E. The country is roughly diamond-shaped – with a long southeastern 'tail' – and extends 925km (575 miles) from east to west and 2,100km (1,300 miles) from north to south [10].

Myanmar is bordered in the northwest by the Chittagong Division of Bangladesh and the Mizoram, Manipur, Nagaland and Arunachal Pradesh states of India. Its north and northeast border is with the Tibet Autonomous Region and Yunnan province for a Sino-Myanmar border total of 2,185 km (1,358 mi). It is bounded by Laos and Thailand to the southeast. Myanmar has 1,930 km (1,200 mi) of contiguous coastline along the Bay of Bengal and Andaman Sea to the southwest and the south, which forms one quarter of its total perimeter [10].

In the north, the Hengduan Mountains form the border with China. Hkakabo Razi, located in Kachin State, at an elevation of 5,881 metres (19,295 ft), is the highest point in Myanmar. Many mountain ranges, such as the Rakhaine Yoma, the Bago Yoma, the Shan Hills and the Tenasserim Hills exist within Myanmar, all of which run north-to-south from the Himalayas.The mountain chains divide Myanmar's three river systems, which are the Irrawaddy, Salween (Thanlwin), and the Sittaung rivers. The Irrawaddy River, Myanmar's longest river, nearly 2,170 kilometres (1,348 mi) long, flows into the Gulf of Martaban. North of the delta lies the Irrawaddy basin and the arid plains of central Myanmar, which are protected by a horseshoe of mountains. Fertile plains exist in the valleys between the mountain chains. The majority of Myanmar's population lives in the Irrawaddy valley, which is situated between the Rakhine Yoma and the Shan Plateau. Generally narrow and elongated in the interior, the central lowlands attain a width of about 320km (about 200 miles) across the Ayarwaddy-Sittaung delta. The delta plains, extremely fertile and economically the most important section of the country, cover an area of about 46,620 sq. km (18,000 sq. ml.). Both the Arakan (in the northwest) and the Tenasserim (in the southwest) coasts of Myanmar are rocky and fringed with

islands. The country has a number of excellent natural harbours. Intensive irrigated farming is practised throughout central Myanmar, and fruit, vegetables and citrus crops thrive on the Shan Plateau. Much of the land and mountains are covered by subtropical forest, although this coverage has been reduced by extensive logging particularly for teak.The vast deltas and flood plains of the Irrawaddy and Sittang Rivers form the heart of Myanmar provide its most productive farmland. Bamboo grows extensively in many parts of the country. Myanmar used to be rich in rainforests, monsoon forests, and mangrove forests. Now, most of these woodlands are gone due to deforestation. The country's remaining forest cover, now less than 30 percent, is found mostly in the relatively inaccessible mountain areas of the north and northeast. The loss of forest cover in Myanmar not only has threatened animal and plant populations, but also has caused landslides, flooding, and drought [10].

Steep, craggy limestone hills with many caves are found in the Shan Plateau and in the southeastern part of the country. Elsewhere in Myanmar there are foothill areas leading up to the mountain chains. The Shan plateau in the east with an average elevation of 1200 meters (3937 feet). The plateau borders to Northern Thailand and Laos. In Kachin State, the very north of Myanmar, May Kha and Malikha, the two rivers create the breathtaking view as the confluence flow into the Ayeyarwaddy River. The Ayeyarwaddy River valley lies across the country north to south. The Ayeyarwaddy River flows down south and forms the confluence with the Chindwin River which flows from the West Flank. The confluence is situated in the Central Basin of Myanmar. At the end, in the south, the Ayeyarwaddy changes into the tributaries of the Ayeyarwaddy delta in which lies the biggest city of Myanmar, Yangon. In the mid-eastern part of Myanmar, the Sittaung River starts flowing parallel to the Ayeyarwaddy River and ends up in the south by flowing into the Gulf of Mataban. The Thanlwin River crosses almost the entire length of Myanmar from the north to south. The Sanlwin River is rooted from China’s side and flows into Myanmar from the north to south. It flows along the Sittaung River more from the eastern side of the country and enters the Gulf of Mataban. Myanmar has very long coastal line so as to have many beaches [10].

3.4.2.2 Climate

Although Myanmar is located in the monsoon region of Asia, its climate is greatly modified by its geographic position and its relief. Much of the country lies between the Tropic of Cancer and the Equator. The climate of Myanmar is roughly divided into three seasons: Summer, Rainy Season, and Winter Season. From the end of February to the beginning of May are Summer months, with highest temperatures during March and April in Central Myanmar up to above 110^0F (43.3^0C) while in Northern Myanmar it is about 97^0F (36.1^0C) and on the Shan Plateau between 85^0F (29.4^0C) and 95^0F (35^0C). Winter which starts from November and lasts to the end of February with temperature in hilly areas of over 3000 feet drops below 32^0F (^{0}C). The cold air masses of Central Asia bring snow to the northern mountains during the winter of the year, but this mountain wall prevents the cold air from moving farther south, so that Myanmar lies primarily under the influence of the monsoon winds. The north-south alignment of ranges and valleys creates a pattern of alternate zones of heavy and scanty precipitation during both the northeast and southwest monsoons. Most of the precipitation, however, comes from the southwest [10].

Humidity ranges from 66 percent to 83 percent. Most of the country's rainfall occurs during the monsoon. Rainy Season, from mid May to the end of October, with annual rain fall of less than 40 inches in Central Myanmar while the coastal regions of Rakhine and Tanintharyi get about 200

inches Annual rainfall in the delta region is approximately 2,500 mm (98.4 in), while average annual rainfall in the Dry Zone in central Myanmar is less than 1,000 mm (39.4 in). As a whole, the location and topography of the country generate a diversity of climatic conditions. Seasonal changes in the monsoon wind directions create summer, rainy and winter seasons. Extremes of temperature are rare. The direction of winds and depression bring rain, and although it is always heavy in the coastal areas during Monsoon season, it seldom creates hardships. The Government is giving priority to forest conservation and greening of nine arid districts in central Myanmar [10].

3.5 Background information of Bangladesh

3.5.1 Geography

Geographical location and physical settings govern the climate of any country. Bangladesh extends from 20°34'N to 26°38'N latitude and from 88°01'E to 92°41'E longitude. Except the hilly southeast, most of the country is a low-lying plain land. It is surrounded by the Assam Hills in the east, the Meghalaya Plateau in the north, the lofty Himalayas lying farther to the north. To its south lies the Bay of Bengal, and to the west lie the plain land of West Bengal and the vast tract of the Gangetic Plain [2].

3.5.2 Climate

Bangladesh is located in the tropical Monsoon region and its climate is characterized by high temperature, heavy rainfall, often excessive humidity, and fairly marked seasonal variations. The most striking feature of its climate is the reversal of the wind circulation between summer and winter, which is an integral part of the circulation system of the South Asian subcontinent. From the climatic point of view, three distinct seasons can be recognized in Bangladesh - the cool dry season from November through February, the pre-monsoon hot season from March through May, and the rainy monsoon season which lasts from June through October. The month of March may also be considered as the spring season, and the period from mid-October through mid-November may be called the autumn season [2].

The dry season begins first in the west-central part of the country by mid-December, where its duration is about four months, and it advances toward east and south, reaching the eastern and southern margins of the country by mid-March where its duration is about one month [2].

The pre-monsoon hot season is characterized by high temperatures and the occurrence of THUNDERSTORMS. April is the hottest month when mean temperatures range from 27°C in the east and south to 31°C in the west-central part of the country. In the western part, summer temperature sometimes reaches upto 40°C. After the month of April, the temperature dampens due to increased cloud cover. The pre-monsoon season is the transition period when the northerly or northwesterly winds of the winter season gradually changes to the southerly or southwesterly winds of the summer monsoon or rainy season (June-September). During the early part of this season, the winds are neither strong nor persistent. However, with the progression of this season wind speed increases, and the wind direction becomes more persistent.

During the early part of the pre-monsoon season, a narrow zone of air mass discontinuity lies across the country that extends from the southwestern part to the northeastern part. This narrow zone of discontinuity lies between the hot dry air coming from the upper Gangetic plain and the warm moist air coming from the Bay of Bengal. As this season progresses, this discontinuity weakens and

retreats toward northwest and finally disappears by the end of the season, making room for the onset of the summer monsoon. The rainy season, which coincides with the summer monsoon, is characterized by southerly or southwesterly winds, very high humidity, heavy rainfall, and long consecutive days of rainfall which are separated by short spells of dry days. Rainfall in this season is caused by the tropical Depressions that enter the country from the Bay of Bengal. [2].

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3.6 International transportation of commodity

For the purpose of this risk analysis latikochuis presumed to be imported from anywhere in India and Myanmar. The commodity would be imported by sea, land and/or by air freighted to Bangladesh through any of the ports mentioned below:

Land ports- Darsana, Chuadanga; Benapole, Jessore; Sonamoszid, C. Nawabganj; Hili, Dinajpur; Burimari,Lalmonirhat; Tamabil, Sylhet; Bhomra, Satkhira; Rohonpur, C. Nawabgonj; Zakiganj, Sylhet; Birol,Dinajpur; Banglabandha, Panchagarh; ICD Kamlapur, Dhaka; Kamalpur, Jamalpur; Belunia, Feni; Betuli, Moulvibazar; Chatlapur, Moulvibazar; Haluaghat, Mymensingh

River port- Narayanganj

However, it should be specified through which port the commodity would be imported. The imported commodity, after Biosecurity checking if found risk free clearance would be given for distribution to any markets, supermarkets, shops throughout the country for sale for consumption or used as seed. Diagrammatic representation of import pathways of Latikochu is shown in Figure 11.

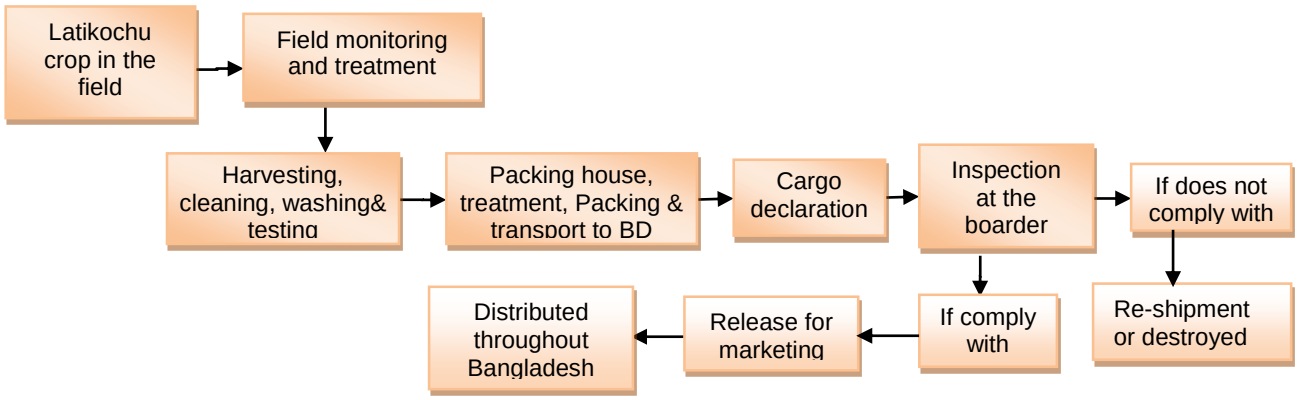

Figure 11.Linear diagram of import pathway of latikochu.

Growers intend to export their latikochu should be enrolled with the Plant Protection Department of their respective countries and need to specify the location of the field, total area, frequent monitoring for the occurrence of pest and diseases and record the measures taken for pest management. The growing area must be free from the specified quarantine pest or disease and the freedom of the specified pest/disease must be ascertained through field inspection, sampling and testing of stolon. This information must be made available to the Govt. inspectors on demand.

The harvesting of the latikochu will be done at full growth followed by cleaning and stolon washing to be done at an accredited. Latikochufor export will then be transported to packing house where necessary grading and cleaning will be done. It should been sured that latikochu should not contain any plant parts, weed seed or soil clods. The commodity must be inspected by a competent quarantine inspector for any quarantine pests and provide treatment and accompanied with phytosanitary certificate from the PPO of the country of origin and packing to be done for shipment to Bangladesh.

The consignment must accompany appropriate certification, e.g. a phytosanitary certificate attesting to the identity of stolon, any treatments completed, or other information required helping mitigate risks. Seeds are to be examined at the border (only visual inspection will not serve the purpose, pathogen/pest specific Standard Seed Health Test should be performed) to ensure compliance with Bangladesh's biosecurity requirements. If, for example quarantine pest is found harbouring with any consignment then decision to be made whether this will be released after necessary treatment. If effective treatment is not available, consignment is to be re-shipped or destroyed. Consignment met all the requirements will be released for distribution throughout the country

3.7 Hazard Identification

3.7.1 Introduction

Hazard identification is the essential step conducted prior to a risk assessment. Unwanted organisms or diseases which could be introduced by risk goods into Bangladesh and is potentially capable of causing unwanted harm, must be identified.

3.7.2 Potential hazard groups

Hazards are the unwanted insect and mite pests, diseases (pathogen) or weeds or any other pests of latikochu which could be introduced into Bangladesh and are potentially capable of causing harm to latikochu production, must be identified. This process begins with the collection of information on insect and mite pests, diseases (pathogen) or weed or any other pests of latikochu present 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.

3.7.3 Organism interceptions on commodity from existing pathways

As reported by the Plant Quarantine Wing (PQW) under Department of Agricultural Extension (DAE), Bangladesh, during inspection in port of entry of latikochu from the exporting counties, not a pest had been intercepted yet today on the latikochu imported into Bangladesh.

3.7.4 Other Risk characteristics of the commodity

Although many pests dealt with in this risk analysis had adequate information for assessment still in some cases adequate information was not available. Moreover, the pests are dynamic, the status of pests might change with the change in climatic factors, variety grown and production practices, therefore, we cannot predict future risk or even the present risks that currently escape detection for a variety of reasons.

3.7.4.1 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 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.

3.7.4.2 Symptomless Microorganisms

Pests such as microbes and fungi infect seeds before transit and may not produce symptoms and mislead the lot as healthy. However, the pathogen introduced as symptomless with the commodity become apparent only when they reach a suitable climate to sporulate or reproduce. Many fungi can infect stolon after arrival making it difficult to distinguish the origin of saprobes and pathogens without adequate identification. Consumers tend to throw away rotten stolon and or plant debris associated with the latikochu rather than taking it to a diagnostic laboratory so there is little data on post entry appearance of “invisible organisms”.

3.8 Assumptions and Uncertainties

3.8.1 Introduction

The major uncertainties encountered in this risk analysis are identified here. The assumptions made to take account of them are explicitly identified where relevant in the text. The assessment of uncertainties and assumptions for each organism often covers similar areas of information or lack of information, with key factors or variables being relevant across different organism groups. The assumptions and uncertainties are covered in these sections rather than individually in each pest risk assessment.

3.8.2 Hazard Biology and Identification

The biology of insect and mite pests and pathogens those have been reared in the laboratory for several generations is often different to wild counterparts established in field conditions. Aspects such as life cycle, pre-oviposition period, fecundity and flight ability, 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. For example longevity and fecundity of adult aphids in a greenhouse was longer and higher than those in a growth chamber with similar conditions.

It is difficult to predict how a species will behave in a new environment, particularly if it has not become established as a pest elsewhere outside its natural range. Therefore there will be considerable uncertainty around the likelihood of an organism colonizing 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.

Where there is uncertainty about the identity of an organism, e.g. *Caliotrhips indicus*, the more serious pest is considered in the PRA. The conclusions may need to be revisited if evidence to the

contrary becomes available. There is uncertainty around the efficacy of risk management measures for many of the hazards identified in this Risk Analysis. In some cases efficacy data for similar species has had to be used.

3.8.3 Assumption regarding transit time of Latikochu

An assumption is made around the time the stolon take to get from the field in India transported to Bangladesh by road. It is assumed that the harvesting, processing, packing and transit to Bangladesh from imported countries mentioned above, inspection and release in Bangladesh will take a minimum of 5-7 days.

3.8.4 Assumption and uncertainty around disposal

It is assumed that a portion of stolon that might have infested or contaminated will be disposed off in a manner that exposes any potential hazard organisms on that seeds to suitable hosts. Disposal would include discarding stolon or plant debris on urban or rural roadsides, in bush reserves, in open rubbish bins in public places, and on open composts in domestic areas.

3.8.5 Assumption and uncertainty around risk management measures

A lot of 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.

This approach makes the following assumptions, that:

- The consignment is homogeneous (stolon are harvested inspected and packaged in similar conditions, and have received similar treatments before arrival into Bangladesh). Heterogeneous or non-randomly distributed consignments would require a higher sampling rate to achieve the same confidence levels. Level of sampling depends on the degree of heterogeneity;
- The samples are chosen randomly from the consignment;
- The inspector is 100 percent likely to detect the pest if it is present in the sample. Because of uncertain distribution of pests within the consignment some pests will not be detected if they are present outside the sample. Some pests are difficult to detect because of their small size and behaviours;
- It is acceptable that the sampling system is based on a level (percentage) of contamination rather than a level of surviving individuals;
- Interception records can rarely be used quantitatively because of limitations in the identification and recording processes.
- There is a paucity of information on the efficacy of the available risk mitigation options in managing the hazards associated with latikochu. In the absence of efficacy data, assumptions are made on the basis of data for similar species or similar treatments.

3.9 Review of management options

3.9.1 Introduction

This chapter provides background information on possible measures to mitigate the biosecurity risk associated with importing Latikochufrom India and Myanmar.

3.9.2 Production and post-harvest measures

It is necessary to provide information about the production and post harvest procedures that growers are expected to use.

3.9.3 Monitoring programmes in production areas

Regular monitoring in field, pest and pathogens is the key to optimizing production while reducing pest and/or disease-related problems, for instance:

- insect pests- regular inspection of leaves, stems, etc. of Latikochu in field to monitor invertebrate population levels eg: coloured sticky boards (white, blue or yellow are attractive to thrips) are commonly used to sample thrips populations; inspection in store ho
- disease organisms – inspection for presence of symptoms.
- Weeds – regular inspection for presence of weeds in field.

Knowledge of pest levels allows for timely and appropriate control measures to be implemented, thus adding to risk reduction.

3.9.4 In-field sanitation

In-field sanitation requires the removal of plant debris, weeds, alternate hosts and diseases infested plant that can harbour disease or pests from Latikochu field. Any infected plant, leaves or plant parts should be cut or removed from the field. Regular inspection and removal of infected plants, weeds facilitate the health and growth by reducing the incidence of various fungal diseases and viral diseases, weeds and allowing in more sunlight.

3.9.5 Pest control measures in field

When pests or diseases reach a volume over a set percentage in field, the grower will use insecticide, fungicide or mineral oil sprays for control. Other forms of control that can be used are pheromone disruption for specific invertebrates such as the introduction of biocontrol agents for entomophagic fungi or parasitizing invertebrates.

3.9.6 Selection of stolon from areas free of pests (Area Freedom)

Several species identified as of quarantine concern to Bangladesh appear to have restricted distributions in the importing countries. If it is possible to guarantee the source of seed, obtaining it from more northerly areas will reduce the risk of importation of these species, although it will not completely eliminate the risk. Other species identified as of quarantine concern however, are appearing to be widely distributed and it will not be possible to identify Latikochu producing regions free of these pests. In general however, infestation pressure declines as one move into more northerly growing areas. If Latikochu is to be sourced using the principles of area freedom, this will require detection, monitoring and delimiting surveys for pests of quarantine to be carried out annually, also the dedication and monitoring of rail cars. This is unlikely to be commercially acceptable in the USA as this is not normal practice.

3.9.7 Stolon quality

Risk of infestation increases with declining in stolon quality measured in terms of its physical condition, homogeneity and extent of admixture of trash and other materials. Many insect species find it much easier to become established in stolon consignments containing admixtures [5]. Complete removal of admixture of Latikochu reduces the risk of some species being imported to negligible levels. Cleaning and washing will remove most snails and other incidental contaminants. Lower grades of Latikochu are notoriously difficult to treat as regions of bulk cargo can be very high in trash and fines – this material tends to segregate during handling and transport of the stolon and forms pockets and layers through which fumigants may have difficulty passing. This results in non-uniform distribution of gas and an increased risk of fumigant survivors. These problems are compounded if fumigation is undertaken in-ship. Clean stolon is much easier to applytreatment properly.

3.9.8 Prevention of infestation during transportation, storage and handling

A number of species identified of quarantine concern, are not host specific and can be pests infesting residues present in latikochu handling systems. Such species can infest latikoch when handled through contaminated facilities. Use of well managed handling and transportation systems will reduce this risk. Fumigation is a non residual treatment and will not confer protection of the stolon during subsequent handling and transportation [3].

Ships used for the importation of latikochu need to be 'fit for purpose'. Vessels can become infested with insects of quarantine concern from previous cargoes and not necessarily only those associated with latikochu. This could include species which are not established in China or Vietnam including the Indian meal moth, prior to loading Latikochu, ships must be clean and free of infestation, at least to the standard expected of vessels which handle Bangladeshi latikochu exports. This includes not only the hold, but all other areas of the vessel including crew quarters and engine room and related areas from which infestation could arise [3].

3.9.9 Disinfestation treatments

Disinfestation treatments are treatments that remove or kill hazard organisms that may be contaminating commodities. Some of the treatments discussed are usually considered "stand alone" disinfestation treatments but these can also be integrated into a systems approach. This depends on a number of variables, such as the commodity type, its tolerance for the treatment/s, the heat treatment is suitable for disinfesting Latikochu stolon.

3.10 Visual inspection at the border of Bangladesh

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 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).However in practice it is not possible to precisely define either efficacy or pest limits.

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4.0 IDENTIFICATION OF PESTS

Pests include insects, mites, diseases organisms, weeds and other organisms which may cause damage to crops. Pests of latikochu in Bangladesh as well as exporting countries have been discussed herein.

4.1 Insect pests, diseases and weeds of latikochu in Bangladesh

Bangladesh does not import latikochu from any other countries of the world. Although latikochu is not imported from our neighboring countries (India and Myanmar), it pests may be introduced in Bangladesh from/through various human activities. Thus insect pests, diseases and weeds of thelatikochu are considered and discussed herein.

4.1.1 Insect and mite pests of latikochu in Bangladesh

Insect and mite pests of latikochu in Bangladesh have been included in this section. Insect and mite pests of latikochu recorded in the cultivation field during field survey are shown in Appendices IV & XI.

In Bangladesh, ten insect pests viz. tobacco caterpillar (*Spodoptera litura*), aphid (*Aphis gossypii*), jassid (*Amrasca bigutulla bigutulla*), whitefly(*Bemisia tabaci*), spiraling whitefly (*Aleurodicus rugioperculatus*), tingid bug (*Stephanitis typica*), mealybug (*Pseudococcus* sp.) spotted flea beetle (*Monolepta signata*), hairy caterpillar (*Pericallia ricini*), taro caterpillar (*Hippotion celerio*) and a mite (*Tetranychus* sp.) are reported to attack taro in the field (Table 3). Of which, tobacco caterpillar (*Spodoptera litura*) was a major pest and widely distributed all over the Bangladesh and other pests were considered as minor [1, 4, 6, 12]. Cotton aphid (*Aphis gossypii*) and spider mite (*Tetranychus* sp.) are minor pests but they caused severe infestation at some locations [6, 8, 11, 12]. Recently rugose spiraling whitefly (*Aleurodicus rugioperculatus*) was found to infest taro leaf at some locations but was not reported in Bangladesh in the past and it is a major pest of coconut and invaded in Bangladesh recently [8]. Most of these pests are polyphagous and reported to infest several other crops in the field but they are also found to attack taro when their preferred hosts were scarce or absent in the field. Some important insect and mite pests at latikochu field in Bangladesh observed during field visits are shown in Figure 12.

Table 3. Recorded insect pests of latikochu, their damaging stage(s), infested plant parts and pest status in Bangladesh

Sl. No.	Common name	Scientific name	Order: Family	Infested plant parts	Status	Reference
01.	Cotton aphid	*Aphis gossypii* Glover	Homoptera: Aphididae	Adult and nymph suck cell sap	Minor, may cause severe infestation	6,12
02.	Jassid	*Amrasca bigutulla bigutulla* Ishida	Homoptera: Cicadellidae	Adult and nymph suck cell sap	Minor, sporadic	6
03.	Whitefly	*Bemisia tabaci* (Gennadius)	Homoptera: Aleyrodidae	Adult and nymph suck cell sap	Minor	6
04.	Rugose spiraling whitefly	*Aleurodicus rugioperculatus* Martin	Homoptera: Aleyrodidae	Adult and nymph suck cell sap form leaves	Minor in taro Recently invaded in Bangladesh and major pest of cocunut	8
05.	Tingid bug/ Banana lace bug	*Stephanitis typica* Distant	Homoptera:	Nymph and adult suck lower surface of leaves	Minor Sporadic	3, 9
06.	Mealybug	*Pseuduococcus* sp.	Homoptera:	Nymph and adult suck tuber in storage and field	Minor	6
07.	Spotted flea beetle	*Monolepta signata* Olivier	Coleoptra: Chrysomelidae	Adult beetles feeds leaf	Minor	1, 10
08.	Tobacco caterpillar/ common cutworm	*Spodoptera litura* (Fabricius)	Lepidoptera: Noctuidae	Larva feed on leaf	Major, widely distributed	1, 4, 6, 12
09.	Hairy caterpillar	*Pericallia ricini* Fabricius	Lepidoptera: Lymentridae	Larva feed on leaves	Minor (Sporadic)	1, 2

Sl. No.	Common name	Scientific name	Order: Family	Infested plant parts	Status	Reference
10.	Taro caterpillar/ Vine hawkmoth/ Silver striped hawkmoth	*Hippotion celerio* (Linnaeus)	Lepidoptera: Sphingidae	Caterpillar voraciously feeds on leaves	Minor	5, 6
11.	Spider mite	*Tetranychus* sp.	Acarina: Tetranychidae	Nymph and adult suck cell sap from leaf	Minor, may cause severe infestation	8, 11

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Taro caterpillar on leaf

Taro caterpillar infested leaf

Aphids on infested leaf

Aphid and ants on infested leaf

Adult hawk moth

Larva of hawkmoth

Spotted flea beetle

Rugose spiraling whitefly

Jassid on infested leaf

Mite infested leaf

Figure12. Some important pests of latikochu in Bangladesh.

4.1.2 Insect and mite pests of latikochu in India

In India, 14 species of pests (13 insects and 1 mite) have been reported from different regions (Table 4). Among them, aphid (*Aphis gossypii*), tobacco caterpillar (*Spodoptera litura*), spotted flea beetle (*Monolepta signata*) and spider mite (*Tetranychus* sp.) have been reported by several authors as major insect pests of taro [8, 9, 11]. Other pests such as banana aphid (*Pentalonia nigronervosa*), whitefly (*Bemisia tabaci*), rugose spiraling whitefly (*Aleurodicus rugioperculatus*), mealybug (*Pseuduococcus citriculus*), taro plant hopper (*Tarophagus colocasiae*), Tingid bug (*Stephanitis typica*), white scale insect (*Aspidiella hartii*), thrips (*Caliothrips indicus*), hairy caterpillar (*Pericallia ricini*) and vine hawkmoth (*Hippotion celerio*) causes less infestation to taro in the field and considered as minor pests [1, 8, 11]. Moreover, infestation of tinged bug and hairy caterpillar were sporadic in the crop field [5, 8, 11] and rugose spiraling whitefly is a major insect pest of coconut in India [4, 7, 10] but it was found to attack taro along with many other crops recently. Most of these pests are polyphagous and reported to infest several other crops in the field and they are also found to attack taro when their preferred hosts were scarce or absent in the field.

Table 4.Recorded insect pests of latikochu, their damaging stage(s), infested plant parts and pest status in India

Sl. No.	Common name	Scientific name	Order: Family	Infested plant parts	Status	Reference
01.	Cotton aphid	*Aphis gossypii* Glover	Homoptera: Aphididae	Nymph and adult suck sap from both sides of leaves and petioles	Major	1, 5, 12, 15
02.	Banana aphid	*Pentalonia nigronervosa*(Coquerel)	Homoptera: Aphididae	Nymph and adult suck sap from both sides of leaves and petioles	Minor	2, 12, 15
03.	Whitefly	*Bemisia tabaci* (Gennadius)	Homoptera: Aleyrodidae	Adult and nymph suck cell sap	Minor	12, 15
04.	Rugose spiraling whitefly	*Aleurodicus rugioperculatus* Martin	Homoptera: Aleyrodidae	Adult and nymph suck cell sap form leaves	Minor	11
05.	Taro plant hopper	*Tarophagus colocasiae* (Matsumura)	Homoptera: Delphacidae	Adult and nymph suck cell sap	Minor	12, 15
06.	Tingid bug/ Banana lace bug	*Stephanitis typica* Distant	Homoptera:	Nymph and adult suck fower surface of leaves	Minor sporadic	4, 8,12

Sl. No.	Common name	Scientific name	Order: Family	Infested plant parts	Status	Reference
07.	Mealybug	*Pseuduococcus* sp.	Homoptera:	Nymph and adult suck tuber in storage and field	Minor	12
08.	Thrips	*Caliothrips indicus* Bagnall	Thysanoptera: Thripidae	Nymph and adult suck both sides of leaves	Minor	12, 13, 15
09.	White scale insect	*Aspidiella hartii* (Coquerel)	Homoptera: Coccodiae	Nymph and adult attacks tuber	Minor	9, 12, 16
10.	Tobacco caterpillar/ Common cutworm	*Spodoptera litura* Fabricius	Lepidoptera: Noctuidae	Larva feed leaves	Major	3, 8, 12
11.	Hairy caterpillar	*Pericallia ricini* Fabricius		Larva feed on leaves	Minor sporadic	10, 12, 15
12.	Spotted flea beetle	*Monolepta signata* Olivier	Coleoptra: Chrysomelidae	Adult feeds leaf	Major	12, 15
13.	Taro caterpillar/ Vine hawkmoth/	*Hippotion celerio* (Linnaeus)	Lepidoptera: Sphingidae	Caterpillar voraciously feeds on leaves	Minor	12, 15
14.	Spider mite	*Tetranychus* sp.	Acarina: Tetranychidae	Nymph and adult suck sap from leaves, starting from older to younger leaves	Major	12, 15

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4.1.3 Insect and mite pests of latikochu in Myanmar

Seven insect pests viz. cotton aphid (*Aphis gossypii*), banana aphid (*Pentalonia nigronervosa*), whitefly (*Bemisia tabaci*), tingid bug (*Stephanitis* typica), thrips (*Caliothrips indicus*), taro caterpillar (*Hippotion celerio*), tobacco (*Spodoptera litura*) and a mite (*Tetranychus* sp.) are reported to infest taro in the field [1, 2] in Myanmar. Of which, cotton aphid and tobacco caterpillar were widely distributed all over the country and considered as major pests and other pests were considered as minor (Table 5). Spider mite was reported as minor pest but it caused severe infestation at some locations. Most of these pests are polgyphagous and reported to infest several other crops in the field but they are also found to attack taro when their preferred hosts were scarce or absent in the field.

Table 5. **Recorded insect pests of latikochu, their damaging stage(s), infested plant parts and pest status in Myanmar**

Sl. No.	Common name	Scientific name	Order: Family	Infested plant parts	Status	Reference
01.	Cotton aphid	*Aphis gossypii* Glover	Homoptera: Aphididae	Nymph and adult suck sap from both sides of leaves and petioles	Major	1, 2, 7, 8
02.	Banana aphid	*Pentalonia nigronervosa* (Coquerel)	Homoptera: Aphididae	Nymph and adult suck sap from both sides of leaves and petioles	Minor	3, 7, 8
03.	Whitefly	*Bemisia tabaci* (Gennadius)	Homoptera: Aleyrodidae	Adult and nymph suck cell sap	Minor	7, 8
04.	Tingid bug/ Banana lace bug	*Stephanitis typica* Distant	Homoptera:	Nymph and adult suck fower surface of leaves	Major, widespr ead	5, 7, 8
05.	Thrips	*Caliothrips indicus* Bagnall	Thysanoptera: Thripidae	Nymph and adult suck both sides of leaves	Minor	7, 8
06.	Tobacco caterpillar/ Common cutworm	*Spodoptera litura* Fabricius	Lepidoptera: Noctuidae	Larva feed leaves	Major	6, 7, 8

Sl. No.	Common name	Scientific name	Order: Family	Infested plant parts	Status	Reference
07.	Taro caterpillar/ Vine hawkmoth/ Silver striped hawkmoth	*Hippotion celerio* (Linnaeus)	Lepidoptera: Sphingidae	Caterpillar voraciously feeds on leaves	Minor	7, 8
08.	Spider mite	*Tetranychus* sp.	Acarina: Tetranychidae	Nymph and adult suck sap from leaves starting from older to younger leaves	Minor	7, 8

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4.1.4 Insect and mite pests of latikochuin Malaysia

Seven insect pests viz. cotton aphid (*Aphis gossypii*), banana aphid (*Pentalonia nigronervosa*), whitefly (*Bemisia tabaci*), tingid bug (*Stephanitis typica*), thrips (*Caliothrips indicus*), vine hawkmoth (*Hippotion celerio*), tobacco (*Spodoptera litura*) and a mite (*Tetranychus* sp.) are reported to infest taro and other crops in the field [1, 2] in Malaysia. Of which, cotton aphid (*A. gossypii*) and tobacco caterpillar (*Spodoptera litura*) were widely distributed all over the country and considered as major pests and other pests were considered as minor (Table 6). Spider mite (*Tetranychus* sp.) was reported as minor pest but it caused severe infestation at some locations. Most of these pests are polyphagous and reported to infest several other crops in the field but they are also found to attack taro when their preferred hosts were scarce or absent in the field.

Table 6. Recorded insect pests of latikochu, their damaging stage(s), infested plant parts and pest status in Malaysia

Sl. No.	Common name	Scientific name	Order: Family	Infested plant parts	Status	Reference
01.	Cotton aphid	*Aphis gossypii* Glover	Homopter: Aphididae	Nymph and adult suck sap from both sides of leaves and petioles	Major	7
02.	Banana aphid	*Pentalonia nigronervosa*(Coquerel)	Homoptera: Aphididae	Nymph and adult suck sap from both sides of leaves and petioles	Minor	2, 7
03.	Whitefly	*Bemisia tabaci*(Gennadius)	Homoptera: Aleyrodidae	Adult and nymph suck cell sap	Minor	6, 7
04.	Taro plant hopper	*Tarophagus colocasiae* (Matsumura)	Homoptera: Delphacidae	Adult and nymph suck cell sap	Minor	1, 7
05.	Tingid bug/ Banana lace bug	*Stephanitis typica* Distant	Homoptera:	Nymph and adult suck flower surface of leaves	Minor sporadic	2, 7
06.	Taro caterpillar/ Tobacco caterpillar	*Spodoptera litura* Fabricius	Lepidoptera: Noctuidae	Larva feed leaves	Major widespread	2, 5, 7

Sl. No.	Common name	Scientific name	Order: Family	Infested plant parts	Status	Reference
07.	Vine hawk moth/Silver striped hawkmoth	*Hippotion celerio* (Linnaeus)	Lepidoptera: Sphingidae	Caterpillar voraciously feeds on leaves	Minor	4
08.	Spotted flea beetle	*Monolepta signata* Olivier	Coleoptra: Chrysomelidae	Adult feeds leaf	Minor	7
09.	Spider mite	*Tetranychus* sp.	Acarina: Tetranychidae	Nymph and adult suck sap from leaves Start from older to younger leaves	Minor	7

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4.1.5 Insect and mite pests of latikochuin United Kingdom

Three insect pests namely cotton aphid (*Aphis gossypii*), whitefly (*Bemisia tabaci)*, taro caterpillar (*Hippotion celerio*) and one spider mite (*Tetranychus Sp.)* have been reported from United Kingdom (UK) (Table 7). These species are polyphagous infest on several host plant species. They have been reported from other host plants but these species are recored from latikochu and other aroids from elswere.

Table 7.Recorded insect pests of latikochu, their damaging stage(s), infested plant parts and pest status in United Kingdom

Sl. No.	Common name	Scientific name	Order: Family	Infested plant parts	Status	Reference
01.	Cotton aphid	*Aphis gossypii* Glover	Homoptera: Aphididae	Nymph and adult suck sap from both sides of leaves and petioles	Minor, localized	6
02.	Whitefly	*Bemisia tabaci* (Gennadius)	Homoptera: Aleyrodidae	Adult and nymph suck cell sap	Minor	3
03.	Taro caterpillar/ Vine hawkmoth/ Silver striped hawkmoth	*Hippotion celerio* (Linnaeus)	Lepidoptera: Sphingidae	Caterpillar voraciously feeds on leaves	Minor, few occurrence	1, 5
04.	Spider mite	*Tetranychus* sp.	Acarina: Tetranychidae	Nymph and adult suck sap from leaves, start from older to younger leaves	Major	2, 4

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4.2 Diseases of latikochu

Diseases of latikochu are discussed herein and diseases recorded during field survey are shown in Appendices V & XI.

4.3.1 Diseases of latikochu in Bangladesh

Diseases of latikochu in Bangladesh along with the causal organism, status and plant parts infected are shown in Table 8. In total 12 diseaseswere identified, among these seven (7) diseases are caused by fungal pathogens, two (2) caused by bacteria, one caused by virusand two (2) caused by nematodes. Among the fungal diseases, three, namely Leaf blight (*Phytophthora colocasiae* Rae.*)*, Leaf spot (*Phyllosticta* sp.*)* andRhizopus rot (*Rhizopus stolonifer* Sacc.) were commonly found all over surveyed areas. Taro dasheen mosaic (*Dasheen mosaic virus* Zettler), Bacterial Leaf Spot (*Xanthomonas campestris* pv. *dieffenbachiae)* and Root knot disease (*Meloidogyne*spp*.)* was also found commonly in all surveyed areas. The status of all commonly found taro diseases are major and infection found in leaves, stem, root and rhizomes. The status of remaining diseases is minor. Some important disease at latikochu field in Bangladesh observed during field visits are shown in Figure 13.

Table 8. Recorded diseases of latikochu and their status in Bangladesh

Sl. No.	Disease	Pathogen	Status	Plant parts affected	References
01.	Leaf blight	*Phytophthora colocasiae* Rae.	Major	Leaf, stem	1
02.	Leaf spot	*Phyllosticta* sp.Weedon	Major	Leaf	1
03.	Leaf spot	*Cladosporium colocasiae* Sawada	Minor	Leaf	2
04.	Rhizome/corm rot	*Pythium aphanidermatu* Fitzpatrick	Minor	Rhizome/ corm	3
05.	Rhizopus Rot	*Rhizopus stolonifer* Sacc.	Major	Rhizome/ corm	4
06.	Foot rot/ Collar rot	*Sclerotium rolfsii* Sacc.	Minor	Root, collar	4
07.	Rot	*Fusarium solani* Mars.	Minor	Rhizome/ corm	4
08.	Taro dasheen mosaic	*Dasheen mosaic virus* Zettler	Major	Leaf	4
09.	Bacterial leaf spot	*Xanthomonas campestris* pv. *dieffenbachiae*	Major	Leaf	6
10.	Bacterial soft rot	*Erwiniacarotovora* L.R. Jones	Minor	Rhizome	7
11.	Root knot	*Meloidogyne* sp.	Major	Root	5
12.	Root lesion	*Pratylenchus* sp.	Minor	Root	5

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Leaf blight

Leaf spot

Taro dasheen mosaic

Rhizome/ corm rot

Foot rot/ Collar rot

Root knot

Figure 14. Some important diseases of latikochu in Bangladesh.

4.2.2 Diseases of latikochu in India

A total of fourteen (14) taro diseases were recorded in India (Table 9). Out of fourteen, eight (8) diseases are caused by fungal pathogens, two (2) caused by bacteria, viruses and nematodes respectively. Among the fungal diseases, five are major and three minor. Among the major fungal diseases, three fungal diseases namely Leaf blight (*Phytophthora colocasiae* Rae.), Leaf spot (*Phyllosticta* sp.) and Rhizopus rot (*Rhizopus stolonifer* Sacc.), are similar to recorded fungal diseases in Bangladesh. It was also found that one bacterial, viral and nemic disease was also found common in both countries. The status of all commonly found taro diseases are major and infection found in leaves, stem, root and rhizomes (Table 9).

Table 9. Recorded diseases of latikochu and their status in India

Sl.No	Disease	Pathogen	Status	Plant parts affected	References
01	Leaf blight	*Phytophthora colocasiae* Rae.	Major	Leaf, stem	4, 6
02	Rhizome/corm rot	*Pythium aphanidermatu* Fitzpatrick	Major	Rhizome	12
03	Leaf spot	*Phyllosticta* sp.	Major	Leaf	12
04	Leaf spot	*Cladosporium colocasiae* Sawada	Minor	Leaf	12
05	Spongy Black Rot	*Botryodiplodia theobromae* Pat.	Major	Corms	7
06	Black Rot	*Ceratocystis fimbriata* Ell. and HaIst.	Minor	Corms	7
07	Rhizopus dot	*Rhizopus stolonifer* Sacc.	Major	Corms	10
08	Fusarium dry rot	*Fusarium solani* Mars.	Minor	Corms	10
09	Taro dasheen mosaic	*Dasheen mosaic virus* Zettler	Major	Leaf	1, 2, 13
10	Alomae and Bobone	Two bacilliform viruses Gollifer and Brown	Minor	Leaf	4
11	Bacterial leaf spot	*Xanthomonas campestris* pv. *dieffenbachiae*	Major	Leaf	3
12	Bacterial soft rot	*Erwiniacarotovora* L.R. Jones	Minor	Rhizome	3
13	Root knot	*Meloidogyne* sp.	Major	Root	5, 8, 9
14	Root lesion	*Pratylenchus* sp.	Minor	Root	5, 11

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4.2.3 Diseases of latikochu in Myanmar

Out of ten (10) diseases of taro recorded in Myanmar, five (5) are fungal diseases, of them three (3) diseases namely Leaf blight (*Phytophthora colocasiae* Rae.*)*, Leaf spot (*Phyllosticta* sp.) and Rhizopus Rot (*Rhizopus stolonifer* Sacc.), are the major concern for taro cultivation in Myanmar. Other diseases recorded in Myanmar, are caused by bacteria, virus and nematode, and their status are major/minor (Table 10).

Table 10. Recorded diseases of latikochu and their status in Myanmar

Sl.No.	Disease	Pathogen	Status	Plant parts affected	References
01	Leaf blight	*Phytophthora colocasiae* Rae.	Major	Leaf, stem	3, 6,7
02	Rhizome/ Corm rot	*Pythium aphanidermatu* Fitzpatrick	Minor	Rhizome	1,6
03	Leaf spot	*Phyllosticta* sp.	Major	Leaf	3,6
04	Rhizopus rot	*Rhizopus stolonifer* Sacc.	Major	Rhizome	3, 4,7
05	Black rot	*Ceratocystis fimbriata* Ell. and HaIst.	Minor	Corms	3,7
06	Fusarium dry rot	*Fusarium solani* Mars.	Minor	Rhizome	3,6
07	Taro dasheen mosaic	*Dasheen mosaic virus* Zettler	Major	Leaf	2, 5, 8
08	Bacterial leaf spot	*Xanthomonas campestris* pv. *dieffenbachiae*	Major	Leaf	9, 10
09	Bacterial soft rot	*Erwinia carotovora* L.R. Jones	Minor	Rhizome	9, 10
10	Root knot	*Meloidogyne* sp.	Major	Root	5
11	Root lesion	*Pratylenchus* sp.	Minor	Root	5

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4.2.4 Diseases of latikochu in Malaysia

In total ten (10) taro diseases are recorded in Malaysiafrom exploring different sources. Out of recorded diseases, five (5) diseases are caused by fungal pathogens, two (2) caused by bacteria, one caused by virusand two caused by nematodes. Among the fungal diseases, four are major and one minor. Among the major fungal diseases, three fungal diseases namely Leaf blight (*Phytophthora colocasiae* Rae.*)*, Leaf spot (*Phyllosticta* sp. Weedon*)* and Rhizopus rot (*Rhizopus stolonifer* Sacc.), are similar to recorded fungal diseases in Bangladesh. It was also found that among the recorded diseases, one bacterial, viral and nemic disease was also found common in both countries. The status of all commonly found taro diseases are major and infectionwas found in leaves, stem, root and rhizomes (Table 11).

Table 11. Recorded diseases of latikochu and their status in Malaysia

Sl. No.	Disease	Pathogen	Status	Plant parts affected	Reference
01	Leaf blight	*Phytophthora colocasiae* Rae.	Major	Leaf, stem	1, 2, 4
02	Rhizome/ Corm rot	*Pythium aphanidermatu* Fitzpatrick	Major	Rhizome	4, 5
03	Leaf spot	*Phyllosticta* sp.	Major	Leaf	4, 5
04	Rhizopus rot	*Rhizopus stolonifer* Sacc.	Major	Corms	4, 5
05	Fusarium dry rot	*Fusarium solani* Mars.	Minor	Corms	4, 5
06	Taro dasheen mosaic	*Dasheen mosaic virus* Zettler	Major	Leaf	3, 5
07	Bacterial leaf spot	*Xanthomonas campestris* pv. *dieffenbachiae*	Major	Leaf	4, 6, 7
08	Bacterial soft rot	*Erwinia carotovora* L.R. Jones	Minor	Rhizome	4, 6, 7
09	Root knot	*Meloidogyne* sp.	Major	Root	5, 6, 7
10	Root lesion	*Pratylenchus* sp.	Minor	Root	5, 6, 7

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4.2.5 Diseases of latikochu in United Kingdom

In total nine (9) diseases of taro caused by fungi, bacteria, viruses and nematodes are reported from UK. Most of the diseases are caused by fungal pathogens others are caused by bacteria, virus and nematode. Among the diseases five (5) fungal diseases cause economic damage to the crops and placed under major category. The major diseases are Leaf blight (*Phytophthora colocasiae* Rae.*)*, Rhizome/corm rot (*Pythium aphanidermatu* Fitzpatrick), Leaf spot (*Phyllosticta* sp.) and Rhizopus rot (*Rhizopus stolonifer* Sacc.) (Table 12).

Table 12. Recorded diseases of latikochu and their status in United Kingdom

Sl.No.	Disease	Pathogen	Status	Plant parts affected	Reference
01	Leaf blight	*Phytophthora colocasiae* Rae.	Major	Leaf, stem	3, 4, 7
02	Rhizome/ Corm rot	*Pythium aphanidermatu* Fitzpatrick	Major	Rhizome	7,
03	Leaf spot	*Phyllosticta* sp.	Major	Leaf	7,
04	Rhizopus rot	*Rhizopus stolonifera* Sacc.	Major	Corms	7,
05	Fusarium dry rot	*Fusarium solani* Mars.	Minor	Corms	7, 8
06	Taro dasheen mosaic	*Dasheen mosaic virus* Zettler	Major	Leaf	6, 9
07	Bacterial leaf spot	*Xanthomonas campestris* pv. *dieffenbachiae*	Major	Leaf	7, 10
08	Root knot	*Meloidogyne* sp.	Major	Root	5
09	Root lesion	*Pratylenchus* sp.	Minor	Root	5

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4.3 Weeds of Latikochu

Weeds of latikochu are discussed herein and weeds recorded during field survey are shown in Appendices VI& XI.

4.3.1 Weeds of Latikochu in Bangladesh

Altogether 41 weed species representing 22 families are, so far, recorded in latikochu field in Bangladesh (Table 13). The highest number of species (five) was found under the grass family Poaceae followed by Amaranthaceae, Euphorbiaceae, Araceae, Cyperaceae, Asteraceaeand Polygonaceae with three species. Two species were found under each of the families Hydrocharitaceae, Convolvulaceae and Leguminoceae. Out of 41 weed species, 25 were major which distributed under 16 families such as Poaceae, Polygonaceae, Amaranthaceae, Hydrocharitaceae, Convolvulaceae, Euphorbiaceae, Pontederiaceae, Typhaceae, Araceae, Cyperaceae, Portulacaceae, Asteraceae and Poaceae.The major weeds were boro anguli (*Digitarias anguinalis*), gitla ghash (*Paspalum distichum*), arail/ swamp rice (*Leersia hexandra*), choto bishkatali/ water piper weed (*Polygonum hydropiper*), alligator weed/ maloncho (*Alternanthera hiloxeroides),* chanchi *(Alternanthera sessilis),* shak notea/ green amaranth (*Amaranthus viridis*), kata notea/ spiny amaranth (*Amaranthus spinosus*), kolmi shak/ water lettuce (*Ipomoea aquatica*), boro dudhia/ asthma weed (*Euphorbia hirta*), chota dhudhia/ prostate spurge (*Euphorbia parviflora*), greater duckweed (*Spirodela polyrhiza*), nutsedge/ mutha (*Cyperus albostriatus*), nunia shak/ common purslane (*Portulaca oleracea),* helancha/ water cress (*Enhydra fluctuans*) (Table 13). Some important weeds at latikochu field in Bangladesh observed during field visits are shown in Figure 15.

Table 13.Recorded weeds of latikochu and their pest status in Bangladesh

Sl. No.	Common Name	Scientific Name	Family	Status	Reference
01	Boro anguli/ Large crabgrass	*Digitaria sanguinalis*	Poaceae	Major	2
02	Gitla ghash/Water couch	*Paspalum distichum*	Poaceae	Major	3
03	Crowfoot grass	*Dactyloctenium*	Poaceae	Minor	3
04	Arail/ Swamp rice	*Leersia hexandra*	Poaceae	Major	2
05	Choto bishkatali/Water piper weed	*Polygonum hydropiper*	Polygonaceae	Major	4
06	Wild buckwheat/ Tearthunb	*Polygonum Convolvulus*	Polygonaceae	Minor	4
07	Curly dock	*Rumex crispus*	Polygonaceae	Minor	2

Sl. No.	Common Name	Scientific Name	Family	Status	Reference
08	Alligator weed/ Maloncho	*Alternanthera hiloxeroides*	*Amaranthaceae*	Major	9
09	Chanchi	*Alternanthera sessilis*	Amaranthaceae	Major	8
10	Shak notea/Green amaranth	*Amaranthus viridis*	Amaranthaceae	Major	3
11	Kata notea/Spiny amaranth	*Amaranthus spinosus*	Amaranthaceae	Major	3
12	Hydrilla	*Hydrilla verticillata*	Hydrocharitaceae	Minor	6
13	Tape grass	*Vallisneria spiralis*	Hydrocharitaceae	Minor	7
14	Kolmi shak/ Water lettuce	*Ipomoea aquatica*	Convolvulaceae	Major	5,10
15	Field bindweed/ Bindo lota	*Convolvulus arvensis*	Convolvulaceae	Minor	4
16	Boro dudhia/Asthma weed	*Euphorbia hirta*	Euphorbiaceae	Major	3
17	Chota dhudhia/ Prostate spurge	*Euphorbia parviflora*	Euphorbiaceae	Major	2
18	Spotted spurge	*Euphorbia maculata*	Euphorbiaceae	Minor	2
15	Araich/ Sickle pod	*Cassia tora*	Leguminoceae	Minor	4
20	Burclover	*Medicago polymorpha*	Leguminosae	Minor	2
21	Shapla /Water lily	*Nymphaea stellata*	Nymphaeaceae	Minor	6
22	Kochuripana	*Eichhornia crassipes*	Pontederiaceae	Minor	6
23	Caaba	*Typha angustifolia*	Typhaceae	Minor	1
24	Poddo	*Nelumbo nucifera*	Nelumbonaceae	Minor	5
25	Chara	*Chara spp*	Characeae	Minor	1
26	Topa pana	*Pistia stratiotes*	Araceae	Minor	5
27	Duck weed	*Wolffia globosa*	Araceae	Minor	3

Sl. No.	Common Name	Scientific Name	Family	Status	Reference
28	Greater duckweed	Spirodela polyrhiza	Araceae	Major	7
29	Coontail/ hornwort plant	*Ceratophyllum demersum*	Ceratophyllaceae	Minor	1
30	Nutsedge/ mutha	*Cyperusalbostriatus*	Cyperaceae	Major	2
31	Boro chucha/ umbrella sedge	*Cyperus iria*	Cyperaceae	Minor	2
32	Chhota cheich	*Cyperus difformis*	Cyperaceae	Minor	8
33	Nunia shak/ common purslane	*Portulaca oleracea*	Portulacaceae	Major	2
34	Dandelion	*Taraxacumofficinale*	Asteraceae	Minor	7,8
35	Helancha/ Water cress	*Enhydra fluctuans*	Asteraceae	Major	3
36	Sagla gacha /Goat weed	*Ageratum conyzoides*	Asteraceae	Minor	5
37	Potamogeton	*Potamogeton perfoliatus*	Potamogetonaceae	Minor	3
38	Bothua	*Chenopodium album*	Chenopediaceae	Minor	3
39	Kakpaya/ Crowfoot grass	*Dactyloctenium aegyptium*	Poaceae	Major	4
40	Sushni shak/ 4-leaved water clover	*Marsilea quadrifolia*	Marsileaceae	Major	2,5
41	Amrul shak/ Indian sorrel	*Oxalis corniculata*	Oxalidaceae	Major	2

Water spinach

Curly dock

Spotted spurge

Burclever

Nunia shak

Crowfoot grass

Boro dudhia

Chotobishkatali

Duckweed

Mutha

Chara

Kochuripana

Figure 15. Some important weeds in latikochu field in Bangladesh.

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4.3.2 Common weeds of latikochu in India

Association of weed species with latikochu crop in India were collected and tabulated. Information provided in the tables include common name of the weed, scientific name, family, status of individual and references. In India, 27 weed species were recorded in latikochu fields at different regions (Table 14). The weed species represented 12 families. The most predominant family was Poaceae under which 6 different weed species were found. This was followed by family Amaranthaceae, Polygonaceae,Euphorbiaceae, Hydrocharitaceaeand Cyperaceae. Among 27 weed species, 16 species are major concern for the growers.

Table 14. Recorded weeds of latikochu and their pest status in India.

Sl. No.	Common Name	Scientific Name	Family	Status	Reference
01	Shapla/ Dwarf water lily	*Nymphaea stellata*	Nymphaeaceae	Minor	1
02	Poddo	*Nelumbo nucifera*	Nelumbonaceae	Major	6
03	Kochuripana	*Eichhornia crassipes*	Pontederiaceae	Major	2, 10
04	Hydrilla	*Hydrilla verticillata*	Hydrocharitaceae	Major	8, 9
05	Tape grass	*Vallisneria spiralis*	Hydrocharitaceae	Major	5
06	Chara	*Chara* spp	Characeae	Minor	8
07	Kolmi shak / Water spinach	*Ipomoea aquatica*	Convolvulaceae	Major	1
08	Water lettuce	*Pistia stratiotes*	Araceae	Minor	1
09	Duck weed	*Lemna gibba*	Araceae	Major	8
10	Boro anguli/ Large crabgrass	*Digitaria sanguinalis*	Poaceae		
11	Bonno joi/Wild oat	*Avena fatua*	Poaceae	Major	3
12	Gitla ghash/Water couch	*Paspalum distichum*	Poaceae	Major	3
13	Crowfoot grass	*Dactyloctenium* sp.	Poaceae	Minor	3
14	Wild-oat	*Avena fatua*	Poaceae	Major	13
15	Wall barley	*Hordeum murinum*	Poaceae	Major	11,12
16	Coontail	*Ceratophyllum demersum*	Ceratophyllaceae	Major	8
17	Common amaranth	*Amaranthus retroflexus*	Amaranthaceae	Major	14
18	Alligator weed/ Maloncho	*Alternanthera hiloxeroides*	*Amaranthaceae*	Major	9
19	Shak notea/Green amaranth	*Amaranthus viridis*	Amaranthaceae	Major	3

Sl. No.	Common Name	Scientific Name	Family	Status	Reference
20	Kata notea/Spiny amaranth	*Amaranthus spinosus*	Amaranthaceae	Major	3
21	Choto bishkatali/Water piper weed	*Polygonum hydropiper*	Polygonaceae	Major	4
22	Wild buckwheat/ Tearthunb	*Polygonum Convolvulus*	Polygonaceae	Minor	4
23	Curly dock	*Rumex crispus*	Polygonaceae	Minor	2
24	Araich/ Sickle pod	*Cassia tora*	Leguminoceae	Minor	4
25	Burclover	*Medicago polymorpha*	Leguminosae	Minor	2
26	Boro dudhia/Asthma weed	*Euphorbia hirta*	Euphorbiaceae	Major	3
27	Spotted spurge	*Euphorbia maculata*	Euphorbiaceae	Minor	2

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4.3.3 Common weeds of latikochu in Myanmar

In Myanmar 17 weed species representing twelve families reported to occur in latikochu crop field are shown in Table 15. Two weed species were found under the Poaceae, Euphorbiaceae and Cyperaceae family. Each of the rest nine families had only one species. Out of 18 weed species eleven were of major importance. These were *Ageratum conyzoides, Portulaca oleracea, Marsile aquadrifolia, Euphorbia hirta Oxalis corniculata, Euphorbia parviflora, Leersia hexandra, Paspalum distichum, Cyperusiria, Cyperus difformis* and *Alternanthera sessilis*.

Table 15. Recorded weeds of latikochu and their pest status in Myanmar.

Sl. No	Common Name	Scientific Name	Family	Status	Reference
01	Topa pana/ Water lettuce	*Pistia stratiotes*	Araceae	Minor	1,2
02	Kochuripana	*Eichhornia crassipes*	Hydrocharitaceae	Minor	3, 4
03	Sagla gacha/ Goat weed	*Ageratum conyzoides*	Asteraceae	Major	5
04	Nunia shak/ Common purslane	*Portulaca oleracea*	Portulacaceae	Major	6
05	Sushni shak/ 4-leaved water clover	*Marsilea quadrifolia*	Marsileaceae	Major	2,5
06	Amrul shak/Indian sorrel	*Oxalis corniculata*	Oxalidaceae	Major	2
07	Baro dudhia/ Garden spurge	*Euphorbia hirta*	Euphorbiaceae	Major	2
08	Chota dhudhia/ Prostate spurge	*Euphorbia parviflora*	Euphorbiaceae	Major	2
09	Arail/ Swamp rice	*Leersia hexandra*	Poaceae	Major	2
10	Gitla grass/ Joint grass	*Paspalum distichum*	Poaceae	Major	2
11	Boro chucha / Umbrella sedge	*Cyperus iria*	Cyperaceae	Major	2
12	Chhota cheich	*Cyperus difformis*	Cyperaceae	Major	8
13	Ban begun/ Black night shade	*Solanum nigrum*	Solanaceae	Minor	2
14	Chanchi	*Alternanthera sessilis*	Amaranthaceae	Major	8
15	Greater duckweed	*Spirodela polyrhiza*	Araceae	Major	7
16	Poddo	*Nelumbo nucifera*	Nelumbonaceae	Minor	5
17	Chara	*Chara* spp.	Characeae	Minor	2, 9
18	Wall barley	*Hordeum murinum*	Poaceae	Major	9

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4.3.4 Common weeds of latikochu in Malaysia

The weeds of latikochu field recorded in Malaysia are shown in Table 16. Altogether 15 weed species representing twelve families were recorded. Poaceae was the most predominant family included 2 species, which was followed by Euphorbiaceae and Cyperaceae under each had two species. Only one species represented each of the nine families such as Characeae, Hydrocharitaceae, Solanaceae, Amaranthaceae, Asteraceae, Araceae, Oxalidaceae, Portulacaceae, Marsileaceae, Aizoaceae, Commelinaceae, Euphorbiaceae, Malvaceae and Portulacaceae.

Table 16. Recorded weeds of latikochu and their pest status in Malaysia.

SL. No.	Common name	Scientific name	Family	Status	Reference
01	Chara	*Chara* spp	Characeae	Major	2
02	Kochuripana	*Eichhornia crassipes*	Hydrocharitaceae	Minor	3
03	Arail / Swamp rice	*Leersia hexandra*	Poaceae	Major	2
04	Gitla grass/ Joint grass)	*Paspalum distichum*	Poaceae	Major	1
05	Boro chucha/ Umbrella sedge	*Cyperus iria*	Cyperaceae	Major	2
06	Chhota cheich	*Cyperus difformis*	Cyperaceae	Major	1
07	Ban begun/ Black night shade)	*Solanum nigrum*	Solanaceae	Minor	1
08	Chanchi	*Alternanthera sessilis*	Amaranthaceae	Major	1
09	Sagla gacha/ Goat weed	*Ageratum conyzoides*	Asteraceae	Minor	1
10	Nuna shak/ Common purslane	*Portulaca oleracea*	Portulacaceae	Major	1
11	Sushni shak/ Four leaved water clover	*Marsilea quadrifolia*	Marsileaceae	Major	2
12	Amrul shak/ Indian sorrel	*Oxalis corniculata*	Oxalidaceae	Major	2
13	Baro dudhia/ Garden spurge	*Euphorbia hirta*	Euphorbiaceae	Major	2
14	Chota dhudhia/ Prostate spurge	*Euphorbia parviflora*	Euphorbiaceae	Major	2
15	Water lettuce	*Pistia stratiotes*	Araceae	Minor	2

Reference

1. Gupta OP, 1933. Aquatic Weed Management. Today and Tomorrow's Printers and Publications, New Delhi, India. pp. 18-19.
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4.3.5 Weeds of latikochu in United Kingdom (UK)

In United Kingdom information on 19 weed species in latikochu (aroids) representing 13 families and their status were shown in Table 17. Out of 19 weed species 9 were major; The major weeds were distributed under seven families of which family Poaceae had the highest number (5) of major weeds. The major weeds were annual mercury (*Mercurialis annua*), hedge mustard (*Sisymbrium officinale*), wall barley (Hordeum murinum), annual meadowgrass (Poa annua), hemlock (*Conium maculatum*), evening primrose (*Oenothera* spp.) and giant hogweed (*Heracleum mantegazzianum*).

Table 17. Recorded weeds of latikochu and their pest status in UK.

SL. No.	Common name	Scientific name	Family	Status	Reference
01	Annual mercary	*Mercurialis annua*	Euphorbiaceae	Major	1.2
02	Hedge mustard	*Sisymbrium officinale*	Brassicaceae	Major	3, 4
03	Himalayan balsam	*Impatiens glandulifera*	Balsaminaceae	Minor	5
04	Common amaranth	*Amaranthus retroflexus*	Amaranthaceae	Major	6
05	Black nightshad	*Solanum nigrum*	Solanaceae	Minor	7
06	Knot grass	*Polygonum heterophyllum*	Polygonaceae	Minor	8
07	Common chick weed	*Stellaria media*	Caryophyllaceae	Minor	9
08	Wall barley	*Hordeum murinum*	Poaceae	Major	10
09	Wild-oat	*Avena fatua*	Poaceae	Major	11
10	Oxford ragwort	Senecio squalidus	Asteraceae	Major	8
11	Common orache	*Atriplex patula*	Amaranthaceae	Minor	8
12	Common poppy	*Papaver rhoeas*	Papaveraceae	Minor	3
13	Wild raddish	*Raphanus raphanistrum*	Brassicaceae	Minor	12
14	Hairy tear	*Vicia hirsute*	Fabaceae	Minor	13
15	Annual meadowgrass	*Poa annua.*	Poaceae	Major	8
16	Barren brome	*Anisantha sterilis*	Poaceae	Major	14
17	Black grass	*Alopecurus agrestis*	Poaceae	Minor	15,16
18	Hemlock	**Conium maculatum**	Umbelliferae	Major	17
19	Goats beard	*Tragopogon pratensis*	Asteraceae	Minor	8

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5.0 QUARANTINE PESTS OF LATIKOCHU FOR BANGLADESH

Quarantine pests includes insect pests, diseases, weeds and other organisms which are absent in Bangladesh. These organisms are likely to invade in Bangladesh with imported latikochu or other modes of transmission in international trade and transport. Latikochu is exported to Malayasia, Middle East, United Kingdom (UK) and other European countries from Bangladesh. So, there is no chance of introduction of any pest with latikochu form these countries. Moreover, information about pests of latikochu of these countries are not available. Although latikochu is not imported from our neighboring countries (India and Myanmar), it pests may be introduced in Bangladesh from/through various human activities. Therefore, list of quarantine pests of latikochu has been prepared considering the pests of Latikochu in India and Mymanmar.

5.1 Quarantine insect pests

Four species of insect species viz. banana aphid (*Pentalonia nigronervosa*), taro plant hopper (*Tarophagus colocasiae),* thrips (*Caliothrips indicus*) and white scale insect (*Aspidiella hartii*) have been identified as quarantine pests of latikochu (taro) in Bangladesh (Table 18). All of these species have been reported from India and only two species, *Pentalonia nigronervosa* and *Caliothrips indicus* have been reported from Myanmar.

Table 18. List of quarantine insect pests of latikochu in exporting countries and plant parts likely to carry the pests.

Sl. No.	Name of the pests	Scientific name (Order: Family)	Name of the countries form where latikochu introduced in Bangladesh		Plant parts are likely to carry the pests
			India	Myanmar	
01.	Banana aphid	*Pentalonia nigronervosa* Coquerel	Present [3, 4, 7, 9]	Present [1, 3,6, 11]	Nymphs and adults carried with leaves,seedlings/ micropropagated plants, stems (above ground)/ shoots/ trunks / branches
02.	Taro plant hopper	*Tarophagus colocasiae* (Matsumura)	Present [2, 4, 7, 9]	Absent	Spread long distance with infested taro plants, leaves, or petioles
03.	Thrips	*Caliothrips indicus* Bagnall	Present [7, 8, 9]	Present [6, 11]	Carried with infested taro plants, leaves, or petioles
04.	White scale insect	*Aspidiella hartii* (Coquerel)	Present [5, 7, 10]	Absent	Infested stem, roots

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5.2 Quarantine diseases

Altogether three diseases have been identified as quarantine diseasesin two selected taro exporting countries, caused by fungi and viruses, which are absent in Bangladesh. Distribution of the quarantine diseases in both taro exporting countries is shown in Table 19.

Table 19. Quarantine diseases of latikochu for Bangladesh and their distribution in two latikochu exporting countries.

Sl. No.	Name of the Disease	Causal organism/Scientific name	Name of the Exporting Countries from where latikochu introduced in Bangladesh		Plant parts are likely to carry the diseases
			India	Myanmar	
01	Spongy Black Rot	*Botryodiplodia theobromae* Pat.	Present [3]	Absent	Mycelial fragment, sprophoresand sporesmay be carried with rhizome/corm and sucker
02	Black Rot	*Ceratocystis fimbriata* Ell. And HaIst.	Present [3]	Present [2, 4]	Mycelial fragment, sprophores and sporesmay be carried with rhizome/corm and sucker
03	Alomae and Bobone	*Two bacilliform viruses* Gollifer and Brown	Present [1]	Absent	Virus may be carried with leaf, leaf blade and petiole, this virus also may be carried by insect vectors plant hoppers.

Reference

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5.3 Quarantine weeds

Three weed species namely; wall barley (*Hordeum murinum*), wild-oat (*Avena fatua*) and common amaranth (*Amaranthus retroflexus*) have been identified as quarantine weeds of latikochu (Aroid) in Bangladesh (Table 20). These three weeds are absent in Bangladesh and may be introduced from the exporting countries through international trading. The distribution of the quarantine weeds in both the exporting countries is shown in Table 20.

Table 20. List of quarantine weeds of of latikochu in exporting countries and plant parts likely to carry the pests.

SL. No.	Name of the weeds	Scientific name	Family	Name of the countries from where latikochu introduced in Bangladesh		Plant parts to carry latikochu
				India	Myanmar	
1.	Wall barley	*Hordeum murinum*	Poaceae	Present [2]	Present [1]	Seed
2.	Wild-oat	*Avenafatua*	Poaceae	Present [1]	Absent	Seed
3.	Common amaranth	*Amaranthus retroflexus*	Amaranthaceae	Present [3]	Absent	Seed

References

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2. Behrendt S, Hanf M,1979. Grass weeds in world agriculture - Identification in the flowerless state, BASF, Ludwigshafen.

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6. PEST RISK ASSESSMENT

6.1 Insect pests

6.1.1 Banana aphid (*Pentalonia nigronervosa*)

6.1.1.1 Hazard Identification

Scientific name: *Pentalonia nigronervosa* Coquerel, 1859

Other scientific name: *Pentalonia caladii* van der Goot, 1917; *Pentalonia nigronervosa* forma *caladii* Van der Goot, 1917 [3]

Synonym:

Taxonomic tree

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Hemiptera
Suborder: Sternorrhyncha
Unknown: Aphidoidea
Family: Aphididae
Genus: Pentalonia
Species: *Pentalonia nigronervosa*

EPPO Code: PENLNI [7]. This pest is categorized as Quarantine pest in Morocco (2018) and A1 list in Bahrain (2003) [7].

P. nigronervosa is the vector of *Banana bunchy top virus* (BBTV; *Nanoviridae*, *Babuvirus*), the etiological agent of BBTD [8].

Bangladesh status: is not known to be present in Bangladesh [3, 5].

6.1.1.2 Biology

Reproduction in the banana aphid is entirely parthenogenetic (without mating). Females give birth to live female young. Males are not known for this species. The life cycle (nymph to adult) is completed in 9 to 16 days. The adult life span ranges from 8 to 26 days; there could be as many as 30 generations produced per year in Hawaii.

Biology and ecology of *P. nigronervosa*, and results reported are variable. *P. nigronervosa* took a period of 10 to 14 days with an average of 10.6 days to develop to the final nymphal moult. Fecundity was 1-4 nymphs per day. Over 10 days it ranged from 9 to 26 nymphs/aphid, the average being 13.2. The average body length, width and length of hind tibia of adult aphid were 0.507 mm, 0.282 mm and 358.18 microgram m. respectively. Life span of *P. nigronervosa* ranged from 19 to 26 days with an average of 20.3 days [19]. Laboratory studies on the biology of *P. nigronervosa* on cardamom

showed a life cycle of four instars that is completed in 10-15 d with adult longevity of 8-26 d and average offspring per female of 14 [14]. Results obtained by rearing *P. nigronervosa* on banana leaf cuttings in the laboratory determined that the nymphal stage took 8-11 d, with adult longevity of 11-12 d and 22 average offspring per female [12].Reproduction in both studies was viviparous and parthenogenetic. Indeed, the biology of banana aphid is almost exclusively anholocyclic. Sexual morphs have been reported only in India and Nepal [2].

Reported differences in the biology of *P. nigronervosa* may be caused by variations of host plant, agroecological conditions, or species form used for experiments [14]. Two different forms of *P. nigronervosa: P. nigronervosa* f. *typica* have been reported on host plants of the family Musaceae [6] and *P. nigronervosa* f. *caladii* van der Goot as found on Araceae. The biology of *P. nigronervosa* in Hawaii may differ from populations in India because of differences in genotype, climate, or host plant cultivars, among other factors. Temperature regulates the developmental rate of insects and this is an essential component of the intrinsic rate of increase (r) when describing population growth [1, 15]. Studies indicate that the population growth of aphids tends to be highest at temperatures ~25°C and that r is negatively affected by higher and lower temperatures [10]. Ideal temperatures vary, with temperate species generally requiring lower maximal temperatures than species from warmer climates [11]. Results also show that reproductive rates and longevity may have different maximal temperatures for the same species. The highest growth rate of *P. nigronervosa*was at 25^0C [9].

6.1.1.3 Hosts

Besides banana, host plants of *P. nigronervosa* include other members of the family Musaceae, taro (*Colocasia esculenta* Schott), ginger (*Alpinia purpurata* Schum), cardamom (*Elettaria cardamomum* Maton), *Heliconia* spp., *Caladium* spp., *Alpinia* spp., and *Dieffenbachia* spp. [2].

6.1.1.4 Geographic distribution

Pentalonia nigronervosa Coquerel (Hemiptera: Aphididae), the banana aphid, was first described in the 19th century on the island of Reunion, then known as Isle de Bourbon, off Madagascar [4]. Coquerel found this aphid on banana and proposed a new genus for this insect based on its distinctive wing venation. *P. nigronervosa* is now widely distributed and is found in tropical and subtropical regions worldwide and in greenhouses in Europe and North America [2]. Timberlake was the first to record the presence of *P. nigronervosa* in Hawaii in 1924 [20] and currently the most important constraint for banana producers in Hawaii [9]. It is distributed throughout the Africa; Asia: Bhutan, China, India, Indonesia, Israel, Japan, Jordan, Laos, Malaysia, Mymanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, Vietnam; Europe: Germany, Italy, Portugal and Spain; North America: Most part of the North AmericaBermuda, Costa Rica, Cuba, Guadeloupe,Guatemala, Haiti, Jamica, United States; all over South America and Oceania [3].

6.1.1.5 Hazard Identification Conclusion

Considering the facts that *Pentalonia nigronervosa*–

- is not known to be present in Bangladesh [3, 5];
- is potentially economic important to Bangladesh because it is an important pest of latikochu and other aroids in Inida [3, 13, 17] from where latikochu may be introduced to Bangladesh.
- can become established in Bangladesh through imports of latikochu or other plant parts. It has the capability to cause damage by direct feeding and as vectors of the rhabdoviruses Alomae and Bobone to banana [3, 7].

Pentalonia nigronervosa is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

6.1.1.6 Risk Assessment

6.1.1.6.1 Entry assessment

Pentalonia nigronervosa can be transported over long distance with infested plant parts like leaf, stems above ground, shoots [CABI 2021]. Most of the time of its life cycle passes through wingless from. So travel through flying of the adult is not possible. As latikochu and other aroids are not imported in Bangladesh form any other countries of the world, probability of entry of *Pentalonia nigronervosa* by personal carrying of latikochu form India to Bangladesh is **low** due to restriction of human movement across the border.

6.1.1.6.2 Exposure assessment

Pentalonia nigronervosa is a polyphagous pest its major host is banana. Other hosts include the family Musaceae, taro (*Colocasia esculenta* Schott), ginger (*Alpinia purpurata* Schum), cardamom (*Elettaria cardamomum* Maton), *Heliconia* spp., *Caladium* spp., *Alpinia* spp., and*Dieffenbachia* spp. [2].Taro is not a major host of*Pentalonia nigronervosa* but it is grown all over Bangladesh. But its major host, banana is grown year round all over Bangladesh. Introduction of latikochu with personal luggage is not carried long distance. The probability of exposure is **high**.

6.1.1.6.3 Establishment assessment

Pentalonia nigronervosa reproduced entirely parthenogenetic (without mating) and life span of *P. nigronervosa* ranged from 19 to 26 days with an average of 20.3 days [19]. There could be as many as 30 generations produced per year in Hawaii. Nymphs, winged adults male and female, are found normally on the green plant parts, where they feed. *Pentalonia nigronervosa*, the banana aphid, was first described in the 19th century on the island of Reunion, then known as Isle de Bourbon, off Madagascar [4]. Timberlake was the first to record the presence of *P. nigronervosa* in Hawaii in 1924 [20]. It has been established in many countries of the world [3] wherever these plants are grown. The climate of Bangladesh is almost similar to those countries where it has been established. The establishment potential is **high** if it is introduced in Bangladesh with latikochu or other plant materials.

6.1.1.6.4 Determination of likelihood of the pest establishment via this pathway in Bangladesh

Table 1. Which of these descriptions best fit of the pest?

Description	The Establishment Potential is:
• **This pest has established in several new countries in recent years, and** YES – *Pentalonia nigronervosa*has been established in new countries in recent years. It is not a strong flier and may be moved long distances when infested taro plants, leaves, or roots are moved [3]. • **The pathway appears good for this pest to enter Bangladesh and establish**, **and** NO – because latikochu and other aroids are not imported in Bangladesh. Thus, *Pentalonia nigronervosa* may be introduced in Bangladesh with personal carrying of latikochu and other aroids from our neighbouring countries. The pathway is not good for entrance of this pest. • **Its host(s) is fairly common in Bangladesh and the climate is similar to places it is established.** YES– latikochu is not a major	High

crop in Bangladesh and is not widely cultivated throughout the country. Other hosts are also uncommon in Bangladesh but climate is similar to places where *Pentalonia nigronervosa* has been established.	
• Not as above or below	**Moderate**
• This pest has not established in new countries in recent years, and. • The pathway does not appear good for this pest to enter in Bangladesh and establish, and • Its host(s) are not common in Bangladesh and its climate is not similar to places it is established.	Low

6.1.1.7 Consequence Assessment

6.1.1.7.1 Economic

Banana aphids are the pest of taro mainly found in the lower region of the leaf along mid rib. Damage is caused by both nymphs and adults by sucking cell sap. Black shooty molds develop on honey dew secreted by aphids on leaves. Dry condition favours population flair up. *P. nigronervosa* is rarely a serious economic pest of latikochu but it is a serious pest of banana. The feeding damage caused by large colonies can cause blemishes on fruit and reduce their market value of banana [18]. The secretion of honeydew by aphid colonies provides a substrate for sooty mould fungus, which reduce banana yields and market value [16]. The build-up of honeydew around the bases of leaves can also lead to rotting and the death of plants. *P. nigronervosa* is of major economic importance due to it being a vector of *Banana bunchy top virus* (BBTV) in Asia, Africa and Australia.

6.1.1.7.2 Environmental

Pentalonia nigronervosa is not expected to lower biodiversity, disrupt natural communities, or change ecosystem processes. It is not expected to directly affect threatened or endangered species or disrupt critical habitats. It may trigger additional treatment programs for commercial cultivation of latikochu and banana. Banana aphid receives a high impact in this category.

6.1.1.7.3 Determination of consequence of the pest establishing via this pathway in Bangladesh

Table 2. Which of these descriptions best fit of the pest?

Description	Consequence
• **Is this is a serious pest of an important crop for Bangladesh?** YES- *Pentalonia nigronervosa*is rarely a serious economic pest of latikochu [17]. As latikochu is an exported item of Bangladesh and exports many countries Bangladesh will lose export market and foreign currency if this pest is entered and established Bangladesh. • **Is this a serious pest of several important crops for Bangladesh?** YES - it is a serious pest of banana due to it being	**High**

Description	Consequence
a vector of *Banana bunchy top virus* (BBTV) in Asia, Africa and Australia [18].	
• Not as above or below	Moderate
• This pest has not established in new countries in recent years, and. • The pathway does not appear good for this pest to enter in Bangladesh and establish, and • Its host(s) are not common in Bangladesh and its climate is not similar to places it is established.	Low

6.1.1.8 Risk Estimation

Calculation of risk of this pest via this pathway in Bangladesh

Establishment Potential	X	Consequence Potential	=	Risk

Table 3. Calculation of risk

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**

Considering all these *Pentalonia nigronervosa*has been classified as a **potential risk organism** for Bangladesh and **risk management** is justified.

6.1.1.9 Possible risk management and phytosanitary measures

- The spread of *Pentalonia nigronervosa* (and the subsequent spread of virus diseases) can be limited by avoiding international transportation of infested taro plants.
- Locally, only uninfested or disinfected taro stems should be used for crop establishment.
- All plant parts, debris should be free from latikochu.
- Latikochu will be imported from the pest free areas.
- Strictly check in border to prohibit introduction of latikochu through human movement.

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6.1.2 Taro plant hopper (*Tarophagus colocasiae*)

6.1.2.1 Hazard Identification

Common name: Taro plant hopper

Scientific name: *Tarophagus colocasiae* (Matsumura)

Other scientific names: *Delphacodes colocasiae* (Matsumura), *Liburnia colocasiae* Matsumura

Synonym: In 1989, the genus *Tarophagus* was revised based on morphological differences in the male genitalia and other distinguishing characters. The species, *Tarophagus proserpina,* has been splitted into three species: *Tarophagus persephone* (Kirkaldy), *Tarophagus proserpina* (Kirkaldy), and *Tarophagus colocasiae* (Matsumura) [1]. Because of this, some ambiguity exists as to what currently valid species is being described in older literature (before 1989), within which *Tarophagus colocasiae* is identified as *Tarophagus proserpina*. However, each of the three newly delineated species has similar external appearances and host plants, and therefore likely has similar life histories (development and behavior).

Taxonomic tree

Kingdom: Animalia
Phylum: Arthropoda
Subphylum: Hexapoda
Class: Insecta
Order: Homoptera
Suborder: Auchenorrhyncha
Family: Delphacidae
Genus: *Tarophagus*
Species: *Tarophagus colocasiae*

Bangladesh status: is not known to be present in Bangladesh [3, 4].

EPPO Code: TAROCO [*Tarophagus colocasiae* (Matsumura)] [6]. *T. colocasiae* is not listed as a quarantine pest by any other states or nations. However, *Tarophagus proserpina* is listed as a quarantine pest by Japan and Korea and that species may be a synonym of *T. colocasiae*.

6.1.2.2 Biology

There are three stages in the life cycle of *T. colocasiae***,** egg, nymph and adult.

Eggs: Adult females oviposit (lay eggs) within the petioles, or leaf stalks of host plants. It was noted that oviposition sites of *Tarophagus proserpina* (likely *T. colocasiae*) on taro (*Colocasia esculenta*) could easily be recognized by the dark residue of sap that had oozed out from oviposition puncture wounds, and onto the petiole surface [11]. These exudates also reported from the damage associated with *T. colocasiae* on taro plants in Cuba [8]. The eggs themselves are ivory colored, slightly over a millimeter long, and are oriented roughly perpendicular to the petiole surface. Mean incubation time of the eggs under laboratory conditions was found to be around 14 days [11].

Nymphs: After the eggs hatch, *Tarophagus colocasiae* passes through five nymphal (juvenile) stages (called instars), before molting into an adult. The fifth instar takes around five days to develop, while each of the previous four instars each take around three days [11]. Nymphs start out paler than adults and darken as they mature [2]. Like the adults, nymphs have characteristic tibial spurs and are capable of hopping. The juvenile planthoppers are gregarious and feed by inserting their piercing-sucking mouthparts into plant tissue and ingesting the sugar-rich phloem (one of two vascular fluids) that its host plant uses to transport energy. Heavy feeding can cause taro plants to severely yellow and wilt.

Adults: The adults are small (between 2.5 and 4.1 mm or 0.1 and 0.16 in long), and mostly dark brown in color, with white markings on the thorax, just behind the head [9]. Feeding, and consequent damage to the host plant, is much the same as it is for nymphs. Long hind legs provide adults with the ability to jump rapidly to escape predation. Adult males can be identified by ornamentation on the opening of their last abdominal segment, or pygofer, which is a distinctive feature for the genus, *Tarophagus*, and varies between each species [2]. However, given the small size of the planthoppers, a powerful hand lens or microscope is required to distinguish between these slight differences in anatomy. Experts can also distinguish between the species by extracting and comparing differences in the morphology of the male genitalia [1]. However, given that there is only one known species currently present in the continental United States, an aggregation of brown and white planthoppers on taro in Florida could be suspected with reasonable certainty to be *Tarophagus colocasiae*.

6.1.2.3 Hosts

Tarophagus colocasiae is a major pest of plants in the genus Colocasia [9]. *Colocasia esculenta*, or taro, is grown for its edible, starchy tuber in many parts of the world. In the United States, plants from the family Araceae in the genera Colocasia, Alocasia, and Xanthosoma are commonly sold as landscape ornamentals, colloquially known as "elephant ears." Given that caged nymphs were also

reported to survive for twenty-four hours on *Caladium bicolor* (Aiton) Vent., and Xanthosoma sp., among several other plant species, these plants may also be considered potential hosts in Florida [5].

6.1.2.4 Geographic Distribution

Tarophagus colocasiae is widespread in Southeast Asia and the Pacific islands [3]. It has been present in Hawaii since at least 1930. The current distribution of *Tarophagus colocasiae* includes much of mainland and maritime Southeast Asia, as well as islands throughout the Pacific. Specific collection records are present from, but not limited to, Thailand, Taiwan, Indonesia, Borneo, Papua New Guinea, Micronesia, Guam, and Hawaii [2]. It has also reported from India [12,13] and Malayasia [14]. In addition to the recent detection in Florida, the planthopper has also been reported from Cuba and Jamaica in the Caribbean [2]. The initial Florida collection was made in Polk County on taro [9]. However, given that Polk County is landlocked and that the initial detection in Cuba was in December of 2014 [8] slightly prior to the first discovery in Florida, it is possible that this planthopper entered the state somewhere else and spread from there to the center of the state.

6.1.2. 5 Hazard Identification Conclusion

Considering the facts that *T. colocasiae* –

- is not known to be present in Bangladesh [3, 4];
- is potentially economic important to Bangldesh because it is an important pest of latikochu and other aroids in Inida [12, 13] from where latikochu may be introduced to Bangladesh.
- can become established in Bangladesh through imports of latikochu or other plant parts. It has the capability to cause damage by direct feeding and as vectors of the rhabdoviruses Alomae and Bobone to latikochu and other aroids [7].

T. colocasiae is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

6.1.2.6 Risk Assessment

6.1.2.6.1 Entry Assessment

Taro planthoppers may be moved long distances when infested taro plants, leaves, or roots are moved. However, their wings do not fully develop and they are not considered to be good fliers [3]. Latikochu and other aroids are not directly imported in Bangladesh from India and other countries. It may introduce only with the personal carrying of latikochu form India to Bangladesh. The probability of entry through this pathway is moderate.

6.1.2.6.2 Exposure Assessment

Tarophagus colocasiae has limited host range, it is known to feed on taro and related aroids [3]. Moreover, introduction of latikochu with personal luggage is not carried long distance. Moreover latikochu is not a major crop in Bangladesh but grown in everywhere in Bangladesh. The probability of exposure is high.

6.1.2.6.3 Establishment Assessment

Tarophagus colocasiae has high reproductive rates. Latikochu is not a major crop in Bangladesh and it is cultivated in all over Bangladesh. But the environment is similar where ithas been established. *T. colocasiae* is expected to be able to establish wherever these plants are grown. Thus establishment potential of *T. colocasiae* is high.

6.1.2.6.4 Determination of likelihood of the pest establishment via this pathway in Bangladesh

Table 1. Which of these descriptions best fit of the pest?

Description	The Establishment Potential is:
• **This pest has established in several new countries in recent years, and Yes**– It is reported to establish in new countries in recent years. *Tarophagus colocasiae* is not a strong flier and may be moved long distances when infested taro plants, leaves, or roots are moved [3]. • **The pathway appears good for this pest to enter Bangladesh and establish,** and YES– because latikochu and other aroids are not imported in Bangladesh. Thus, *Tarophagus colocasiae* may be introduce in Bangladesh with personal carrying of latikochu and other aroids from our neighbouring countries. The pathway is not good for entrance of this pest. • **Its host(s) is fairly common in Bangladesh and the climate is similar to places it is established.** YES– latikochu is not a major crop in Bangladesh and is not widely cultivated throughout the country. Other hosts are also uncommon in Bangladesh but climate is similar to places where *T. colocasiae* has established.	**High**
• Not as above or below	Moderate
• This pest has not established in new countries in recent years, and. • The pathway does not appear good for this pest to enter in Bangladesh and establish, • Its host(s) are not common in Bangladesh and its climate is not similar to places it is established.	Low

6.1.2.7 Consequence Assessment

6.1.2.7.1 Economic

The planthopper feeds by sucking sap and/or xylem from the plant tissue. Feeding produces honeydew, sooty mold, and necrotic areas on leaves and discoloration of bark on stems. Heavy

infestations may cause stunting and/or wilting of the taro plants [3]. Taro planthopper is also reported to vector alomae and bobone diseases, which are caused by rhabdoviruses, between taro plants [7]. *If Tarophagus colocasiae* were to establish in Bangladesh it would be likely to lower the yield of commercial latikochu and other aroids in farms and gardens. The planthopper would also be likely to increase crop production costs. Latikochu is an exported item of Bangladesh and exports many countries. Bangladesh will lose export market and foreign currency if this pest is entered and established Bangladesh. The economic impact of *Tarophagus colocasiae* is high.

6.1.2.7.2 Environmental

Tarophagus colocasiae is not expected to lower biodiversity, disrupt natural communities, or change ecosystem processes. Taro planthopper is not expected to directly affect threatened or endangered species or disrupt critical habitats. The planthopper may trigger additional treatment programs by gardeners and growers of commercial taro. The planthopper may also significantly impact taro plants in home/urban gardens. Taro planthopper receives a high impact in this category.

6.1.2.7.3 Determination of consequence of the pest establishing via this pathway in Bangladesh

Table 2. Which of these descriptions best fit of the pest?

Description	Consequence
• **Is this is a serious pest of an important crop for Bangladesh?** YES- *Tarophagus colocasiae* is a serious pest of latikochu and other aroids. Taro planthopper is also reported to vector alomae and bobone diseases, which are caused by rhabdoviruses, between taro plants [7]. Latikochu is an exported item of Bangladesh and exports many countries. Bangladesh will lose export market and foreign currency if this pest is entered and established Bangladesh. • **Is this a serious pest of several important crops for Bangladesh?** No- latikcahu and other aroids are not important crops in Bangladesh but have high economic significance as it is an exported product and source of earning foreign currency.	**High**
• Not as above or below	Moderate
• This pest has not established in new countries in recent years, and. • The pathway does not appear good for this pest to enter in Bangladesh and establish, and • Its host(s) are not common in Bangladesh and its climate is not similar to places it is established.	Low

6.1.2.8 Risk Estimation

Calculation of risk of this pest via this pathway in Bangladesh

Establishment Potential	X	Consequence Potential	=	Risk

Table 3. Calculation of risk.

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**

Considering all these *Tarophagus colocasiae* has been classified as a **potential risk organism** for Bangladesh and **risk management** is justified.

6.1.2.9 Possible risk management and phytosanitary measures

- The spread of *Tarophagus colocasiae* (and the subsequent spread of virus diseases) can be limited by avoiding international transportation of infested taro plants.
- Locally, only uninfested or disinfected taro stems should be used for crop establishment.
- All plant parts, debris should be free from latikochu.
- Latikochu will be imported from the pest free areas.
- Strictly check in border to prohibit introduction of latikochu through human movement.

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6.1.3 Thrips (*Caliothrips indicus*)

6.1.3.1 Hazard identification

Common name: Sesbania or Latikochu thrips

Scientific name: *Caliothrips indicus* (Bagnall, 1913)

Other scientific name: *Heliothrips indicus*Bagnall, 1913

Synonym: Onion thrips, black thrips

Taxonomic tree

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

EPPO Code: CALHIN (*Caliothrips indicus*) [5] and it has been included CPPC A1 list.

Bangladesh status: is not known to be present in Bangladesh [3, 4, 5] and *Caliothrips indicus* was not found during official surveys of taro pests at 30 districts in Bangladesh.

6.1.3.2 Biology

Biology of four common thrips pests *Frankliniella schultzei* (Trybom), *Scirtothrips dorsalis* Hood, *Megalurothrips usitatus* (Bagnall) and *Caliothrips indicus* (Bagnall) almost similar.Duration of egg incubation period for *F. schultzei* and *S. dorsalis* was 6-8 days, of larval instars 6-7 days and prepupal and pupal stages 2-4 days. For *C. indicus*, the duration of egg instar was slightly longer, 7-10 days, and was similar to *F. schultzei* and *S. dorsalis* for other development stages. *C. indicus* produced many more progeny than the other two species [**1].** *C. indicus* causes stippling on older leaves.

S. dorsalis goes through five developmental phases: egg, two active larval instars that feed, followed by 2 relatively inactive pupal instars and winged, feeding adults. Eggs are inserted into young and soft tissues of leaves, stems and fruit. The first and second larval stages are found on the green plant parts from which the second stage larvae seek out some sheltered place (leaf litter or crevices of bark) and then pass through two resting stages called propupa and pupa, respectively. Rarely, these occur beneath the calyces of fruits. Winged adults, male and female, are found normally on the green plant parts, where they feed. Eggs are bean-shaped, minute (less than 0.2 mm). The two feeding larval stages are yellow to orange, cigar-shaped and just visible to the naked eye. The pest has no diapause.

Caliothrips indicus is one of the serious pests of Latikochu in Saurashtra region of Gujarat India causing extensive losses. Seven years (1999 to 2005) field studies report indicated that *its*

population was present throughout the year on Latikochu and fluctuated from season to season. However, the intensity was greater during summer followed by rabi and kharif. Further correlation studies between weather parameters and *C. indicus* population revealed that, maximum and minimum temperature showed significant positive correlation morning and evening relative humidity showed significant negative correlation during rabi. In summer, morning and evening relative humidity showed significant negative correlation during kharif, only morning relative humidity showed significant negative correlation while the remaining parameters fail to show any significant correlation with the thrips population [9]. This species is a pest on soybeans, peas, clover and other legumes, sometimes causing considerable yield reduction through feeding damage to leaves in India.

6.1.3.3. Hosts

Major hosts: Onions, garlic, leek, etc., (*Allium*), latikochu (*Arachis hypogaea*) Fabaceae (leguminous plants), soyabean (*Glycine max*) [5].

Minor/ alternate hosts: Grasspea (*Lathyrus sativus*), sesame (*Sesamum indicum*), aubergine (*Solanum melongena*), sorghum (*Sorghum bicolor*), moth beans (*Vigna aconitifolia*), black gram (*Vigna mungo*), mung bean (*Vigna radiata*) [4], aroids [7].

C. indicus was found as a serious pest of some economic crops, especially legumes, during summer in the Punjab. Its host range included a total of 29 cultivated and wild plant species belonging to 11 different families, with the Leguminosae predominating. Seventeen of these hosts are reported for the first time [1]. It is a major pest of Latikochu in India [6, 9, 11].

6.1.3.4 Geographic distribution

India (Delhi, Gujrat [8], Madhya Pradash, Maharashtra, Odisha, Rajasthan, Tamil Nadu) [5] and Thailand [2, 13]. It is widespread in India and reported as a minor pest of taro [7, 12] but major pests of Latikochu [[6, 9, 11]].

6.1.3.5 Hazard identification conclusion

Considering the facts that *C. indicus*–

- is not known to be present in Bangladesh [3, 4, 5];
- is potentially economic important to Bangldesh because it is an important pest of Latikochu [5, 6, 9, 10, 11] and minor pest of taro [8, 12] in India from where latikochu may be introduced in Bangladesh.
- can become established in Bangladesh through introduction of latikochu or Latikochu or other plant parts. It has capability to cause direct economic damage to many valuable cultivated crops other than taro [4].

*C. indicus*is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

6.1.3.6 Risk Assessment

6.1.3.6.1 Entry Assessment

Adult thrips can fly and ensure natural spread within crops. *C. indicus* can be transported over long distance by the horticultural trade with fruits and vegetables, cut flowers, plants for planting of host plants, soil, from countries where *C. indicus* occurs. *C. indicus* inserted eggs into young and soft tissues of leaves, stems and fruit. The first and second larval stages are found on the green plant

parts from which the second stage larvae seek out some sheltered place (leaf litter or crevices of bark) and then pass through two resting stages called prepupa and pupa, respectively. Rarely, these occur beneath the calyces of fruits. Winged adults, male and female, are found normally on the green plant parts, where they feed. Moreover, the lower leaves of the plant are preferred for feeding. As latikochu and other aroids are not imported in Bangladesh form any other countries of the world, probability of entry of *C. indicus* by personal carrying of latikochu form India to Bangladesh is low due to restriction of human movement across the border. So the probability of

6.1.3.6.2 Exposure Assessment

C. indicus is a polyphagous pest which can attack onions, garlic, Latikochu (*Arachis hypogaea*), Fabaceae (leguminous plants), soyabean (*Glycine max*) [4]. Its host range included a total of 29 cultivated and wild plant species belonging to 11 different families, with the Leguminosae predominating [1]. During loading and unloading at different locations, larvae and adults of thrips may be exposed to the environment and attack different host plants. Therefore, the probability of exposure of *C. indicus* in Bangladesh environment is high.

6.1.3.6.3 Establishment Assessment

Hosts of *C. indicus* are fairly common in Bangladesh and transported within the PRA area. Thus, because of the difficulties to detect the pest at low infestation levels and the wide host range, spread by movement of plant material can be extensive. Climate is also similar to places where it is established. The probability of establishment in Bangladesh is high.

6.1.3.6.4 Determination of Likelihood of the Pest Establishment Via This Pathway in Bangladesh

Table 1. Which of these descriptions best fit of the pest?

Description	The Establishment Potential is:
• **This pest has established in several new countries in recent years, and** NO – *C. indicus* is a minor pest of taro [8, 12] but major pests of other important corps in India [6, 7, 8, 10, 11] and is not reported from Myanmar [4, 5]. It has not established in other countries. • **The pathway appears good for this pest to enter Bangladesh and establish, and** NO– Latikochu is not directly imported from India. It may introduce through personal carrying of latikochu from India to Bangladesh. So, the pathway of transportation of thrips through latikochu is not good. • **Its host(s) is fairly common in Bangladesh and the climate is similar to places it is established**. YES –Many hosts are widely distributed and commonly transported within the PRA area. Thus, because of the difficulties to detect the pest at low infestation levels and the wide host range, spread by movement of plant material can be extensive. Climate is also similar to places where it is established.	High

Description	The Establishment Potential is:
• 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 in Bangladesh and establish, and • Its host(s) is not common in Bangladesh and its climate is not similar to places it is established.	Low

6.1.3.7 Consequence Assessment

6.1.3.7.1 Economic

Thrips feeding on base of leaves and leaf petiole, affect plants' cosmetic appearance with morphological deformity but does not cause serious damage in latikochu and aroids [7, 12]. It has been reported as serious pests of many other important crops in different regions of India causing extensive losses [7, 9, 11]. Entry of thrips form any countries will seriously affect exportation of latikochu to different countries as it is one of the exporting item in Bangladesh.

6.1.3.7.2 Environmental

No direct impact on environment of this pest has been reported. Application of chemical insecticides for its management may cause health and environmental hazards.

6.1.3.7.3 Determination of Consequence of the Pest Establishing via this Pathway in Bangladesh

Table 2. Which of these descriptions best fit of the pest?

Description	Consequence
• **Is this is a serious pest of an important crop for Bangladesh?** Yes – Although *C. indicus* is not a serious pest of latikochu it is one of the important exporting vegetables from Bangladesh. So entry of this pest in Bangladesh from any other countries will seriously affect export market. • **Is this a serious pest of several important crops for Bangladesh?** YES-This is also serious pest of several important crops like Latikochu, onion, garlic, soybean in Bangladesh.	**High**
• Not as above or below	Moderate
• This is not likely to be an important pest of common crops grown in Bangladesh.	Low

6.1.3.8 Risk Estimation

Calculation of risk of this pest via this pathway in Bangladesh

Establishment Potential	X	Consequence Potential	=	Risk

Table 3: **Calculation of risk.**

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**

Considering all these *C. indicus* has been classified as a risk organism for Bangladesh and risk management is justified.

3.1.3.9 Possible Risk Management and Phytosanitary Measures

- Planting material of host-plant species of *C. indicus* should be inspected in the growing season previous to shipment and be found free of infestation [4, 5].
- All plant parts, debris should be free from latikochu.
- Latikochu will be imported from the pest free areas.
- Strictly check in border to prohibit introduction of latikochu through human movement.

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6.1.4 White scale (*Aspidiella hartii*)

6.1.4.1 Hazard identification

Common name: White scale

Scientific name: *Aspidiella hartii* (Coquerel 1895)

Other scientific name*:* *Aspidiotus hartii* Coquerel 1895, *Targionia hartii*, *Aspidiotus curcumae* Borchsenius, 1966.

Synonym: Ubi scale, Yam rhizome scale, Yam scale, turmeric root scale [CABI 2020, Tsatsia Jackson 2021]

Taxonomic tree

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Hemiptera
Suborder: Sternorrhyncha
Unknown: Coccoidea
Family: Diaspididae
Genus: *Aspidiella*
Species: *Aspidiella hartii*

EPPO Code: ASPIHA (*Aspidiella hartii*) [5]

Bangladesh status: is not known to be present in Bangladesh [2]

6.1.4.2 Biology

Little is known about the biology of *A. hartii*; apparently reproduction is sexual. It has five stages in life cycle: egg, larva, second-stage larva, pupa and adult [2]. The scale is an armoured species, so-called because it makes a hard covering over its body. This scale has males and females, and the females lay eggs. Armoured scales do not produce honeydew [14].

Eggs: The elongate eggs, with ends equally rounded, are laid within the puparium.

Nymphs: The first stage larvae are active crawlers for a short time before selecting a feeding site. Once feeding begins the waxy protective shield starts to form. The second stage larvae occur after the first molt in which the discarded skin becomes incorporated into the puparium. This stage is similar in appearance to the adult except it does not have the grouped circumgenital glands. The last stage is sometimes referred to as pupae. They have lost all traces of mouth organs and are thus a non-feeding stage. They have rudimentary legs, antennae, wings and stylus (mouth).

Adults: Adults are moderately convex, approximately 1/20 inch in diameter, and brownish-gray with a slight purplish tint. Females are generally circular in shape where males are more oval [18] Females have rudimentary antennae and are unable to move about.

The crawlers are the active stage, walking or blown by wind to new hosts. Once the female settles down to feed, it secretes the round (1-2.5 mm diameter), brownish to brownish-grey waxy covering over its body - the armour. The scale lives beneath it, feeding and breeding. The second-stage male

also settles down to feed and develops a scale cover, which is similar to that of the female but is rounder and slightly smaller. However, it goes through a resting stage, a pupa, and hatches as a tiny mosquito-like insect, with wings. It has no mouthparts so cannot feed. It lives for only a few hours or a few days. Its task is to find females and mate [14].

6.1.4.3 Hosts

A. hartii has been recorded on hosts from the plant family Dioscoreaceae and Zingiberaceae. The species is associated with yams, especially tubers in storage, but also occurs on other root crops, especially Zingiberaceae when grown in proximity with yams [18]. Hosts include species of *Colocasia*, *Curcuma longa, Dioscorea*, *Ipomoea batatas* [12] and *Zingiber*. Main hosts of *A. hartii* are taro (Araceae) [11], turmeric (*Curcuma longa*) [8, 15], Asiatic yam (*Dioscorea esculenta*) [15] and ginger (*Zingiber officinale*) [18].Yams, especially *Dioscorea alata* and *Dioscorea esculenta.* Ginger, taro and turmeric are minor hosts [14].

6.1.4.4 Geographic distribution

A. hartii is present in many countries of world.

Africa: Benin, Côte d'Ivoire, Ghana, Mauritius, Nigeria and Sierra Leone

Asia: India (Karnataka, Kerala, Maharashtra, Tamil Nadu) [6, 8, 15, 11], Philippines [6], Sri Lanka [2].

North America: Antigua and Barbuda, Barbados, Cayman Islands, Dominican Republic, Grenada, Guadeloupe, Haiti, Jamaica, Martinique, Panama, Puerto Rico, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Trinidad and Tobago, U.S. Virgin Islands [2].

Oceania: Federated States of Micronesia, Fiji, Guam, New Caledonia, Papua New Guinea, Solomon Islands, Tonga, Vanuatu, Wallis and Futuna [2].

South America: Ecuador, Galapagos Islands, Venezuela [2].

A. hartii is a tropicopolitan species [18] whose area of origin is not known. It has not been recorded from Europe, and has been eradicated from USA (Hawaii) [7].

6.1.4.5 Hazard identification conclusion

Considering the facts that *A. hartii* –

- is not known to be present in Bangladesh [2, 3];
- is potentially economic important to Bangladesh because it is an important pest of latikochu and other aroids, turmeric, zinger, sweet potato [2, 7, 8, 9] in many countries of the world .
- can become established in Bangladesh through introduction with latikochu or other tuber crops. It has capability to cause direct economic damage to many valuable cultivated crops other than taro [2, 7, 8, 9].

*C. indicus*is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

6.1.4.6 Risk assessment

6.1.4.6.1. Entry Assessment

Aspidiella hartii may be found on latikochu stolon and other aroids and is likely to survive transport on ginger. It is a minor pest of latikcahu and other aroids but major pest of yam, ginger and termic during storage [4]. Only first instar crawlers and male adults are active, which are likely to be dislodged during harvest and processing. Other stages are sessile under a protective scale and unable to move. Adult males do not live for more than a day, so are not likely to be present on imported ginger rhizomes, unless they emerge from pupation during transit. Eggs are laid within the puparium (scale) [9] and may remain intact during processing and transit if not detected. Live Diaspididae scales are difficult to remove with high pressure water spray and a small percentage are likely to remain attached [19]. As Bangladesh does not import latikochu and other aroids form any other countries of the world the probability of entry through this pathway is low.

6.1.4.6.2 Exposure Assessment

Hosts of *Aspidiella hartii* include sweet potato, taro, turmeric and yams [17]. Crawler wandering generally serves to disperse young scales away from the mother onto new growth of the same host, and movement between plants seldom occurs unless such plants are in contact [1]. Diaspid crawlers can only move for short distances, and with great difficulty, across sand or bare soil [1]. The period of crawler mobility is limited by their small energy reserves and need to feed [1] Given the immobility of *Aspidiella hartii* during most of the life stages, the probability of a scale finding a suitable new host is moderate. However, if rhizomes infested with yam scales were planted and established, then the scales would have a high likelihood of having available host plants on which to establish. So the probability of exposure through this pathway is also low.

6.1.4.6.3 Establishment Assessment

The main risk for establishment is posed by the first instar larvae, as they are capable of seeking out suitable hosts over short distances if introduced into the environment. First instar larvae may be blown off the ginger during transport. However, the likelihood of these larvae landing on or near suitable hosts via wind dispersal would be very low. *Aspidiella hartii* is thought to reproduce sexually [17], like most other armoured scales [1], although parthenogenetic reproduction may also occur [Abdulla Koya et al. 1991]. Adult males of sexually reproducing Diaspididae may have flight capability, but are unable to establish populations [10]. Adult males only live for a few hours, so have a limited period in which to find a mate. An imported single gravid female may be all that is necessary to initiate an infestation [1]. However, establishment of a population would require both male and female crawlers to find hosts in close proximity and complete their development, and then for the flying adult male to locate an adult female for mating. Climatic conditions, particularly temperature, humidity and rainfall, influence the rate of development and survival of armoured scale species [1].

6.1.4.6.4 Determination of Likelihood of the Pest Establishment Via This Pathway in Bangladesh

Table 1. Which of these descriptions best fit of the pest?

Description	The Establishment Potential is:
• **This pest has established in several new countries in recent years, and** NO – *C. indicus* is a minor pest of taro but major pests of other corps like ginger, turmeric which are also minor crops in Bangladesh. • **The pathway appears good for this pest to enter Bangladesh and establish, and** NO– Latikochu is not directly imported from India. It may introduce through personal carrying of latikochu from India to Bangladesh. So, the pathway of transportation of thrips through latikochu is not good. • **Its host(s) is fairly common in Bangladesh and the climate is similar to places it is established**. YES – Some of its hosts are widely distributed and commonly transported within the PRA area. Climate is also similar to places where it has been established.	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 in Bangladesh and establish, and • Its host(s) is not common in Bangladesh and its climate is not similar to places it is established.	Low

Consequence Assessment

6.1.4.7.1 Economic impact

The scale insect damages stored yams. Large numbers turn the yams light grey. The scales have long tube-like mouthparts that pierce the skin of the yam tubers and feed on the flesh beneath. The scale insects feed on the phloem of hosts. Feeding damage from individual scales is minor, but large populations may develop, resulting in yellowing, defoliation, reduction in fruit set and loss of plant vigour [9]. Symptoms may not appear on foliage. When large numbers of scales are present the yams become fibrous and this affects their quality. This is a common insect on stored yams in all countries where it is recorded [14]. *Aspidiella hartii* is unlikely to have a significant impact on international trade. The economic impact is low.

6.1.4.7.2 Environmental impact

There is no evidence from areas where this pest is present to indicate it would have significant indirect impacts on the environment or non-commercial activities such as: significant effects on plant communities, environmentally sensitive areas, changes in ecological processes or ecosystem ability, effects on human use, or environmental restoration costs. Potential impacts to plant life are likely to be minor and localized and would not result in discernible changes to plant communities, ecological processes or human recreational uses. The environmental impact is also low.

6.1.4.7.3 Determination of Consequence of the Pest Establishing via this Pathway in Bangladesh

Table 2. Which of these descriptions best fit of the pest?

Description	Consequence
• **Is this is a serious pest of an important crop for Bangladesh?** No – Although *Aspidiella hartii* is not a serious pest of latikochu but it is one of the important exporting vegetables from Bangladesh. So entry of this pest in Bangladesh from any other countries will seriously affect export market. • **Is this a serious pest of several important crops for Bangladesh?** Yes – It is a serious pest of several spices crops in Bangladesh such as ginger, termeric.	High
• Not as above or below	**Moderate**
• This is not likely to be an important pest of common crops grown in Bangladesh.	Low

Risk Estimation

Calculation of risk of this pest via this pathway in Bangladesh

Establishment Potential	**X**	**Consequence Potential**	**=**	**Risk**

Table 3: **Calculation of risk.**

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**

Considering all these *Aspidiella hartii*has been classified as a risk organism for Bangladesh and risk management is justified.

6.1.4.9 Possible Risk Management and Phytosanitary Measures

- Planting material of host-plant species of *Aspidiella hartii* should be inspected in the growing season previous to shipment and be found free of infestation.
- All plant parts, debris should be free from latikochu.
- Latikochu will be imported from the pest free areas.
- Strictly check in border to prohibit introduction of latikochu through human movement.

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6.2 Diseases

6.2.1 Spongy Black Rot (*Botryodiplodia theobromae*)

6.2.1.1 Hazard Identification

Scientific name: *Botryodiplodia theobromae* Pat.1967

Other scientific name: *Lasiodiplodia theobromae* (Pat.) Griffon & Maubl 1967.

Synonym: *Botryosphae riarhodina* (Berk. and Curtis)

Systematic position

Kingdom: Fungi

Division: Eumycota

Sub-division: Ascomycotina

Class: Dothideomycetes

Order: Botryosphaeriales

Family: Botryosphaeriaceae

Genus: *Botryodiplodia*

Species: *Botryodiplodia theobromae*

EPPO Code: EPPO Code: PHYORH [2]. This pest is categorized as Quarantine pest in India (2018) and A1 list in Malaysia.

Bangladesh status: is not known to be present in Bangladesh [1].

6.2.1.2 Biology

More than 20 anamorphs have been linked to *Botryosphaeria*, the most common of whichinclude *Botryodiplodia*, *Diplodia*, *Dothiorella*, *Fusicoccum*, *Lasiodiplodia*, *Macrophoma* and *S phaeropsis* [2]. In recent years there have, however, been a number of suggestions to synonymize some of these taxa. It was concluded that *Fusicoccum* and *Diplodia* were the only two genera that can be validated. These taxa were delineated as having typically hyaline, narrower conidia (normally <10 µm) with thinner walls (<0.5 µm) (*Fusicoccum*), or conidia that are wider (normally more than 10 µm) with thicker walls (0.5-2 µm) and are often pigmented when they age (*Diplodia*) [[3]. More recently, *Dothiorella* was re-erected to accommodate the anamorphs of a group of Botryosphaeriaceae with pigmented conidia (much like *Diplodia*), which already discolored in the pycnidium, and that have teleomorphs with pigmented ascopores (*Dothidotthia*). Despite their morphological similarity to *Diplodia*, *Dothiorella* spp. are more closely related to *Fusicoccum*-like species. A number of the *Fusicoccum*-like species form a *Dichomera* synanamorphwas shown. These multi-, sometimes muriform-, septate spores are sufficiently distinct from traditional views of Botryosphaeriaceaeanamorphs that they could easily be overlooked in targeted endophyte surveys that rely on morphology.

6.2.1.3 Hosts

L. theobromae causes diseases such as dieback, blights, and root rot in a variety of different hosts in tropical and subtropical regions [10]. These include guava, coconut, papaya, and grapevine (*NCBI taxonomy)*.

6.2.1.4 Geographic distribution

A new distribution map is provided for *Lasiodiplodia theobromae* (Pat.) Griffon and Maubl. (Ascomycota: Botryosphaeriales). This species is widespread throughout tropical and subtropical countries on a wide range of hosts. The main hosts include plurivorous plant species. Information is given on the geographical distribution in Europe (Cyprus, France, Germany, Italy, Sicily, Malta, Portugal, Romania, Spain and Switzerland), Asia (Bangladesh, Bhutan, Brunei Darussalam, China, Fujian, Gansu, Guangdong, Guangxi, Hainan, Hong Kong, Hunan, Jiangsu, Sichuan, Zhejiang, Republic of Georgia, India, Indonesia, Irian Jaya, Java, Sumatra, Iran, Israel, Japan, Ryukyu Archipelago, Korea Republic, Laos, Malaysia, Peninsular Malaysia, Sabah, Sarawak, Myanmar, Nepal, Oman, Pakistan, Philippines, Saudi Arabia, Singapore, Sri Lanka, Taiwan, Thailand, Turkey, United Arab Emirates, Vietnam and Yemen), Africa (Algeria, Benin, Burkina Faso, Cameroon, Chad, Comoros, Congo, Congo Democratic Republic, Cote d'Ivoire, Egypt, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Kenya, Libya, Madagascar, Malawi, Mali, Mauritius, Morocco, Mozambique, Niger, Nigeria, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia and Zimbabwe), North America (Canada, Alberta, Manitoba, Quebec, Mexico, USA, Central America and Caribbean (Bahamas, Barbados, Belize, British Virgin islands, Costa Rica, Cuba, Dominica, Dominican Republic, El Salvador, Grenada, Guatemala, Haiti, Honduras, Jamaica, Martinique, Nicaragua, Panama, Puerto Rico, Saint Lucia, Saint Vincent and Grenadines and Trinidad and Tobago), South America (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru and Oceania (American Samoa, Australia, New South Wales, Northern Territory, Queensland, Australia, Fiji, Guam, New Caledonia, New Zealand, Northern Mariana Islands, Papua New Guinea.

6.2.1.5 Hazard Identification Conclusion

Considering the facts that *Botryodiplodia theobromae* –

- is not known to be present in Bangladesh [1],
- is potentially economic important to Bangldesh because it is an important disease in India, Myanmar and other Asian countries. It is a major pest of taro in India [10] from where taro is imported to Bangladesh.
- can become established in Bangladesh through imports of taro or other plant parts It has capability to cause direct economic and ecological damage to many valuable cultivated crops.

B. theobromae is a quarantine disease for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

6.2.1.6 Risk Assessment

6.2.1.6.1 Entry Assessment

Botryodiplodia theobromae is reported to be a seed-borne/corms pathogen. It also causes infection to any above ground parts (leaves, stem and sucker) of taro plant. Corm infection sometimes remains symptomless. The pathogen can survive in the corms for several years. Therefore, there is high probability of entering this organism through this pathway.

6.2.1.6.2 Exposure Assessment

Bangladesh is importing taro from India where the spongy black rothas been reported. Similarly, Sometime taro germplasms are being imported from India and Myanmar from where the diseases has been reported. After entry, the germplasms are transported to different parts of the country. During handling and transport operations of the infected or contaminated plant parts associated with corms there is high risk of spilled and exposed to the environment. Besides, the symptomless corm/sucker might escape and exposed to the environment when sown in the field. Therefore, the probability of exposure of the fungal pathogen to the environment of the PRA area is high.

6.2.1.6.3 Establishment Assessment

The inoculum of *B. theobromae* once exposed to the environment may get its host readily other than the taro plant from the infected rhizomes/corms. Because the inoculum of *B. theobromae* can survive in a variety of different host crops in tropical and subtropical regions [10]. Therefore, the establishment potential of this organism in the PRA area is also high.

6.2.1.6.4 Determination of likelihood of the pest establishment via this pathway in Bangladesh

Table 1. Which of these descriptions best fit of the pest?

Description	The Establishment Potential is:
• **This taro disease has been established in several new countries in recent years, and YES**– It is a native disease of India and established many Asian countries in recent years [10]. This species is widespread throughout tropical and subtropical countries on a wide range of hosts. [10]. • **The pathway appears good for this disease to enter Bangladesh and establish, and YES** - The inoculum of *B. theobromae* are transported with leaves, stems, corms and sucker. It can be transported with cargo and aircraft for long distance. It has been introduced in many new countries with plant trades recently [10]. • **Its host(s) is fairly common in Bangladesh and the climate is similar to places it is established**. **YES** – Many of its major and alternate hosts are common in Bangladesh and climate is also similar to places where it is established like in India.	**High**

Description	The Establishment Potential is:
• 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 in Bangladesh and establish, and • Its host(s) are not common in Bangladesh and its climate is not similar to places it is established	Low

6.2.1.7 Consequence Assessment

6.2.1.7.1 Economic

B.theobromae has the potential to occur in almost all areas where taro are grown. The infection from plant materials has caused yield losses of up to 50-70%, but in India economic losses from infected corms may reach more than 30% [1]. Rhizomes/corms infection by the fungal pathogen can discolor rhizome and become spongy, which can reduce the market value of the tuber crop significantly.

6.2.1.7.2 Environmental

So far, no information is available on direct environmental impact of this fungal pathogen.

6.2.1.7.3 Determination of consequence of the pest establishing via this pathway in Bangladesh

Table 2. Which of these descriptions best fit of the pest?

Description	Consequence
• **Is this is a serious pest of an important crop for Bangladesh? YES**- *B. theobromae* is a serious pest of taro, because now taro is an important crop in Bangaldesh. This fungal pathogen caused serious damage to corms of taro in India [11, 12, 13]. • **Is this a serious pest of several important crops for Bangladesh?** YES-This is a serious pest of several important crops; these include guava, coconut, papaya, and grapevine (*NCBI taxonomy)* for Bangladesh. This species has been documented with a distribution in Asia, Africa, North America and South America and Oceanic regions including the Caribbean nations [11].	**High**
• Not as above or below	Moderate
• This is not likely to be an important pest of common crops grown in Bangladesh.	Low

6.2.1.8 Risk Estimation

Calculation of risk of this pest via this pathway in Bangladesh

Establishment Potential	X	Consequence Potential	=	Risk

Table 3.Calculation of risk.

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

Considereing all these *B.theobromae* been classified as a **potential risk organism** for Bangladesh and **risk management** is justified.

6.2.1.9 Possible risk management and phytosanitary measures

- Planting material of host-plant species of *B. theobromae* should be inspected in the growing season previous to shipment and be found free of infestation.
- Avoid importation of taro leaves, rhizome and sucker or other host plants from countries where *B. theobromae* reported.
- It is relatively easy to detect the *B. theobromae* by inspection or isolation, so the basic requirement is that imported consignments of plants for planting should be free from the disease. Any shipments of fresh plant material from a reported country should be examined thoroughly to detect *B. theobromae after* the consignment has arrived in Bangladesh.

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6.2.2 Black Rot (*Ceratocystis fimbriata)*

6.2.2.1 Hazard Identification

Common name: Black Rot

Scientific name: *Ceratocystis fimbriata* Ell. and HaIst.

Other scientific names: *Ceratocystis fimbriata* Ellis & Halst. (1890), *Endoconidiophora fimbriata*

Synonym: *Ceratocystis moniliformis* f. *coffeae*, *Ceratostomella fimbriata*, *Ophiostoma coffeae* and *Ophiostoma fimbriatum*

Systematic position

Kingdom: Fungi
Division: Eumycota
Sub-division: Ascomycotina
Class: Sordariomycetes
Order: Microascales
Famiy: Ceratocystidaceae
Genus: *Ceratocystis*
Species: *Ceratocystis fimbriata*

Bangladesh status: is not known to be present in Bangladesh [Khalequzzaman 2018].

EPPO Code: CERAFI [5]. This pest is categorized as Quarantine pest in India (2015) and A1 list in Mayanmar (2017).

6.2.2.2 Biology

Although outcrossing is possible, most isolates are self-fertile due to unidirectional mating type switching [13]. Fruiting bodies (perithecia) are produced from the mycelium in culture in about a week. The fungus may be dispersed as fragments of mycelium, conidia, aleurioconidia or ascospores. Aleurioconidia are probably the most common survival units because they are thick-walled and durable, and they probably facilitate survival in soil [1] and in insect frass [7]. The fungus may survive in wood fragments in river water [6] and in the soil (Accordi, 1989) for at least 3 months in the winter. *C. fimbriata* produces a strong fruity odour that varies with the medium. This has been assumed to be an adaptation for dispersal by insects, which are attracted to diseased plants and can become covered with sticky spores if the fungus is sporulating.

Wounds, either natural or from human activities, are important infection courts for all members of the genus Ceratocystis, including *C. fimbriata*. Inoculum may reach an open wound by being blown in the wind in insect frass [7] or by being carried by insects that visit the wound. Nitidulid beetles that feed on fungi and plant sap may be important vectors [8]. Cultivation practices such as pruning may also provide infection courts [11].

6.2.2.3 Hosts

Ceratocystis fimbriata is an ascomycete fungal pathogen. The species as a whole can infect a wide variety of hosts, but particular pathogenic races are host-specific. One example is the Ipomoea form of the fungus, which is specific to sweet potato (*Ipomea batatas*) and wild morning glory.

6.2.2.4 Geographic Distribution

In addition to the published reports, the following specimens are held in the US National Fungus Collections: Mexico (BPI 596218 and 595433), St Vincent and Grenadines (BPI 596219), Massachusetts and Rhode Island, USA (BPI 595868 and 595867, respectively); and there is an accession from Suriname in the American Type Culture Collection (ATTC 14503). Confirmed isolates of C. fimbriata have also been collected from Iowa (on Caryacordiformis), Missouri (on Platanusoccidentalis) and Wisconsin, USA (on C. cordiformis) (TC Harrington, Iowa State University, USA, unpublished data).

Several older reports of C. fimbriata (cited in CMI, 1983) may be erroneous but have been included in the listed distribution. The fungus has been reported as a saprobe on Hevea in Uganda [10] and two reports have suggested it as a pathogen on Hevea in the Congo Democratic Republic [9]. Unverified voucher specimens from Fagus and Larix in the UK are cited in CMI (1983), but Larix is a very unlikely host, and there are no confirmed reports of the fungus from the UK. The report of the fungus on Theobroma in the Philippines [5] was only a tentative identification.

Because of the numerous cryptic species in the *C. fimbriata* complex and the history of human-mediated movement of host-specialized strains around the world [2], it is difficult to know which of the reports of *C. fimbriata* in specific countries are of native populations of C. fimbriata or of exotic populations. For some cases where there is clear evidence that the pathogen was introduced, such as on the ornamental cultivars of Syngonium [12], it appears that the fungus has been restricted to cultivated plants in nurseries or greenhouses. Otherwise, the introduced strains are considered to be invasive populations.

6.2.2.5 Hazard Identification Conclusion

Considering the facts that *Ceratocystis fimbriata* –

- is not known to be present in Bangladesh ;
- is potentially economic important to Bangldesh because it is an important disease of many crops in China, India, Pakistan, Vietnam, Iran, Iraq and other Asian countries), Africa countries, USA, UK. It is a major disease in India [11] from where taro is imported to Bangladesh.
- can become established in Bangladesh through imports of taro or other plant parts It has capability to cause direct economic and ecological damage to many valuable cultivated crops.

C.fimbriata is a **quarantine disease** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

6.2.2.6 Risk Assessment

6.2.2.6.1 Entry Assessment

*Ceratocystis fimbriata*is reported to be a seed-borne/corms pathogen. It also causes infection to any above ground parts (leaves, stem and sucker) of taro plant. Corm infection sometimes remains symptomless. The pathogen can survive in the corms for several years. Therefore, there is high probability of entering this organism through this pathway.

6.2.2.6.2 Exposure Assessment

Bangladesh is importing taro from India where the spongy black rothas been reported. Similarly, Sometime taro germplasms are being imported from India and Myanmar from where the diseases has been reported. After entry, the germplasms are transported to different parts of the country. During handling and transport operations of the infected or contaminated plant parts associated with corms there is high risk of spilled and exposed to the environment. Besides, the symptomless corm/sucker might escape and exposed to the environment when sown in the field. Therefore, the probability of exposure of the fungal pathogen to the environment of the PRA area is high.

6.2.2.6.3 Establishment Assessment

The inoculum of *C.fimbriata* once exposed to the environment maynot get its host readily other than the taro plant from the infected rhizomes/corms. Because, there is clear evidence, the pathogen was introduced and it appears that the fungus has been restricted to cultivated plants. Therefore, the introduced pathogenic race is considered as an invasive population [5]. So the establishment potential of this fungal pathogen in the PRA area is medium.

6.2.2.6.4 Determination of likelihood of the pest establishment via this pathway inBangladesh

Table 1. Which of these descriptions best fit of the pest?

Description	The Establishment Potential is:
• **This taro disease has been established in several new countries in recent years-Yes,** it is not known which country is specific country of native population of *C. fimbriata* or exotic populations. This fungus is reported and established many countries in the world in recent years [3]. • **The pathway appears good for this disease to enter Bangladesh and establish, YES**- The inoculum of *C. fimbriata*are transported with corms and sucker. It can be transported with cargo and aircraft for long distance. It has been introduced in many new countries with plant trades recently [3]. • **Its host(s) is fairly common in Bangladesh and the climate is similar to places it is established**. **YES** –Many of its hosts are common in Bangladesh and climate is also similar to places where it is established like in India.	**High**

Description	The Establishment Potential is:
• Not as above or below	Moderate
• This pest has not been established in new countries in recent years, and • The pathway does not appears good for this pest to enter in Bangladesh and establish, and • Its host(s) are not common in Bangladesh and its climate is not similar to places it is established	Low

6.2.2.7 Consequence Assessment

6.2.2.7.1 Economic

C. fimbriata has the potential to occur in almost all areas where taro are grown. The infection from plant materials has caused yield losses of up to 30%, but in India economic losses from infected corms may reach more than 10-30% [3]. Rhizomes/corms infection by the fungal pathogen can discolor rhizome and become spongy, which can reduce the market value of the tuber crop significantly.

6.2.2.7.2 Environmental

So far, no information is available on direct environmental impact of this fungal pathogen.

6.2.2.7.3 Determination of consequence of the pest establishing via this pathway in Bangladesh

Table 2. Which of these descriptions best fit of the pest?

Description	Consequence
• **Is this is a serious pest of an important crop for Bangladesh? YES**- *C. fimbriata* is a pest of taro, because now taro is an important crop in Bangaldesh. This fungal pathogen caused serious damage to corms of taro in India [3, 11]. • **Is this a serious pest of several important crops for Bangladesh?** YES- This is a serious pest of some specific crops (*NCBI taxonomy)* for Bangladesh. This species has been documented with a distribution in Asia, Africa, North America and South America and Oceanic regions including the Caribbean nations [4].	**High**
• Not as above or below	Moderate
• This is not likely to be an important pest of common crops grown in Bangladesh.	Low

6.8 Risk Estimation

Calculation of risk of this pest via this pathway in Bangladesh

Establishment Potential	X	Consequence Potential	=	Risk

Table 3.Calculation of risk.

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

Considereing all these *C.fimbriata* has been classified as a **potential risk organism** for Bangladesh and **risk management** is justified.

6.2.2.9 Possible risk management and phytosanitary measures

- Planting material of host-plant species of *C. fimbriata* should be inspected in the growing season previous to shipment and be found free of infestation
- Avoid importation of leaves, rhizome, sucker or other host plants from countries where *C. fimbriata* reported.
- It is relatively easy to detect the *C. fimbriata* by inspection or isolation, so the basic requirement is that imported consignments of plants for planting should be free from the disease. Any shipments of fresh plant material from an infested country should be examined thoroughly to detect*C. fimbriata* after the consignment has arrived in Bangladesh.

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6.2.3 Alomae and Bobone (*Bacilliform viruses)*

6.2.3.1 Hazard Identification

Common name: Alomae and Bobone

Scientific name: *Two bacilliform viruses* Gollifer and Brown

Other scientific names: Several viruses have been identified in plants with these diseases, but it is not yet certain which ones is the cause. The viruses associated with these diseases are: *Colocasia bobone disease rhabdovirus* (CBDV); *Taro vein chlorosis rhabdovirus* (TaVCV); *Taro badnvirus* (TaBV); *Dasheen mosaic potyvirus* (DsMV).

Synonym: *Colocasia bobone disease rhabdovirus* (CBDV); *Taro vein chlorosis rhabdo virus* (TaVCV)

Preferred name: Viruses (unclassified)

Bangladesh status: is not known to be present in Bangladesh [BARI, 1982].

EPPO Code: 1VIUUD [EPPO 2007]. This pest is categorized as Quarantine pest in India (2018).

6.2.3.2 Symptoms and life cycle

Plants with *alomae* show a variety of symptoms. The leaves are shorter than normal with distorted leaf blades, but remain green, or they can show stunted young leaves which remain rolled, twisted and pale yellow. Galls may be present on the petioles of the distorted leaves. Soon after the initial symptoms, plants stop producing leaves and gradually die as the plants rot.Plants with *bobone* are similar to *alomae* at first: the leaves remain green, but are stunted, thickened, curled or partly curled, and there are galls, but plants gradually recover.Insects spread the viruses that are found in *alomae* and *bobone*:

- Taro rhabdoviruses are spread by *Tarophagus* species, planthoppers.
- The tenuivirus (as yet unnamed) may be spread by planthoppers.
- *Taro badnavirus* is spread by *Planococcus* and *Pseudococcus* mealybugs.
- Dasheen mosaic is spread by aphids.

The insects suck up the viruses as they feed on diseased plants, and spread the viruses as they move to healthy plants and feed. The viruses are also spread in planting material. Often, the viruses do not show symptoms; in this case they are said to be 'latent'. For instance, most plants examined contain *Taro badnavirus* and *Dasheen mosaic virus* without showing symptoms, or only rarely showing symptoms. However, the viruses inside the plant pass from mother plants to their suckers. In the same way, it is likely that all 'female' taro are infected with the *Colocasiabobone disease rhabdovirus.* Sometimes *bobone* occurs after planting, when plant hoppers are absent. Possibility, stress at planting causes the virus to multiply and then symptoms occur. *Alomae* is also spread in planting material. If infection occurs near harvest, plants may be used for planting the next crop as they still look healthy.

6.2.3.3 Hosts

Colocasia bobone disease virus and Taro vein chlorosis virus have only been recorded from taro (Colocasia esculenta); Taro badnavirus has been recorded from taro, Xanthosoma sagittifolium (tannier) and Alocasia macrorrhizos (giant taro). Dasheen mosaic virus occurs in all the edible aroids (taro, giant taro, giant swamp taro, Xanthosoma), and in many ornamental aroids.

6.2.3.4 Geographic Distribution

Alomae and bobone occur in India. Taro badnavirus and Dasheen mosaic virus are present worldwide. The distribution of the viruses is as follows: i) Colocasiabobone disease rhabdovirus occurs only in Solomon Islands and Papua New Guinea; ii) Taro vein chlorosis virus is recorded in Fiji, Federated States of Micronesia, New Caledonia, Palau, the Philippines, Samoa, Solomon Islands, and Vanuatu; and The undescribed tenuivirus has been recorded from Papua New Guinea and Solomon Islands.

6.2.3.5 Hazard Identification Conclusion

Considering the facts that Alomae and Bobone–

- is not known to be present in Bangladesh;
- is potentially economic important to Bangldesh, because *TaroBacilliform viruses* of Alomae and Bobone are present worldwide. It is a major disease in India [Pacific Pests, Pathogens & Weeds] from where taro is imported to Bangladesh.
- can become established in Bangladesh through imports of taro or other plant parts like leaves, rhizome and suckers. It has capability to cause direct economic and ecological damage to many valuable cultivated crops as well.

Alomae and Boboneis a **quarantine viral disease** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

6.2.3.6 Risk Assessment

6.2.3.6.1 Entry Assessment

Alomae and Bobone caused by two taro Bacilliform viruses. The insects (plant hopper) suck up the viruses as they feed on diseased plants, and spread the viruses as they move to healthy plants and feed. The viruses are also spread in planting material. Often, the viruses do not show symptoms; in this case they are said to be 'latent'. However, the viruses inside the plant pass from mother plants to their suckers. Sometimes *bobone* occurs after planting, when plant hoppers are absent. Possibility, stress at planting causes the virus to multiply and then symptoms occur. *Alomae* is also spread in planting material. If infection occurs near harvest, plants may be used for planting the next crop as they still look healthy. Therefore, there is high probability of entering this organism through this pathway.

6.2.3.6.2 Exposure Assessment

Bangladesh is importingtaro from India where the Alomae and Bobone has been reported. Similarly, Sometime taro germplasms are being imported from India and Myanmar from where the diseases have been reported. After entry, the germplasms are transported to different parts of the country. During handling and transport operations of the infected or contaminated infected plant parts associated with corms there is high risk of spilled and exposed to the environment. Besides, the symptomless corm/sucker might escape and exposed to the environment when sown in the field. Therefore, the probability of exposure of the viruses to the environment of the PRA area is high.

6.2.3.6.3 Establishment Assessment

The strain of Alomae and Bobone viruses once exposed to the environment may not get its host readily other than the plant grown from the infected corms/rhizomes. Because taro is the only known host for this viruses. Therefore, the establishment potential of this organism in the PRA area is medium.

6.2.3.6.4 Determination of likelihood of the pest establishment via this pathway in Bangladesh

Table 1. Which of these descriptions best fit of the pest?

Description	The Establishment Potential is:
• **This pest has established in several new countries in recent years, and** NO – Alomae and Bobone viruses are minor pest of taro [3, 4] and is not reported from Myanmar [5,6]. It has not established in other countries yet. • **The pathway appears good for this pest to enter Bangladesh and establish, and** NO– Latikochu is not directly imported from India. It may introduce through personal carrying of latikochu from India to Bangladesh. So, the pathway of transportation of plant hoppers through latikochu is not good. • **Its host(s) is fairly common in Bangladesh and the climate is similar to places it is established**. YES – Many hosts are widely distributed and commonly transported within the PRA area. Thus, because of the difficulties to detect the pest at low infestation levels and the wide host range, spread by movement of plant material can be extensive. Climate is also similar to places where it is established.	High
• Not as above or below	**Moderate**
• This pest has not been established in new countries in recent years, and • The pathway does not appear good for this pest to enter in Bangladesh and establish, and • Its host(s) are not common in Bangladesh and its climate is not similar to places it is established.	Low

6.2.3.7 Consequence Assessment

6.2.3.7.1 Economic

Alomae and Bobone has the potential to occur in almost all areas where taro are grown. The infection from plant materials and insect vectors, plant hoppers has caused yield losses of up to 100%, but in India economic losses from infected corms may reach more than 80% [3]. Rhizome/corm infection by the viruses can discolor rhizome, which can reduce the market value of the tuber crop significantly.

6.2.3.7.2 Environmental

So far, no information is available on direct environmental impact of the viruses.

6.2.3.7.3 Determination of consequence of the pest establishing via this pathway in Bangladesh

Table 2. Which of these descriptions best fit of the pest?

Description	Consequence
• **Is this is a serious pest of an important crop for Bangladesh?** Yes – Although Alomae and Bobone viruses are not a serious pest of latikochu it is one of the important exporting vegetables from Bangladesh. So entry of this pest in Bangladesh from any other countries will seriously affect export market. • **Is this a serious pest of several important crops for Bangladesh?** No-This is highly host specific only taro major host.	High
• Not as above or below	**Moderate**
• This is not likely to be an important pest of common crops grown in Bangladesh.	Low

6.2.3.8 Risk Estimation

Calculation of risk of this pest via this pathway in Bangladesh

Establishment Potential	**X**	**Consequence Potential**	**=**	**Risk**

Table 3.Calculation of risk.

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

Establishment potential	Consequence potential	Risk rating
Low	Moderate	Low
Low	Low	Low

CALCULATED RISK RATING– Moderate

Considereing all these Alomae and Bobone been classified as a potential risk organism for Bangladesh and risk management is justified.

6.2.3.9 Possible risk management and phytosanitary measures

- Planting material of host-plant species of Alomae and Bobone should be inspected in the growing season previous to shipment and be found free of infestation
- Avoid importation of leaves, rhizome, sucker or other host plants from countries where Alomae and Bobone viral disease is reported.
- The basic requirement is that imported consignments of planting material should be free from the disease. Any shipments of fresh plant material from a reported country should be examined thoroughly to detect *bacilliform viruses* which cause Alomae and Bobone viral disease after the consignment has arrived in Bangladesh.

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6.3 Weeds

6.3.1 Wild-barley *(Hordeum murinum L*inneaus*)*

6.3.1.1 Hazard Identification

Common name: Wild barely

Scientific name: *Hordeum murinum* Linneaus

Other scientific name: No other scientific name [1]

Synonym: Mouse barley, way bentgrass [1]

Taxonomic Tree

Domain: Eukaryota
Kingdom: Plantae
Phylum: Spermatophyta
Subphylum: Angiospermae
Class: Monocotyledonae
Order: Cyperales
Family: Poaceae
Genus: *Hordeum*
Species: *Hordeum murinum*

Bangladesh status: Not present in Bangladesh [5]

EPPO Code: HORMU [11]

6.3.1.2 Biology

Like many common grasses, wall barley seeds tend to germinate in the cool moist conditions of the autumn after shedding [5]. In glasshouse tests, seedlings from seed sown on the soil surface emerged well but the seed was slow to germinate [8]. Seed sown at 2 mm below the surface or at 25 mm deep emerged well but with seed sown at 50, 75 or 100 mm emergence gradually declined. The deeper sown seeds did germinate but failed to emerge. Light was not required for germination. In Petri dish tests with seed maintained under high or low light intensity or in darkness, seed germinated completely in all conditions [4]. Germination was uniformly high in alternating and constant temperatures in darkness and under a ‘safe’ green light [5]. Wall barley flowers from June to July [2].

6.3.1.3 Hosts

Aroids, cowpea, oat, mustard, cassava, tobacco, rice, sugarcane, date-plam, pearl millet and black mustard are the natural main host for this weed. Nigeria it is also recorded as a main weed in upland rice [4].

6.3.1.4 Geographic distribution

Wall barley is an annual grass that occurs on the margins of cultivated fields [1] . It is common in central, southern and eastern England and scattered elsewhere. Distribution of wall barley in the UK is related both to the availability of ruderal habitats and to climate. Frequency decreases with increasing rainfall and with decreasing temperature, although it can cope with increased rainfall if temperatures are higher. In ruderal situations it extends further into cooler wetter regions by taking advantage of features such as the base of house walls where conditions are locally warmer and drier. Wall barley is part of a complex of overlapping sub-species whose centre of distribution is in the Mediterranean region [3]. Sub-species *murinum* is a native annual grass found on waste and rough ground and barish patches in rough grassland in the UK. Sub-species *leporinum* and *glaucum* are introduced casuals. In Australia, ssp. *leporium* and ssp. *glaucum* biotypes have been reported with resistance to paraquat [7]. Among the selected four countries, it is present in India and UK. *Hordeum murinum* has been reported to be present in India and Mayanmar among the neighboring countries to Bangladesh. The weed is widespread in India and Mayanmar. This is also present in most of the countries in Asia, African, Central America and Caribbean and South America [1, 9]

6.3.1.5 Hazard Indentification Conclusion:

Considering the facts that *Hordeum murinum*-

- is not known to be present in Bangladesh;
- is present in India and Mayanmar
- can cause economic damage to the crop
- and the weed seed may be present with rhizomes latikochu or other host species as contaminant; and thus

Hordeum murinum is considered to be a **potential hazard organism** in this risk analysis.

6.3.1.6 Risk Assessment

6.3.1.6.1 Entry Assessment

The weed is reported from India and Mayanmar where Bangladesh receives latikochu There is a possibility of mixing weed seed with latikochu rhizomes ans stolon during harvesting. The probability of entry into Bangladesh along with this commodity is considered as low.

6.3.1.6.2 Exposure Assessment

Once the weed seed entered into Bangladesh it becomes exposed to the nature while transporting.The probability of exposure to the nature is medium.

6.3.1.6.3 Establishment Assessment

The environmental condition in Bangladesh is suitable for the growth of *Hordeum murinum.* The released weed seeds under favorable condition germinate and grow to produce seed, which may be dispersed to other areas through soil or irrigation or rain water and establish in new areas. Therefore the probability of establishment in the PRA area is high.

6.3.1.6.4 Determination of likelihood of the pest establishing via this pathway in Bangladesh

Table 1. Which of these descriptions best fit of the pest?

Description	The Establishment Potential is:
• **This pest has been established in several new countries in recent years,** and Yes- It has been establshid several new countries of the world [1]. • **The pathway appears good for this pest to enter Bangladesh and establish,** and Yes- The pathway is good to enter the weed in Bangladesh [1]. • **Its host(s) are fairly common in Bangladesh and the climate issimilar to places it is established.** YES- The hosts are common and climate is similar where it has been established [11].	**High**
• Not as above or below	Moderate
• This pest has not been established in new countries in recent years • The pathway does not appears good for this pest to enter in Bangladesh and establish, and • Its host(s) are not common in Bangladesh and its climate is not similar to places it is established	Low

6.3.1.7 Consequence Assessment

6.3.1.7.1 Economic Impact

H. murinum is reported as one of the predominant weeds of cassava in India and also the most common principal weed in mustard in India [10]. It is also recorded as a main weed in upland rice [7].This species is a common weed spreading rapidly, disturbed places and finally cause economic loss of crop.

6.3.1.7.2 Environmental Impact

*H.murinum*is a first growing weed. It can reduced native biodiversity, cause modification of successional patterns and negatively impacts agriculture [1].

6.3.1.7.3 Determination of consequence of the pest establishing via this pathway in Bangladesh

Table 2. Which of these descriptions best fit of the pest?

Description	Consequence
• **Is this is a serious pest of an important crop for Bangladesh?** Yes – it is a serious pests of latikochu and other aroids in Bangladesh. • **Is this a serious pest of several important crops for Bangladesh?** YES-This is also serious pest of several important crops like cowpea, oat, mustard, cassava, tobacco, rice, sugarcane in Bangladesh.	**High**
• Not as above or below	Moderate

Description	Consequence
• This is not likely to be an important pest of common crops grown in Bangladesh	Low

6.3.1.8 Risk Estimation

Calculation of risk of this pest via this pathway in Bangladesh.

Establishment Potential X Consequence Potential = Risk

Table 3. Calculation of risk.

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

Considering all these *Hordeum murinum*has been classified as a **potential risk organism** for Bangladesh and **risk management** is justified.

6.3.1.9 Phytosanitary Measures

- Preferably grow the crop for export purpose in areas free from *H. murinum* weed.
- Top cutting of the weed before seed setting.
- Test the samples for the presence of the seed of *H.murinum*. Declare in Phytosanitary certificate that the consignment is free from bedstraw seed.
- Test the sample at the port of entry for the presence of *H.murinum* seed.

References

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6.3.2 Wild oat (*Avena fatua*)

6.3.2.1 Hazard Identification

Common name: Wild oat

Scientific name: *Avena fatua* Linneaus

Other scientific name: *Avena fatua* subsp. *meridionalis*, *Avena sativa* subsp. *fatua* [3]

Synonym: Spring wild oat, spring oat [3]

Taxonomic tree

Domain: Eukaryota
Kingdom: Plantae
Phylum: Spermatophyta
Subphylum: Angiospermae
Class: Monocotyledonae
Order: Cyperales
Family: Poaceae
Genus: *Avena*
Species: *Avena fatua*

Bangladesh status: Not present in Bangladesh [1, 5]

EPPO Code: AVEFA (*Avena fatua*) [3]

6.3.2.2 Biology

Wild-oat flowers from June to October [2] .The first panicles become visible above the cereal crop in early June but flowering and panicle production can continue up until harvest . Wild-oat is normally self-pollinated but up to 12% out-crossing does occur [5]. In the absence of competition a single well-tillered plant could produce up to 2,000 seeds. In a cereal crop, average seed production is 60 seeds per plant but seeds per m^2 may average 9,000 [3]. Spring barley reduced seed number per flower head slightly more than wheat but in spring beans seed numbers were much greater. The average seed number per plant is 138. Seeds become viable around 10 days after fertilization [1]. Wild-oat seeds are shed as they ripen and this occurs over an extended period. The later a crop is harvested the more of the weed seed that is shed on the ground leaving less to contaminate the crop seed. In cereals, up to 66% of wild-oat seeds are shed before crop harvest and 20% are lost during the harvesting process. A further 2.5% of seeds are lost in the chaff and straw and 7.5% remain in the harvested grain.

6.3.2.3 Host

Aroids, latikochu, oat, soybean, upland rice, sugarcane, cowpea, maize [1]

6.3.2.4 Geographic Distribution

Wild-oat is an introduced, annual grass weed of arable, waste and rough ground and roadsides [1, 3, 6]. Among the four selected countries *Avena fatua* is present in India (specially, Maharastra, Manipur, Punjab, Rajasthan, Uttarakhand) UK It has also been reported to present in many countries in Asia specially Bhutan, China, Hongkong Africa, Europe North America, Central America and Caribbean, South America, and Oceania. It is common in most of England especially in the south and east, but scattered elsewhere. Wild-oat is found on all types of arable land, heavy, light, acid and alkaline [4]. It occurs over a wide of range climatic regions but prefers cooler conditions and is a serious annual weed of temperate arable crops [7] Wild oat is a frequent bird seed alien among the selected four countries; it is present in India and UK.

6.3.2.5 Hazard Identification Conclusion

Considering the facts that *Avena fatua*–

- is not known to be present in Bangladesh;
- is present in India
- can cause economic damage to the crop, and
- the weed seed may be present with latikochu or other host species as contaminant; and thus

*Avena fatua*is considered to be a **potential hazard organism** in this risk analysis.

6.3.2.6 Risk Assessment

6.3.2.6.1 Entry Assessment

The weed is reported from India from where Bangladeshi latikochu contaminated with *A. fatua*. As the weed produce profuse seed there is possibility of mixing weed seed with latikochu stolon and rhizomes.The probability of entry into Bangladesh through this pathway is considered as medium.

6.3.2.6.2 Exposure Assessment

Once the weed seed entered into Bangladesh it becomes exposed to the nature while transporting. It also get exposed when contaminated rhizome are sown. The probability of exposure to the nature is high.

6.3.2.6.3 Establishment Assessment

The environmental condition in Bangladesh is suitable for the growth of *A. fatua.* The released weed seeds under favorable condition germinate and grow to produce plant and seed, which may be dispersed to other areas through soil or irrigation or rain water and establish in new areas. Therefore the probability of establishment in the PRA area is high.

6.3.2.6.4 Determination of likelihood of the pest establishing via this pathway in Bangladesh

Table 1. Which of these descriptions best fit of the pest?

Description	The Establishment Potential is:
• **This pest has been established in several new countries in recent years,** and Yes- It has been establshid several new countries of the world [1]. • **The pathway appears good for this pest to enter Bangladesh and establish,** and Yes- The pathway is good to enter the weed in Bangladesh [1]. • **Its host(s) are fairly common in Bangladesh and the climate issimilar to places it is established.** YES- The hosts are common and climate is similar where it has been established [1].	**High**
• Not as above or below	Moderate
• This pest has not been established in new countries in recent years • The pathway does not appears good for this pest to enter in Bangladesh and establish, and • Its host(s) are not common in Bangladesh and its climate is not similar to places it is established	Low

6.3.2.7 Consequence Assessment

6.3.2.7.1 Economic Impact

Crops in which it is reported as a major weed includecotton, cowpeas, maize, oat, Latikochu, sorghum, soyabean, and upland rice [4]. Season long *A. fatua* interference reduced the yield of latikochu [1].

6.3.2.7.2 Environmental impact

Avena fatua is a first growing weed. It can be reduced native biodiversity, cause modification of successional patterns and negatively impacts agriculture [1].

6.3.2.7.3 Determination of consequence of the pest establishing via this pathway in Bangladesh.

Table 2. Which of these descriptions best fit of the pest?

Description	Consequence
• **Is this is a serious pest of an important crop for Bangladesh?** Yes – it is a serious pest of latikochu and other aroids in Bangladesh. • **Is this a serious pest of several important crops for Bangladesh?** YES- This is also serious pest of several important crops like cowpea, oat, mustard, cassava, tobacco, rice, sugarcane, in Bangladesh.	**High**
• Not as above or below	Moderate
• This is not likely to be an important pest of common crops grown in Bangladesh	Low

6.3.2.8 Risk Estimation

Calculation of risk of this pest via this pathway in Bangladesh.

Establishment Potential X Consequence Potential = Risk

Table 3. Calculation of risk.

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

Considering all these *Avena fatua*has been classified as a **potential risk organism** for Bangladesh and **risk management** is justified.

CALCULATED RISK RATING – HIGH

6.3.2.9 Phytosanitary Measures

- Latikochu rhizome used for growing the crop for export purpose should free from *A. fatua* seed.
- Preferably grow the crop for export purpose in areas free from *A. fatua* weed.
- Top cutting of the weed before seed setting.
- Test the samples for the presence of the seed of *A.fatua*.
- Declare in Phytosanitary certificate that the consignment is free from *E.heterophylla*seed.
- Test the sample at the port of entry for the presence of *A.fatua*seed

Reference

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6.3.3 Common amaranth *(Amaranthus retroflexus)*

6.3.3.1 Hazard Identification

Common name: Common amaranth

Scientific name: *Amaranthus retroflexus* Linneaus

Other scientific name: *Amaranthus delilei, Amaranthus spicatus, Amaranthus strictus* [15].

Synonym: Redroot pigweed, carelessweed, redroot [1, 15]

Taxonomic tree

Domain: Eukaryota
Kingdom: Plantae
Phylum: Spermatophyta
Subphylum: Angiospermae
Class: Dicotyledonae
Order: Caryophyllales
Family: Amaranthaceae
Genus: Amaranthus
Species: *Amaranthus retroflexus*

Bangladesh status: Not present in Bangladesh [1]

EPPO Code: AMARE (*Amaranthus retroflexus*) [1, 15]

6.3.3. 2 Biology

Common amaranth flowers from July to September [1, 3]. The date of flowering depends on latitude, and the time to flowering is hastened in short days. The flowers are unisexual and predominantly wind pollinated but some insect pollination can occur. Common amaranth is self-compatible and the flowers are self-pollinated. Seed matures from August to October [5,6]. The minimum time for seed development following fertilization is 30 days [4]. The average seed number per plant is given as 117,400 [7, 9] and 9,254 [8] but a large plant may have 229,175 seeds [10]. Closely spaced plants produced an average of 34,600 seeds per plant [13, 14]. The 1,000 seed weight ranges from 0.340 to 0.439 g. The seeds on plants that matured earlier in the season were found to be significantly heavier than seeds on plants that matured later [2]. Seeds can be retained in the inflorescence overwinter [8, 11, 12].

6.3.3.3 Hosts

Onion, latikochu, oats, aroids, beetroot, rape, peppers, citrus, coffee, carrot, strawberry, soybean, cotton,sunflower, barley, flax, tobacco, pea, beans, millet, rice, rye, potato, sorghum, grapevine, maize [1].

6.3.3.4 Geographic distribution

Among the selected four countries It is present in UK and India It is also present in many countries in Africa, South America, North America, Central America, and Caribbean, Europe and Oceania [1]

6.3.3.5 Hazard Identification Conclusion

Considering the facts that *Amaranthus retroflexus*-

- is not known to be present in Bangladesh;
- It is present in many countries in the world including UK and India
- *retroflexus* is growing in latikochu field and the seed may be associated with latikochu

Amaranthuretroflexus is considered as a **potential hazard organism** in this risk analysis.

6.3.3.6 Risk Assessment

6.3.3.6.1 Entry assessment

Amaranthus retroflexus is grown along with latikochu crop in the field. This weed is produce hugenumber of seeds. During harvesting there is little chance to contaminate latikochu stolon withweed seed. So there is medium probability of entering this organism through this pathway from India.

6.3.3.6.2 Exposure assessment

After entry, the seeds are transported to different parts of the country through rhizome. During handling and transport operations the weed seed may fall on the ground and exposed to the environment. It also exposed to the environment if contaminated imported seeds are sown. Therefore, the probability of exposure of the pathogen to the environment of the PRA area is high.

6.3.3.6.3 Establishment

Once exposed to the environment the seed will germinate under optimum condition. Germinationrequirements are highly variable depending on distribution and local climatic and ecologicalconditions. However, recent studies suggest that germination is stimulated by light and hightemperatures. Therefore the probability establishment of this weed in the PRA area is high.

6.3.3.6.4 Determination of likelihood of the pest establishing via this pathway in Bangladesh

Table 1. Which of these descriptions best fit of the pest?

Description	The Establishment Potential is:
• **This pest has been established in several new countries in recent years,** and Yes- It has been establshid several new countries of the world [1]. • **The pathway appears good for this pest to enter Bangladesh and establish,** and Yes- The pathway is good to enter the weed in Bangladesh [1]. • **Its host(s) are fairly common in Bangladesh and the climate issimilar to places it is established.** YES- The hosts are common and climate is similar where it has been established [1].	**High**
• Not as above or below	Moderate
• This pest has not been established in new countries in recent years • The pathway does not appears good for this pest to enter in Bangladesh and establish, and • Its host(s) are not common in Bangladesh and its climate is not similar to places it is established	Low

6.3.3.7 Consequence Assessment

6.3.3.7.1 Economic Impact

Yield reduction under *A. retroflexus* interference was found. Thus if introduce this weed will cause significant damage to the crops inBangladesh [1].

6.3.3.7.2Environmental impact

Avena fatua can reduced native biodiversity, cause modification of successional patterns and negatively impacts agriculture [1].

Table 2. Which of these descriptions best fit of the pest?

Description	Consequence
• **Is this is a serious pest of an important crop for Bangladesh?** Yes – it is a serious pests of latikochu and other aroids in Bangladesh. • **Is this a serious pest of several important crops for Bangladesh?** YES-This is also serious pest of several important crops like onion, Latikochu soybean, cotton,sunflower, barley, flax, tobacco, pea, beans in Bangladesh [1].	**High**
• Not as above or below	Moderate
• This is not likely to be an important pest of common crops grown in Bangladesh	Low

6.3.3.8 Risk Estimation

Calculation of risk of this pest via this pathway in Bangladesh.

Establishment Potential X Consequence Potential = Risk

CALCULATED RISK RATING – High

6.3.3.9 Phytosanitary Measures

- Rhizomes for growing the crop for export purpose should be free from *A. retroflexus* seed.
- Prevent rhizome production for several consecutive years.
- Top cutting of the weed before seed setting.
- Test the samples for the presence of *A. retroflexus* seed.
- Declare in Phytosanitary certificate that the consignment is free from *A. retroflexus* seed.
- Test the sample at the port of entry for the presence of *A. retroflexus* seed from India origin.

Reference

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7.0 RISK MANAGEMENT

7.1 Risk management options and phytosanitary procedures for the potential pests

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 introduction of latikcahu from India and Myanmar through personal carrying. Plant Quarantine Wing of Bangladesh will consider the risk management measures proposed below is commensurate with the identified risks.

7.1.1 Pre-harvest management options

Various cultural control practices are important to prevent pest's infestation of latikochu during production. Good Agricultural Practices (GAP) should be adopted for the management of various latikochu or taro pests:

7.1.1.1 Field sanitation

Destruction of debris, crop residues, weeds and other alternate hosts and deep summer ploughing; weeding and earthing up in rows should be done 25-30 days after sowing to prevent soil based pupation of insect pests [28].

7.1.1.2 Use of pest resistant varieties

The use of resistant varieties is a common and effective component in reducing pest risk. Cultavation of resistant varieties can reduce thrips damage [14] and use of resistant and tolerant varieties recommended by the State Agricultural Universities of the region for the management of taro and other aroids [30].

Crop rotation

Adoption of proper crop rotation is beneficial in several ways: i. more effective use of residual soil fertility; ii. improved efficiency in controlling certain weeds; and iii. reduction in soil borne disease and nematode problems [7]. Diversify the growing environment by growing a range of different plants or crops; host-finding for aphids will be more difficult than in a monocrop [20].

7.1.1.4 Manuring

Application of well decomposed FYM @ 20-25 tones per hectare or vermicompost @ 12 tons per hectare treated with *Trichoderma* sp. @ 5 kg per hectare for seed / nursery treatment and soil application.

7.1.1.5 Trapping

Setting up yellow/blue traps/ sticky traps 15 cm. above the crop canopy for monitoring and mass trapping of thrips, white fly, aphids @ 25-50 traps per hectare [20] significantly reduce their population in latikochu and other aroids.

7.1.1.6 Biological control

Bio-control agents like predators and parasitoids of various insect pests can be conserved and release in the production field of latikochu. The existing bio-control agents like Spiders, Coccinellids, Syrphid flies etc. must be conserved in the field by avoiding, delaying and reducing the use of

chemical pesticides. Augmentation of the parasitiods like egg parasitoids *Trichogramma* sp., larval parasitoid- *Bracon* sp., *Campoletis chlorideae*, predators like *Chrysopa* sp., *Coccinella* sp. can reduce population of various pests of latikochu in the field [32].

Chemical spray program

Pre-harvest chemical sprays may be used to control pests within production fields when necessary. Chlorpyrifos and acephate foliar sprays have been effective in reducing aphid populations and the attending ants [5,6]. Spraying Imidacloprid, Thiamethoxam, Spinosad, Neem based insecticides like Phytomax or Horticultural soaps and oils and dish washing detergents and water can control the sucking insect pests.

Control of insect pests

Sucking and chewing insects may transmit many diseases. For example the virus disease was found to transmit by aphid and thrips. The control of these insects and the rouging of infected plants as early as possible from the crop filed may prevent spread of diseases in the field.

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 latikochu production. Laboratory testing should be done periodically. Quarantine restrictions may be used to limit spread of insects, mites, diseases and weeds detected.

7.1.2 Post-harvest management options

Sanitization of equipment and storage material

All machinery, transport and storage surfaces that the latikochu will contact should be cleaned and disinfected prior to receiving new ones. 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.

7.1.2.2 Washing and cleaning

After harvest latikochu stolon should be washed. Prewashing in a mild detergent or soap solution, opening tight bracts, followed by a 5 minute dip in an insecticidal soap or soap-pyrethroid combination at the label rate eliminates most aphids [3].

7.1.2 Phytosanitary measures

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. Establishment and maintenance of pest-free areas or production sites should be in compliance with international standards [17].

Hot water treatment

Immersing latikahu stolones, leaves in hot water at 49 degrees Centigrade for 10 minutes kills banana aphids and other pests. This treatment is safe for many commodities, but preconditioning may be required.

Accept only certified planting material

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 seed 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 [15].

Shipments traceable to place of origin in exporting countries

A requirement that latikochu stolon or other parts is packed in containers with identification labels indicating the place of origin, variety and grade is necessary to ensure traceability to each production site.

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 requirements of Bangladesh. If quarantine pests of latikochu with high risk potential are found during inspection, the phytosanitary procedures should be maintained.

Consignments of latikochu from countries where these pests occur should be inspected for symptoms of infestation and those suspected should be observed carefully in order to look for immature stages of insects. EPPO recommends [5] that latikochu should come from an area where pests are not occurred and where routine intensive control measures are applied [19].

Latikochu should be kept in dry condition for maintaining moisture level. Before loading cargo should be cleaned and fumigated with alluminium phosphide or other fumigants for disinfestation.

Ethylene dibromide was previously widely used as a fumigant but is now generally withdrawn because of its carcinogenicity; Fumigation should be done with aluminium phosphide for disinfestation of stolon or infested stolon [6].

Requirement of phytosanitary certification from country of origin

The phytopathological service of the country of origin should ensure that latikochu of the consignment was grown in the vicinity of pests free areas and was inspected by a duly authorized official/phytopathological service and the crops have been produced in areas within the country free from all pests and diseases.

Port-of-entry inspection and treatment

Upon arrival in Bangladesh, each consignment of latikochu should be inspected to detect pests, with export phytosanitary certificate and seed certificate. Sampling of 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.

7.1 Risk Management for specific quarantine insect pests, diseases and weeds of latikochu

Insect and mite pests, diseases organisms and weeds are transported with latikochu. Thus risk management is essential. Manament practices for quarantine pests associated with latikochu trade and transportation are discussed herein.

7.2.1 Risk management for insect pests

Four insect pests of latikochu have been identified as quarantine pests in the present analysis which was found to have significant risk to enter into the PRA area through the present pathway. So, risk management options of these four insect pests have been discussed herein.

7.2.1.1 Management of *Pentalonia nigronervosa*

- The spread of *Pentalonia nigronervosa* (and the subsequent spread of virus diseases) can be limited by avoiding international transportation of infested taro plants.
- Locally, only uninfested or disinfected taro stems should be used for crop establishment.
- All plant parts, debris should be free from latikochu.
- Latikochu will be imported from the pest free areas.
- Strictly check in border to prohibit introduction of latikochu through human movement.

7.2.1.2 Management of *Tarophagus colocasiae*

- The spread of *Tarophagus colocasiae* (and the subsequent spread of virus diseases) can be limited by avoiding international transportation of infested taro plants.
- Locally, only uninfested or disinfected taro stems should be used for crop establishment.
- All plant parts, debris should be free from latikochu.
- Latikochu will be imported from the pest free areas.
- Strictly check in border to prohibit introduction of latikochu through human movement.

7.2.1.3 Management of *Caliothrips indicus*

- Planting material of host-plant species of *C. indicus* should be inspected in the growing season previous to shipment and be found free of infestation [1].
- Movement of latikochu with personal carrying from the neighbouring countries strictly prohibited.
- All plant parts, debris should be free from latikochu stolon or leaves of taro.
- If necessary latikochu will be imported from the pest free areas.

7.2.1.4 Management of *Aspidiella hartii*

- Planting material of host-plant species of *Aspidiella hartii* should be inspected in the growing season previous to shipment and be found free of infestation.
- All plant parts, debris should be free from latikochu.
- Latikochu will be imported from the pest free areas.
- Strictly check in border to prohibit introduction of latikochu through human movement.

7.2.2 Risk management for disease organisms

Three diseases of latikochu have been identified as quarantine diseses in the present analysis which was found to have significant risk to enter into the PRA area through the present pathway. So, risk management options of these three diseases have been discussed herein.

7.2.2.1 Management of *Botryodiplodia theobromae*

- Planting material of host-plant species of *B. theobromae* should be inspected in the growing season previous to shipment and be found free of infestation.
- Avoid importation of taro leaves, rhizome and sucker or other host plants from countries where *B. theobromae*reported.
- It is relatively easy to detect the *B. theobromae* by inspection or isolation, so the basic requirement is that imported consignments of plants for planting should be free from the disease. Any shipments of fresh plant material from reported country should be examined thoroughly to detect *B. theobromae after* the consignment has arrived in Bangladesh.

7.2.2.2 Management of *Ceratocystis fimbrata*

- Planting material of host-plant species of *C. fimbriata* should be inspected in the growing season previous to shipment and be found free of infestation
- Avoid importation of leaves, rhizome, sucker or other host plants from countries where *C. fimbriata* reported.
- It is relatively easy to detect the *C. fimbriata* by inspection or isolation, so the basic requirement is that imported consignments of plants for planting should be free from the disease. Any shipments of fresh plant material from an infested country should be examined thoroughly to detect *C. fimbriata* after the consignment has arrived in Bangladesh.

7.2.2.3 Management of *Alomae and Bobone*

- Planting material of host-plant species of Alomae and Bobone should be inspected in the growing season previous to shipment and be found free of infestation
- Avoid importation of leaves, rhizome, sucker or other host plants from countries where Alomae and Bobone viral disease is reported.
- The basic requirement is that imported consignments of planting material should be free from the disease. Any shipments of fresh plant material from an reported country should be examined thoroughly to detect *bacilliform viruses* which causes Alomae and Bobone viral disease after the consignment has arrived in Bangladesh.

7.2.3 Risk management for weeds

Three weed species namely *Amaranthus retroflexus* L, *Boerhavia diffusa* L. and *Euphorbia geniculata* Ort. were identified as quarantine weeds of latikochu for Bangladesh and all the three possess the potential risk for Bangladesh. Therefore management options of these weed species are presented here.

7.2.3.1 Management of *Amaranthus retroflexus*

- Preferably grow the crop for export purpose in areas free from *H. murinum* weed.
- Top cutting of the weed before seed setting.
- Test the samples for the presence of the seed of *H. murinum*.
- Declare in Phytosanitary certificate that the consignment is free from bedstraw seed.
- Test the sample at the port of entry for the presence of *H. murinum* seed.

7.2.3.2 Management of *Avena fatua*

- Latikochu rhizome used for growing the crop for export purpose should free from *A. fatua* seed.
- Preferably grow the crop for export purpose in areas free from *A. fatua* weed.
- Top cutting of the weed before seed setting.
- Test the samples for the presence of the seed of *A. fatua*.
- Declare in Phytosanitary certificate that the consignment is free from *A. fatua* seed.
- Test the sample at the port of entry for the presence of *A.fatua*seed

7.2.3.3 Management of *Amaranthus retroflexus*

- Rhizomes for growing the crop for export purpose should be free from *A. retroflexus* seed.
- Prevent rhizome production for several consecutive years.
- Top cutting of the weed before seed setting.
- Test the samples for the presence of *A. retroflexus* seed.
- Declare in Phytosanitary certificate that the consignment is free from *A. retroflexus* seed.
- Test the sample at the port of entry for the presence of *A. retroflexus* seed from India origin.

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APPENDICES

Appendix I. Terms of Reference (ToR) for conducting Pest Risk Analysis (PRA) of Latikochu

Terms of Reference

Terms of Reference (TOR) for selecting Consulting Firm for conducting Pest Risk Analysis (PRA) of Aroid (লতিকচু)

1. BACKGROUND

PRA is the process of evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it. The unwanted pests may be introduced into the country through potentialcarriers such as people, commodities and conveyances. For excluding foreign pests, recognition of these risks' measures should be reflected in quarantine legislation to control the movement ofconsignments as a way of protecting plant life and health. All these quarantine policy and riskmanagement measures should be based on risk analysis to minimize the trade barrier. As a contracting party to the International Plant Protection Convention (IPPC) Bangladesh iscommitted to follow the principles and guidelines of the IPPC. One of the main tasks of the contracting party is to conduct pest risk analysis for safeguarding the country's agriculture from entering into the Invasive Alien Species (IAS) that is usually destructive pests. The PRA includes list of pests of specific crops which are usually required for exporting agricultural commodities because on the basis of presence of pests, climate and other criteria importing countries consider importing agricultural commodities from other countries.

Now more than 300 Destructive Insects and Pests are prevailing in the world where Bangladesh is exclusively free from most of these pests. But we are afraid of maintaining such situations because Bangladesh has to import a huge quantity (about 1 crore MT.) of plants and plant products every year. So, we are at the highest risk of entering those destructive pests because these pests are usually brought in along with imported Agricultural commodities. On the contrary Bangladesh has successfully entered in to the highly competitive intemational export market. We are earning a good amount of valuable foreign currency through exporting 10-12 lakhs metrictons of agricultural products. So, to safeguard our agriculture from entering IAS by imported commodities and maintain and develop our market access by fulfilling the importing countries requirement conducting PRA is most essential. Considering this situation, the project will conduct PRA on Aroid (লতিকচু).

2. PROJECT GOAL:

Ensuring food security of the growing population of the country, ensuring social security, increasing the income of the people in the project area, especially in the economically backward areas including char areas, self-employment and increasing sustainable, safe and profitable cropproduction and nutritious development are the main objective of the project.

3. INTERVENTION AND PROJECT DESCRIPTION:

DAE are being implemented many projects for mechanization of farms, agricultural development such as climate change and enhancing knowledge and skills on environment-friendly agriculture. As technology is constantly changing in the age of globalization, TCDP project has been taken up to bring this innovative modern technology to the doorsteps of the farmers. To achieve the objectives of the project, liaison will be maintained with the Ministries, Departments, Research Institute, and stakeholders. The latest technology and advice developed by BARI will be adopted. The experts of the respective organizations will be selected as trainers in the training activities.

Although potato, sweet potato, taro, cassava, and air potato are potential and nutritious crops, their cultivation is not being expanded due to lack of proper initiatives and technical support. If the improved varieties of tuber crop developed by BARI, can be extended to the farmer level, ensuring proper use of production technology, prevention of post-harvest wastage and increase in storage facilities, rural faimers will be able to earn the financial benefits by producing tuber crop. If production increases, the use of tuber crop will also increase and it will require more malnutrition. To meet the food needs of the growing population of the country, we need to increase the production of tuber. As a result of the initiative of the Department of Agricultural Extension, it is expected to increase the cultivation and production of tuber crop in the country to a considerable extent.

4. OBJECTIVES OF THE PRA (PEST RISK ANALYSIS):

The objective of this consulting service is to provide technical assistance to do Pest Risk Analysis of Aroid (latikochu) in Tuber Crops Development Project as identified here to in the scope of work detailed in the subsequent sections. Specifically, the consulting service must achieve the following objectives:

I. To conduct Pest Risk Analysis on Aroid (লতিকচু) and categorize risk as high, medium, low and minimum;
II. To determination of an organism as a pest;
III. To create lists of regulated pests of the above mentioned commodities for the purpose of import regulation;
IV. To recommend appropriate pest risk management and assessment options.

Specific Objectives of the recruitment of a Pest Risk Analysis Consulting Firm are (according to ISPM-11 in the framework of ISPM-2.):

i. Listing of major and minor pests mentioning plant parts affected (Prepare a pest list);
ii. Listing of regulated pests (Quarantine and Non- Quarantine Pests);
iii. Identification and categorization of pests likely to be associated with a pathway;
iv. Determination of pests up to species level;
v. Identification of potentials for entry, establishment and spread of regulated pests;
vi. Identification of probability of survival during transport or storage & transfer of hosts;
vii. Nature of damage;
viii. Identification of probability of pest surviving existing pest management procedures;
ix. Identification of availability of suitable hosts, alternate hosts and vectors in the PRA areas;
x. Identification of potential economic and environmental impacts;
xi. Assessment of potential loss by the pests;
xii. Analysis of uncertainties;
xiii. Identification of management options for control of regulated pests;
xiv. Preparation of report on risk analysis of the pests following the relevant ISPMs;
xv. Identification of host plants and more damaging host plant species if present;
xvi. Identification of Risk management options.
xvii. To detect pest, it is recommended to follow relevant ISPMs where procedures are beingdescribed;
xviii. Perform pest risk analysis and other responsibilities assigned by PD of TCDP.

5. SCOPES OF WORK:

The entire work under this consulting service is planned to focus on the Pest Risk Analysis of the selected commodities (Aroid: লতিকচু) based on ISPM-2 (Framework for pest risk analysis), ISPM-11 (Pest risk analysis for quarantine pests including analysis of environmental risks andliving modified organisms), ISPM-21 (Pest risk analysis for regulated non quarantine pests). Series of consultation meetings with TCDP and other experts will be held by the consultant toupdate the progress and getting feedbacks during the tenure. Draft final report of the PRA shouldbe prepared by the consultant and be presented in the expert meeting for feedback. The constructive suggestions and feedbacks from the interaction workshop must be incorporated inthe final report.

The main elements of documentation are;

- Purpose of the PRA

A. Initiation:

i. Initiation Point:
- Documenting the initiating event and scope
- Defining the pathway
- Identification of the pests
- Identification of an organism not previously

ii. Determination of an organism as Pests
- Identify Plant as pests
- Defining the Biological control agents and other beneficial organisms
- Identify organisms which will be not described
- Defining living modified organisms
- Import organisms in any cases.

iii. Specified the PRA area
- Outline the previous Pest Risk Analysis
- Outline the summary of the initiation.

B. Pest Risk Assessment:

Identification of Previous Risk Assessments: Current Status of Importations, and Pertinent Pest Interceptions (if available).

Pest Categorization: Produce a list of pests of the commodity parent species and thendetermine their quarantine status.

Identification of Potential QuarantinePests: Identify, pests of potential quarantine significance reported to be associated withthe host species in the exporting country/region.

Identification of Quarantine Pests Likely to Follow the Pathway: Determine whichquarantine pests may reasonably be expected to follow the pathway.

Assessment of Consequences of Introduction: for each quarantine pest expected tofollow the pathway, estimate the consequences of introduction.

Assessment introduction Potential: For each quarantine pest expected to follow thepathway, estimate the likelihood of introduction via the pathway.

Assessment of uncertainty for elements: Uncertainty of hazard biology, pest's infestation during travel and transports, control measures in the field.

Conclusion/Phytosanitary Measures: Pest Risk Potential of Quarantine Pests:

Produce a single rating which represents an overall estimate of the risk posed by each quarantine pest. Comment briefly on the meaning of the Pest Risk Potentials for eachquarantine pest. Although this document focuses on risk assessment, the risk assessment risk management stages are interrelated. Accordingly, the risk assessor may occasionally make brief comments regarding risk management options associated with the requested commodity importations.

C. Pest Risk Management

- Risk management in pest risk analysis
- Uncertainties risk management
- Risk mitigation notes

6. METHODOLOGIES

The methodology should be primarily based on information in the national and international context. To gather qualitative information/ data, the consulting firm is expected to use appropriate methodologies to

ensure the expected outputs and objectives of the study are met according to the standards set by IPPC. The Consulting Firm is expected to employ various participatory methodologies that are holistic rather than sectoral to provide lessons to the implementers. Different tools can be used in the conducting Sweet Potato PRA (Pest Risk Analysis) e.g., group discussions, key informant interview, structured questionnaires, surveys, interviews, observations, workshops, meetings, review of the documents, etc.) are expected in an elaborated manner. In the conducting PRA and gathering any information, the different govemment organizations and Upazllla to be included (listed in Table 2) during the data collection process, so that a comprehensive perspective can be captured in conducting PRA. Information for PRA may come from a variety of sources. The provision of official information regarding pest status is an obligation under the IPPC (Art. VIII.lc) facilitated by official contact points (Art. VIII.2).

Sampling plan: Develop of important guideline for determining an organization is pest of Aroid (লতিকচু) with the targeting pests associated with pathway. It will be conducted in projectarea that will be selected by Project Director of TCDP.

Documents Review: Develop review repots for evaluation of any previous PRA reports. Acheck should also be made as to whether pathways, pests or policies have already been subjectedto the PRA process, either nationally or internationally. If a PRA exists, its validity should bechecked as circumstances and information may have changed. The possibility of using a PRA from a similar pathway or pest that may partly or entirely replace the need for a new PRA should also be investigated.

Develop Report: Develop reports to categorization of the pests and economic consequences (including Environmental impact), probability of the introduction and spread all points should be added. (Unacceptable economic impact is described in ISPM No. 5 Glossary of phytosanitary terms, Supplement No. 2: Guidelines on the understanding of potential economic importance and related terms). Pest introduction is comprised of both entry and establishment. Assessing the probability of introduction requires an analysis of each of the pathways with which a pest may be associated from its origin to its establishment in the PRA area. In a PRA initiated by a specific pathway (usually an imported commodity), the probability of pest entry is evaluated for the pathway in question. The probabilities for pest entry associated with other pathways need to be investigated as well. Briefly develop report on probability of entry of a pest, survival duringtransport or storage, transfer to a suitable host & establishment [in order to estimate theprobability of establishment of a pest, reliable biological information (life cycle, host range,epidemiology, survival etc.) should be obtained liom the areas where the pest currently occurs)], availability of suitable hosts, alternate hosts and vectors in the PRA area, Suitability ofenvironment, Cultural practices and control measures, pest effects (direct & indirect), degree ofuncertainty, risk management options and so on which related with the PRA process.

Submission of Final report preparation: The Consulting Firm will prepare the final report after the debriefing session and incorporate feedback from the debriefing and data validationworkshop using the standard reporting template.

7. ACCOUNTABILITY AND SUPPORT

The Consulting Firm will report to the Project Director and close collaboration with PRAConsultant in TCDP project. In addition, the Project Office, field will provide necessary supports and when required. In addition, the Sub Assistant Agriculture Officer (SAAO) and Upazila Agriculture Office will provide essential support in the data collection process at the fieldlevel. Consulting firm will be arranging workshop, monitoring tour, visit to different Quarantine Station, experiment field and so on for the Project Director and related officer.

8. EXPECTED OUTPUT AND THE DELIVERABLES

The consulting firm will be required to submit a short and concise monthly, and a detailed final report towards the end of the assignment to Project Director, TCDP. Besides these reports, theconsulting firm is responsible to produce the following deliverables. The reports developed bythe consulting firm should be submitted to the Project Director, TCDP, first for comment andfinal copies after its comments/suggestions are incorporated.

I. Updated action plan for the contract period - within 2 weeks of the agreement;
II. Provision for amangement of workshop for preparation and finalization of inception report (3 hard copies) - within 4 weeks of the agreement;

III. The completion of PRA process involves monitoring and the visit of phytosanitaryexpert (PRA Consultant, PD, DPD and or any of the Phytosanrtary Expert) to the country and abroad of export to carry out preshipment inspections and or evaluate postharvest treatment technologies and quarantine inspection and certification facilities;
IV. Mid-term draft report (3 hard copies)- within 3 months of the agreement;
V. Liaison with all stakeholders like Research Institutes, Universities and relevant stakeholders is a must for setting up traps, collecting data, interpretation of data, speciesidentification of species report writing and so on
VI. Arrange a validation workshop before submission of final PRA report. Final reportcovering the entire sets of tasks needs to be submitted to TCDP in both hard (200 copieswith binding) and e-copies (flash drive) with images or/and PDF format. The reportshould be prepared in Times New Roman Font with 12 font sizes maintaining 1.5" pagemargin in all sides (top, bottom, left and right).

9. QUALIFICATIONS AND THE EXPERTISE OF CONSULTING FIRMS AND CONSULTANTS

General Qualification of the Firm/firms: The Qualification and experience of the Pest Risk Analysis consulting firm should be as below:

a. The consulting firm should have minimum 05 (Five) years professional experience in the field of conducting consulting services and experience in conducting at least five (5) Pest Risk Analysis (PRA) of the crops;
b. The consulting firm should have at least one specialist of Entomologist, Pathologist, Agronomist (crop science) and Economist. Specialists in Statistics, Ecology Epidemiology &Botany will be given preference;
c. The firm should have experience in management of similar nature of works. Preference will be given to Firm which has PRA experience on Tuber Crops.
d. The firms/ Joint Venture firms meeting above minimum criteria are requested to submit EOI along with company registration, Up-to-date trade license, tax clearance paper, last threeyears" audit reports, annual turnover (minimum 40 lakh taka), bank solvency certificate,credit facility, ISO certificate and company certification. Interested firms are also requested to include a write up about the proposed PRA with their EOI.

Note: i. The consulting firm should not be under a declaration of ineligibility for corrupt, fraudulent, coercivepractices in completing for, or in executing a contract under public fund.
ii. The consulting firm is not insolvent, in receivership, bankrupt or being wound up their business activitie have not been suspended and it is not the subject oflegal proceedings for any ofthe foregoing.
iii. The consulting firm has fulfilled its obligations to pay taxes and social security contribution under therelevant national laws and regulation.

Team Leader: Team leader must be senior level professional with at least 10 years of working experience in the related task with a minimum academic qualification of master degree in therelated field. She must have a proven track record of management, leadership and coordination skills and proven capacit_v to work as Consultant's liaison officer for such service, as well asexperience of quality compliance officer.

Entomologist: Must be senior experts with at least 15 years of working experience in the Entomology related task, holding minimum of master degree in Entomology and received training on Pest Risk Analysis. S/he must have a proven track record of entomological research, extension and training, and have demonstrated technical leadership at national and internationallevels along with management, leadership and coordination skills. The specialists like entomologists should have clear and sound knowledge of detecting and identification of pestspecies and pest host range

Plant Pathologist: Must be senior experts with at least 10 years of working experience in the Flant Pathology related task, holding minimum of master degree in Plant Pathology and received training on Pest Risk Analysis. S/he must have a proven track record of plant pathological research (mycology, bacteriology, bacteriology and virology), extension and training, and have demonstrated technical leadership at national and international levels.

Agronomist: Must be senior expert'with at least 10 years of working experience in the agronomy related task, holding minimum of master degree. S/he must have a proven track recordof agronomy research,

extension and training, and have demonstrated technical leadership atnational and international levels. needed to support the Team's tasks.

Economist: Must be senior expert with at least 10 years of working experience in the economics related task, holding minimum of master degree. S/he must have a proven track record of economy, extension and training, and have demonstrated technical leadership at national and international levels. The Consultant can propose one of the experts to work as team leader and additional human resources (e.g., finance and administration, secretary and logistics, etc.) needed to support the Team's tasks.

Note: a. The above key staff composition and estimated total key staff man-month is Client's estimate at this stage. More detailed and specific requirements need to be defined in the detailed and customized ToRthat will be an outcome of the PRA report. The consultants are advised to assess their own requirement and propose their own staff composition and staff input requirement for efficient performance of their jobas per the Terms of Reference. If the proposed consultant's team is found inadequate or not sufficient during the performance of the services then additional staff shall be provided by the consultant at their own cost.

b. A Technical Proposal shall be considered unsuitable and shall be rejected for further evaluation if itdoes not respond to important aspect of TOR.

10. PHYSICAL FACILITY OF THE CONSULTANT FIRM

It should be noted that the consultant will need to provide all the administrative, technical, professional and support staff needed to carry out their services efficiently. The Consultants will also be responsible for providing all other necessary facilities and logistical support for itsstaff teams engaged, including accommodation, vehicles/transportation, office equipment, field survey and investigation equipment. authentic laboratory testing, communications, utilities,office supplies, training, monitoring tour arrangement, meeting arrangement, workshop arangementand other miscellaneous requirements wherever applicable to render their services.

11. EMPLOYER SUPPORT

The following shall be provided to the Consultant by the Employer/TCD, DAE:

- Access to relevant documents and data available which may be supportive to the Consultant;
- Upazilas and districts selection the PRA area, PD will be done for doing PRA;
- Letter(s) introducing the Consultant wherever required in performing the assignment.

12. WORKING AREA

The expert workers of the consulting firms will collect survey data from areas where Tuber Crops grow and area specified by PD, TCDP. The raw data is required to share nearer Agricultural related office or Institutes. Data will be collected from 30 Upazlla in 29 Districts.Two-Block shall be selected from each Upazila and interviews will be conducted with 10 Farmers from each Block [Considering the importance of work, place (District, Upazilal Bloik) can be changed, which will be done by PD, TCDPI.

The proposed work area is:

Sl. No.bi	District	Upazila	Sl. No.	District	Upazila
01.	Dhaka	Savar	16.	Nogaon	Raninagar
02.	Gazipur	Shripur	17.	Bogra	Shajahanpur
03.	Narsingdi	Shibpur	18.	Rangpur	Mitahapukur
04.	Manikgonj	Singair	19.		Gangachara
05.	Rajbari	Sadar	20.	Panchagohr	Boda
06.	Cumilla	Barura	21.	Khulna	Dumuria
07.	Tangail	Modhupur	22.	Sunamgonj	Bishawmvapur
08.	Sherpur	Nalitabari	23.	Sylhet	Golapgonj
09.	Jamalpur	Madargonj	24.	Habigonj	Nabigonj
10.	Kishorgonj	Kuliarchar	25.	B.Baria	Nabinagor
11.	Mymenshingh	Trishal	26.	Noakhali	Companigonj
12.	Jhenaidah	Sadar	27.	Chattogram	Boalkhali
13.	Joypurhat	Panchbibi	28.	Patuakhali	Kolapara
14.	Madaripur	Kalkini	29.	Barishal	Ujirpur
15.	Chuadanga	Sadar	30.	Shariotpur	Jajira

Table: 1: PRA conducted work area

13. DURATION OF CONTRACT AND INIDICATIVE TIMELINES

The contract will remain valid only for December/ 2021 to Aprill 2022 in the FY 2021-2022 and the client will not be responsible to ensure the payment upon failure of the consultant to complete the assignment within the FY 2021-2022.

Details	Proposed Deadline
Signing of the Contract	As requirement of TCDP as PPR rules & acts
Inception Training/Workshop/Report	within 4 weeks of the agreement
Monitoring Report	within 2 months of the agreement
Progress Monitoring Report	within 3 months of the agreement
Draft Report of the PRA	within 4 months of the agreement
Validation Workshop	within 4 andhalf months of the agreement
End of the assignment and presentation	within 5 months of the agreement

Table: 2: PRA conducted probably time
*** Ifthe work ofPRA starts late due to delay in contract agreement, the name ofcontract deviation month will be changed.
However, in this case the work has to be completed within 5 months.

14. PAYMENT METHOD

The Consultant Firm shall be paid as below:

a. after submission of inception report: up to 10% of the contract amount.
b. after submission of finalized survey instruments, recruitment and training to field staff andapproval of scoping and ToR documents by concerned project: up to 25 % of the contractamount.
c. after submission of midterm report/plans acceptable to the Employer/TCDP: up to 30 %o of thecontract amount.
d. after submission of the final PRA report and accepted by the Employer/TCDP: remaining (fulland final payment) of the contract amount.

15. TAXATION

The consulting firm shall be fully responsible for all taxes imposed by Government ofBangladesh. The firm must be registered in VAT.

16. CONTRACTUAL ARRANGEMENT

The Consultant Firm contract will be with Tuber Crops Development Project, Department ofAgricultural Extension, Govemment of Bangladesh and will be based on a contract agreementconsistent with the PPA 2006 & PPR 2008 guidelines for consultancy services contracts.

17. CONFIDENTIALITY AND COPYRIGHT

All papers shared with the consultant are confidential to the Tuber Crops Development Project (TCDP) and should not be used outside of TCDP without permission. Information received bythe consultant from the TCDP and fields and offices should be treated confidentially. The assessment report will be owned by the TCDP and disseminated as the organizatron sees fit.

Appendix II: List of Varieties of Latikochucrop Released by BARI with Year of Release

Bangladsh Agricultural Resesrch Institute (BARI) so far released six Latikochu varities which are shown below:

Sl. No	Name of Variety	Year of release	Production Sason	Yield (t/ha)
1	BARI Panikochu-1 (Latiraj)	1988	Kharif	Lati:25-30 Rhizome rot:15-20
2	BARI Panikochu-2	2008	Kharif	Lati:25-30 Rhizome rot:18-22
3	BARI Panikochu-3	2008	Kharif	Lati:10-12 Rhizome rot:25-30
4	BARI Panikochu-4	2013	Kharif	Lati:5-8 Rhizome rot:35-45
5	BARI Panikochu-5	2013	Kharif	Lati:5-7 Rhizome rot:40-45
6	BARI Panikochu-5	2017	Kharif	Lati:5-8 Rhizome rot:50-60

Appendix III: Area and Production of Pani and Latikochu, Mukhikochu and Olkochu crops in Bangladesh

Sl. No.	Name of crops	2019-2020		2020-2021		2021-2022	
		Area (ha)	Production (m.t)	Area (ha)	Production (m.t)	Area (ha)	Production (m.t)
1.	Pani and Latikochu	10153	211060	10416	216527	10823	224988
2.	Mukhikochu	13547	209205	13820	213421	14122	218085
3.	Olkochu	2752	66048	2803	67272	2847	68328

Source: Tuber Crops Development Project of DAE.

Appendix IV: Insect pests of latikochu recorded during Field Survey

A field survey on Insect pests of latikochu crop from 30 upazilas of 29 selected districts (Table 1) was done during March-April 2022 using the structured Questionnaire/ Format, recorded data were analyzed, examined with earlier reports and finally the insect pest's status was determined. The data were presented in tabular form of each district showing the insect pests status of the crop of each upazila of the respective districts. Appendix Table 1 showed the detailed report**.**

Appendix Table 1. Insect pests of latikochu in selected 30 Upazilas of 29 districts

Sl. No.	District	Upazila	Variety	Name of Insect pests	Infestation (%)	Distribution 1= Rare 2=Common 3= Widespread	Effect 1=Low 2=Medium 3=High	Status 1=Major 2=Minor
1.	Dhaka	Savar	BARI Panikochu	Caterpillar	5	2	2	1
				Red Mite	6	2	2	1
				Aphid	1	1	1	1
2.	Gazipur	Shripur	Narkeli Panikochu Latiraj	Tarocluster	20	2	2	1
				Caterpillar	30	2	2	1
				Cotton Aphid	10	2	1	1
3.	Narsingdi	Shibpur	Latiraj	Caterpillar	30	2	3	1
				Cotton Aphid	20	2	2	1
4.	Manikgonj	Singair	Latiraj	Aphid	20	2	2	1
				Mite	10	1	1	1
				Caterpillar	10	1	1	2
5.	Rajbari	Sadar	Latiraj	Aphid	10	1	2	1
				Mite	10	2	1	1
				Caterpillar	20	2	2	1
6.	Cumilla	Barura	BARI Panikochu	Caterpillar	10	2	2	1
				Aphid	10	1	2	1
7.	Tangail	Modhupur	Latiraj Panikochy	Caterpillar	20	2	2	1
8.	Sherpur	Nalitabari	Latiraj	Caterpillar	60	2	3	1
9.	Jamalpur	Madargonj	Latiraj Narkeli	Caterpillar	10	1	1	1
				Aphid	10	1	1	1
10.	Kishorgonj	Kuliarchar	Latiraj	Caterpillar	20	2	2	1
				Spider Mite	20	2	2	1
11.	Mymenshingh	Trishal	Latiraj	Caterpillar	20	2	1	1
				Red pumpkin Beetle	10	1	1	1
12.	Jhenaidah	Sadar	Latiraj	Caterpillar	20	2	2	1
				Aphid	10	1	1	2
				Mite	20	2	1	1
13.	Joypurhat	Panchbibi	Latiraj	Whitefly	2	1	1	2
				Taro Armyworm	20	2	2	1
14.	Madaripur	Kalkini	BARI Panikochu	Aphid	15	2	2	1
15.	Chuadanga	Sadar	Latiraj	Aphid	10	1	1	1

Sl. No.	District	Upazila	Variety	Name of Insect pests	Infestation (%)	Distribution 1= Rare 2=Common 3= Widespread	Effect 1=Low 2=Medium 3=High	Status 1=Major 2=Minor
				Mite	10	1	2	1
				Mature Caterpillar	10	1	1	2
16.	Nogaon	Raninagar	Latiraj	Armyworm	10	1	1	1
				Whitefly	2	1	1	2
17.	Bogra	Shajahanpur	Latiraj Panikochu	Taro Armyworm	10	1	1	1
				Whitefly	5	1	1	2
18.	Rangpur	Mithapukur	Latiraj	Taro Armyworm	10	1	1	1
		Gangachara	Latiraj	Taro Armyworm	10	1	1	1
19.	Panchagohr	Boda	Latiraj	Taro Armyworm	5	1	1	1
				Cotton Aphids	10	1	1	2
20.	Khulna	Dumuria	Latiraj	Caterpillar	20	1	1	2
				Aphid	10	1	1	1
				Mite	10	2	1	1
21.	Sunamgonj	Bishawmvapur	BARI Panikochu	Caterpillar	20	2	1	2
				Mite	10	1	1	2
22.	Sylhet	Golapgonj	BARI Panikochu	Leaf Folder	20	2	1	2
				Grasshopper	10	1	1	2
23.	Habigonj	Nabigonj	Latiraj	Caterpillar	20	2	2	2
				Mite	20	2	2	2
24.	B.Baria	Nabinagor	BARI Panikochu	Caterpillar	20	2	2	1
				Mite	10	1	1	1
25.	Noakhali	Companigonj	Deshi Modon 2	Caterpillar	20	2	2	1
				Red Mite	10	1	1	1
26.	Chattogram	Boalkhali	Latiraj	Caterpillar	20	2	2	1
				Aphid	10	1	1	2
				Mite	10	2	1	2
27.	Patuakhali	Kolapara	BARI Panikochu	Aphid	1	2	1	1
28.	Barishal	Ujirpur	BARI Panikochu	Aphid	1	2	1	-
29.	Shariotpur	Jajira	BARI Panikochu	Aphid	1	1	1	1
				Mite	2	2	2	1

Appendix V: Diseases of latikochu recorded during Field Survey

A field survey on diseases of latikochu crop from 30 upazilas of 29 selected districts (Table 1) was done during March-April 2022 using the structured Questionnaire/ Format, recorded data were analyzed, examined with earlier reports and finally the diseases status was determined. The data were presented in tabular form of each district showing the diseases status of the crop of each upazila of the respective districts. Appendix Table 2 showed the detailed report**.**

Appendix Table 2. Diseases of latikochuin selected 30 Upazilas of 29 districts

Sl. No.	Districts	Upazila	Variety	Disease	Incidence (%)	Distribution 1= Rare 2=Common 3= Widespread	Severity 1=Low 2=Medium 3=High	Status 1=Major 2=Minor
1.	Dhaka	Savar	BARI Panikochy	Leaf blight	20	1	3	2
				Leaf spot	20	1	3	2
				Rhizome rot	22	1	3	2
2.	Gazipur	Shripur	Latiraj Panikochu	Leaf blight	8	2	1	2
				Taro Dasheen Mosaic	3	2	2	1
3.	Narsingdi	Shibpur	Latiraj	Leaf blight	8	2	1	2
				Leaf spot	4	2	1	1
4.	Manikgonj	Singair	Latiraj	Leaf blight	10	1	1	1
				Leaf spot	10	1	1	1
				Rhizome rot	10	2	1	1
5.	Rajbari	Sadar	Latiraj	Leaf blight	10	1	1	1
				Leaf spot	10	1	1	1
6.	Cumilla	Barura	BARI Panikochu	Mosaic	1	2	2	2
				Corm Rot	1	1	1	1
7.	Tangail	Modhupur	Latiraj Panikochu	Leaf blight	6	2	1	2
8.	Sherpur	Nalitabari	Latiraj	Leaf blight	20	1	1	2
				Mosaic	10	2	1	2
9.	Jamalpur	Madargonj	Latiraj Narkeli	Leaf blight	20	1	1	1
				Leaf spot	20	2	1	1
10.	Kishorgonj	Kuliarchar	Latiraj	Leaf blight	8	1	2	2
				Taro	4	1	2	2

Sl. No.	Districts	Upazila	Variety	Disease	Incidence (%)	Distribution 1= Rare 2=Common 3= Widespread	Severity 1=Low 2=Medium 3=High	Status 1=Major 2=Minor
				Dasheen Mosaic				
11.	Mymenshingh	Trishal	Latiraj	Leaf blight	5	2	1	2
12.	Jhenaidah	Sadar	Latiraj	Leaf blight	10	1	1	1
				Leaf spot	10	2	1	1
				Rhizome rot	10	1	1	1
13.	Joypurhat	Panchbibi	Latiraj	Leaf blight	50	3	1	2
				Taro Dasheen Mosaic	10	1	2	1
				Leaf spot	30	2	2	2
14.	Madaripur	Kalkini	Panikochu	Root Lesion	5	2	1	2
15.	Chuadanga	Sadar	Panikochu	Leaf blight	10	1	1	1
				Leaf spot	10	1	2	1
16.	Nogaon	Raninagar	Latiraj	Dasheen Mosaic Virus	30	1	1	-
				Leaf spot	10	2	1	-
				Leafblight	5	2	1	-
17.	Bogra	Shajahanpur	Latiraj	Leaf blight	10	1	2	1
				Leaf spot	5	1	2	1
				Rhizome rot	2	1	2	1
				Taro Dasheen Mosaic	5	1	2	1
18.	Rangpur	Mithapukur	Latiraj	Leaf blight	40	2	1	2
				Leaf spot	20	1	2	1
				Taro Dasheen Mosaic	10	1	2	1
		Gangachara	Latiraj	Leaf blight	5	1	1	1

Sl. No.	Districts	Upazila	Variety	Disease	Incidence (%)	Distribution 1= Rare 2=Common 3= Widespread	Severity 1=Low 2=Medium 3=High	Status 1=Major 2=Minor
				Root Lesion	1	1	2	1
19.	Panchagohr	Boda	Latiraj	Leaf blight	15	1	1	1
				Taro Dasheen Mosaic	5	1	2	1
20.	Khulna	Dumuria	Latiraj	Leaf blight	10	1	1	1
				Leaf spot	10	1	1	1
21.	Sunamgonj	Bishawmvapur	Latiraj	Leaf blight	10	1	2	1
22.	Sylhet	Golapgonj	Latiraj	Leaf blight	10	1	2	1
				Leaf spot	10	1	2	1
23.	Habigonj	Nabigonj	Latiraj	Leaf blight	10	1	2	1
				Leaf spot	10	1	2	1
				Foot rot	10	1	2	1
24.	B.Baria	Nabinagor	BARI Panikochu	Leaf blight	10	1	2	1
25.	Noakhali	Companigonj	BARI Panikochu	Leaf blight	5	1	2	1
				Leaf spot	5	1	2	1
				Foot rot	4	1	2	1
26.	Chattogram	Boalkhali	BARI Panikochu	Leaf blight	20	2	1	2
				Leaf spot	10	1	2	1
				Mosaic	10	1	2	1
27.	Patuakhali	Kolapara	BARI Panikochu	Rhizome rot	1	1	1	1
				Mosaic	1	1	1	1
28.	Barishal	Ujirpur	BARI Panikochu 2	Rhizome rot	1	1	1	1
29.	Shariotpur	Jajira	BARI Panikochu 2	Corm Root	1	1	1	1
				Root Lesion	1	2	1	2
				Taro Dasheen Mosaic	1	1	1	1

Appendix VI: Weeds of latikochu recorded during Field Survey

A field survey on weeds of latikochu crop from 30 upazilas of 29 selected districts (Table 1) was done during March-April 2022 using the structured Questionnaire/ Format, recorded data were analyzed, examined with earlier reports and finally the Weeds status was determined. The data were presented in tabular form of each district showing the Weeds status of the crop of each upazila of the respective districts. Appendix Table 3 showed the detailed report**.**

Appendix Table 3. Weeds of latikochuin selected 30 Upazilas of 29 districts

Sl. No.	Districts	Upazila	Variety	Name of Weeds	Incidence (%)	Distribution 1= Rare 2=Common 3= Widespread	Effect 1=Low 2=Medium 3=High	Status 1=Major 2=Minor
1.	Dhaka	Savar	BARI Panikochy	Durba	40	2	3	1
				Chechi ghash	30	2	3	1
				Helencha	45	2	3	1
				Kochuripana	43	2	3	1
2.	Gazipur	Shripur	Latiraj Panikochy	Nuna Shak	60	2	3	1
				Mamlocho	20	2	2	1
3.	Narsingdi	Shibpur	Latiraj	Gitla Ghash	50	2	2	1
				Nuna Shak	20	2	2	2
4.	Manikgonj	Singair	Latiraj	Tape Grass	10	1	1	2
5.	Rajbari	Sadar	Latiraj	PaspalumDistichum	10	1	2	1
				Cyperus Albostriatus	20	2	2	1
				Rumex Cripus	10	1	1	1
				Euphorbia Hirta	20	2	2	1
6.	Cumilla	Barura	Latiraj	Buring	20	1	2	1
				Topapana	15	2	1	1
				Arich	20	2	1	1
				Burclver	20	2	2	1
7.	Tangail	Modhupur	Latiraj Panikochu	Arich	20	2	2	1
				Mutha	10	2	1	1
				Burclver	20	2	2	1
8.	Sherpur	Nalitabari	Latiraj	Goicha	30	2	3	1
				Mutha	10	2	1	2
				Gitla Ghash	40	2	3	1
9.	Jamalpur	Madargonj	Latiraj Narkeli	Mutha	20	1	1	2
				Gitla Ghash	10	2	1	2
				Chapra	20	1	1	2
10.	Kishorgonj	Kuliarchar	Latiraj	Tape Grass	5	2	2	1
				Mamlocho	5	2	2	1
11.	Mymenshingh	Trishal	Latiraj	Kolmi	20	2	1	1
				Bindo Lota	30	1	1	2
12.	Jhenaidah	Sadar	Latiraj	Pasplum Disticchu	10	1	1	1
				Asthma Hita	20	2	2	1
				Water	10	1	1	2

Sl. No.	Districts	Upazila	Variety	Name of Weeds	Incidence (%)	Distribution 1= Rare 2=Common 3= Widespread	Effect 1=Low 2=Medium 3=High	Status 1=Major 2=Minor
				Couchweed				
				Duck Weed	10	1	2	1
				Medicago Polymorpha	10	2	1	1
				Water Cres	10	1	1	1
13.	Joypurhat	Panchbibi	Latiraj	Shanchi Shak	50	2	3	1
				Bishkathali	5	2	3	1
				Water purselane	30	2	3	1
				Durba	15	1	1	1
14.	Madaripur	Kalkini	Panikochu	Mutha	25	2	3	1
				Chapra	10	2	3	1
				Durba	10	2	3	1
				Kolmi Shak	5	2	3	1
15.	Chuadanga	Sadar	Latiraj	Paspalum Distichum	10	1	2	1
				Euphorbia Histra	10	2	1	1
				Medicago Polymonpha	20	1	1	2
16.	Nogaon	Raninagar	Latiraj	Sanchi shak	80	2	1	1
				Birbira	70	3	3	1
				Purslane	20	1	1	2
				Bonchukhai	10	1	1	2
				Pani morich	10	1	1	2
				Mutha	10	1	1	2
17.	Bogra	Shajahanpur	Panikochu	Shanchi Shak	20	1	1	2
				Mutha	40	2	2	1
				Boro Anguli	20	1	1	2
				Shak Notey	5	1	1	2
				Crab Grass	15	1	1	2
18.	Rangpur	Mithapukur	Latiraj	Chapa Shak	70	3	3	1
				Shak Notey	20	1	1	2
				Kata Notey	10	1	1	2
		Gangachara	Latiraj	Nuna Shak	50	3	3	1
				Shak Notey	30	2	2	1
				Culy Dock	5	1	1	2
				Bishkathali	10	1	1	2
				Jirakata Ful	5	1	1	2
19.	Panchagohr	Boda	Latiraj	Boro Anguli	60	3	3	1
				Mutha	25	2	2	1
				Shak Notey	10	1	1	1
				Bothua Shak	5	1	1	1
				Kochuripana	70	3	3	1
20.	Khulna	Dumuria	Latiraj	Medicago Polymonpha	10	1	1	1
				Paspalum Distichum	10	2	1	1

Sl. No.	Districts	Upazila	Variety	Name of Weeds	Incidence (%)	Distribution 1= Rare 2=Common 3= Widespread	Effect 1=Low 2=Medium 3=High	Status 1=Major 2=Minor
				Pistata stratiotes	10	1	2	1
				Wolffiagobbsa	10	3	1	1
				Cyperus Albostriatus	10	1	2	1
21.	Sunamgonj	Bishawmvapur	Latiraj	Mutha	20	2	1	2
				Boro Anguli	10	1	1	2
22.	Sylhet	Golapgonj	Latiraj	Helencha	20	2	2	1
				Khudepana	40	3	3	1
				Amrul	10	1	1	2
				Nutsedges	10	1	1	2
				Coontail	10	1	1	2
				Gitla Ghash	30	2	2	1
				Mamlocho	20	2	2	2
				Gratiola	10	1	1	2
23.	Habigonj	Nabigonj	Latiraj	Mamlocho	20	2	1	2
				Gitla Ghash	30	3	2	1
				Amrul	10	1	1	2
				Khudepana	80	3	1	1
				Topapana	70	3	1	1
24.	B.Baria	Nabinagor	Panikochu	Helencha	30	2	2	1
				Panilog	10	1	1	2
				Khudepana	60	3	3	1
25.	Noakhali	Companigonj	Latiraj	Mutha	30	1	1	1
				Burclver	10	2	2	2
				Kolmi	10	2	2	2
				Mamlocho	5	2	2	2
				Nuna Shak	10	1	1	2
26.	Chattogram	Boalkhali	Latiraj	Mutha	30	3	2	1
				Gitla Ghash	10	2	1	1
				Kolmi Shak	10	1	1	2
27.	Patuakhali	Kolapara	Panikochu	Mutha	10	1	1	1
				Durba	8	1	2	1
				Kolmi Shak	3	1	2	1
28.	Barishal	Ujirpur	Latiraj	Mutha	5	1	1	1
29.	Shariotpur	Jajira	Latiraj	Mutha	10	2	2	1
				Shama	5	3	2	1

Appendix VII: Farmers' Profile

The profile of 600 latikochu growing farmers of selected 30 upazilas under 29 distrcts is presented in Appendix Table 4. Interview was taken from 20 farmers of each upazila. Ten blocks were selected from each upazila based on Latikochu cultivation consulting with Upazila Agricultural Officer (UAO) and 10 farmers were selected from each Block by the help of SAAO. The age of most of the farmers was within 60 years although the minimum and maximum ages were 15 and 85, respectively. The education level of farmers was no education to Higher Secondary or graduate level. The farming experience of farmers varied from 2 to 65 years, however, most of the farmers had 5 to 40 years farming experience.

Appendix Table 4. Information of latikochu growers (Farmers Profile)

Sl. No.	District	Upazila	Farmer's profile							
			Total no. of farmers	Age (Year)	Education**	Farmingexperience (Year)	Membership in club		Training received	
							Yes	No	Yes	No
1.	Dhaka	Savar	20	30-62	1-4	5-40	11	9	14	6
2.	Gazipur	Shripur	20	18-70	1-4	5-46	7	13	9	11
3.	Narsingdi	Shibpur	20	27-66	1-4	5-45	14	6	17	3
4.	Manikgonj	Singair	20	21-65	1-4	2-40	20	0	20	0
5.	Rajbari	Sadar	20	37-68	1-3	9-30	13	7	13	7
6.	Cumilla	Barura	20	32-72	1-3	10-48	14	7	13	7
7.	Tangail	Modhupur	20	32-65	1-4	10-41	6	14	7	13
8.	Sherpur	Nalitabari	20	26-66	1-4	12-50	6	14	15	5
9.	Jamalpur	Madargonj	20	32-68	1-4	3-40	5	15	9	11
10.	Kishorgonj	Kuliarchar	20	25-75	1-4	7-40	16	4	15	5
11.	Mymenshingh	Trishal	20	29-70	1-4	5-44	14	6	12	8
12.	Jhenaidah	Sadar	20	26-71	1-4	2-40	15	5	15	5
13.	Joypurhat	Panchbibi	20	21-65	1-4	4-50	6	14	7	13
14.	Madaripur	Kalkini	20	35-80	1-4	3-60	2	18	7	13
15.	Chuadanga	Sadar	20	35-54	1-4	3-20	9	11	7	13
16.	Nogaon	Raninagar	20	26-75	1-4	10-55	5	15	9	11
17.	Bogra	Shajahanpur	20	15-70	1-4	2-40	7	13	10	10
18.	Rangpur	Mithapukur	20	29-78	1-4	10-65	8	12	5	15
		Gangachara	20	21-85	1-4	4-65	13	7	16	4
19.	Panchagohr	Boda	20	18-63	1-4	7-40	9	11	1	19
20.	Khulna	Dumuria	20	19-55	2-4	2-40	9	11	11	9
21.	Sunamgonj	Bishawmvapur	20	29-66	2	5-40	0	20	0	9
22.	Sylhet	Golapgonj	20	30-60	2	4-35	0	20	0	20
23.	Habigonj	Nabigonj	20	21-71	1-3	3-50	4	16	1	19
24.	B.Baria	Nabinagor	20	23-64	1-3	2-25	0	20	2	18
25.	Noakhali	Companigonj	20	26-70	1-2	5-40	10	10	5	15

Sl. No.	District	Upazila	Farmer's profile							
			Total no. of farmers	Age (Year)	Education**	Farmingexperience (Year)	Membership in club		Training received	
							Yes	No	Yes	No
26.	Chattogram	Boalkhali	20	30-75	1-3	5-40	2	18	8	12
27.	Patuakhali	Kolapara	20	24-57	1-4	5-45	15	5	8	12
28.	Barishal	Ujirpur	20	35-70	1-4	2-40	2	18	8	12
29.	Shariotpur	Jajira	20	22-63	1-3	8-40	1	19	6	14

** 1= No Education 2= Primary 3= Secondary 4= Higher Secondary and above

Appendix VIII: Farmer's Practice for the Management of Insect Pests, Diseases and Weeds of latikochu

Farmers' opinions on the prevalence of insect pests, diseases and weeds of latikochu crop and their management practices from selected 29 districts are shown in Appendix Table 5. It was evident that most of the farmers do not know the insect pests and diseases. In some cases they applied insecticide to control the disease and vise-versa indicating their ignorance about the right chemicals for a particular pest. However, when colored pictures of insect pests and diseases were shown they identified some as they have observed on their latikochu crop.

Appendix Table 5. Farmer's Practice for the Management of Insect Pests, Diseases and Weeds of Latikochu

Sl. No.	District	Upazila	Insect pests	Control Measures	Disease	Control Measures	Weeds	Control Measures
1.	Dhaka	Savar	Caterpillar Aphid Red Mite Snail Leaf Roll Insect	Chemical	Leaf blight Leaf spot Rhizome rot	Chemical	Durba Chechi ghash Helencha Kochuripana	Weeding
2.	Gazipur	Shripur	Caterpillar Red Mite Cotton Aphid Whitefly	Chemical	Leaf blight Rhizome rot Root Rot Collar Rot	Chemical	Tapa Grass Boro Anguli Curly Dock Mutha Burclver Kak Paya Caaba Topapana Gitla Ghash Helancha Mamlocho	Weeding
3.	Narsingdi	Shibpur	Caterpillar Red Mite Leaf Thrips	Chemical	Leaf blight Stom rot Root Lesion Spider Mite Aphid Cotton Aphid	Chemical	Helancha Kochuripana Tapa Grass Kolmi Araich Burclver Mamlocho	Weeding

Sl. No.	District	Upazila	Insect pests	Control Measures	Disease	Control Measures	Weeds	Control Measures
							Topapana	
4.	Manikgonj	Singair	Caterpillar Aphid Mite Leaf Roll Insect	Chemical	Cormo Rot Leaf blight Leaf spot	Chemical	Mutha Katanate Boro Dudhia Helancha Burclver	Weeding
5.	Rajbari	Sadar	Mature Aphid	Chemical	Leaf blight Leaf spot	Chemical	Gitla Ghash Mutha Burclver Boro Dudhia	Weeding
6.	Cumilla	Barura	Caterpillar Mite Aphid	Chemical	Rhizome rot Foot rot Leaf blight	Chemical	Buring Topapana Arich Burclver Shama Nuria Helencha Susni	Weeding
7.	Tangail	Modhupur	Caterpillar Aphid Spider Mite Spotted Flea Beetle Whitefly	Chemical	Leaf blight Leaf spot Root Kont	Chemical	Caaba Tapa Grass Canra Araich Mutha Burclver Kata Notey Gitla Ghash	Weeding
8.	Sherpur	Nalitabari	Caterpillar Aphid Red Mite	Chemical	Leaf blight Leaf spot Rhizome rot	Chemical	Shama Topapana Mutha	Weeding

Sl. No.	District	Upazila	Insect pests	Control Measures	Disease	Control Measures	Weeds	Control Measures
			Whitefly		Foot rot		Burclver	
			Grasshopper		Root Kont		Helencha	
					Mosaic		Kata Notey	
							Boro Dudhia	
							Gitla Ghash	
9.	Jamalpur	Madargonj	Caterpillar	Chemical	Leaf blight	Chemical	Durba	Weeding
			Red Mite		Leaf spot		Chapra	
			Grasshopper		Stem Rot			
			Leaf Roll Insect					
			Aphid					
10.	Kishorgonj	Kuliarchar	Caterpillar	Chemical	Leaf blight	Chemical	Helencha	Weeding
			Red Mite		Rhizome rot		Kochuripana	
			Cotton Aphid		Collar Rot		Tapa Grass	
			Whitefly		Taro Dasheen Mosaic		Kolmi	
			Spotted Flea Beetle		Root Lesion		Araich	
			Spider Mite				Burclver	
							Topapana	
							Mamlocho	
11.	Mymenshingh	Trishal	Caterpillar	Chemical	Leaf blight	Chemical	Tapa Grass	Weeding
			Cotton Aphid		Leaf spot		Burclver	
			Spider Mite		Collar Rot		Helencha	
					Foot rot		Mamlocho	
					Taro Dasheen Mosaic		Kata Notey	
					Rhizome rot		Khudepana	
							Bindo Lota	
							Gitla Ghash	
							Spotted Suprge	
12.	Jhenaidah	Sadar	Mature	Chemical	Leaf blight	Chemical	Gitla Ghash	Weeding
			Aphid		Leaf spot		Boro Dudhia	

Sl. No.	District	Upazila	Insect pests	Control Measures	Disease	Control Measures	Weeds	Control Measures
			Mite		Rhizome rot		Khudepana	
					Yellow spot		Helencha	
							Durba	
							Burclver	
13.	Joypurhat	Panchbibi	Caterpillar	Chemical	Leaf blight	Chemical	Mutha	Weeding
			Cotton Aphid		Leaf spot		Khudepana	
			Leaf Minor		Rhizome rot		Topapana	
							Kata Notey	
							Shak Notey	
							Shanchi Shak	
							Bishkathali	
							Amrul	
14.	Madaripur	Kalkini	Caterpillar	Chemical	Leaf blight	Chemical	Mamlocho	Weeding
			Aphid		Rhizome rot		Kolmi	
			Red Mite		Foot rot		Mutha	
							Durba	
							Topapana	
15.	Chuadanga	Sadar	Aphid	Chemical	Leaf blight	Chemical	Gitla Ghash	Weeding
			Mite		Leaf spot		Burclver	
			Mature				Mutha	
							Boro Dudhia	
16.	Nogaon	Raninagar	Caterpillar		Leaf blight		Sanchi	
			Mite		Mosaic		Durba	
			Whitefly		Leaf spot		Amrul	
			Aphids		Root rot		Birbira	
							topapana	
							Shyama	
							Bishkatali	
							Khude pana	
							Shushni	
17.	Bogra	Shajahanpur	Caterpillar	Chemical	Leaf blight	Chemical	Shanchi Shak	Weeding

Sl. No.	District	Upazila	Insect pests	Control Measures	Disease	Control Measures	Weeds	Control Measures
			Mite		Leaf spot		Bothua Shak	
			Whitefly		Taro Dasheen Mosaic		Amrul	
			Aphids		Rhizome rot		Nura Shak	
							Shak Notey	
							Mutha	
							Benua	
							Jhol Kochu	
							Nune Shak	
18.	Rangpur	Mithapukur	Caterpillar	Chemical	Leaf blight	Chemical	Cudweed	Weeding
			Red Mite		Leaf spot		Bishkathali	
			Leaf Rollar		Rhizome rot		Nuna Shak	
			Aphid				Durba	
			Whitefly				Boro Anguli	
			Taro Armyworm				Mutha	
			Cotton Aphids				Topapana	
							Khudepana	
							Chapra	
							Bothua Shak	
							Shama	
		Gangachara	Caterpillar	Chemical	Leaf blight	Chemical	Mutha	Weeding
			Red Mite		Leaf spot		Kata Notey	
			Leaf Rollar		Rhizome rot		Shak Notey	
			Aphid		Collar rot		Khudepana	
			Whitefly				Amrul	
			Spider Mite				Mamlocho	
			Armyworm				Nuna Shak	
			Grasshopper				Chapra	
			Cotton Aphids				Bishkathali	
							Bothua Shak	
							Durba	

Sl. No.	District	Upazila	Insect pests	Control Measures	Disease	Control Measures	Weeds	Control Measures
19.	Panchagohr	Boda	Caterpillar Aphid Whitefly Mite	Chemical	Leaf blight Leaf spot Taro Dasheen Mosaic Rhizome rot	Chemical	Coontail Chapra Topapana Hydrilla Shak Notey Boro Anguli Gitla Ghash Mutha	Weeding
20.	Khulna	Dumuria	Aphid Mite Mature	Chemical	Leaf blight Leaf spot	Chemical	Gitla Ghash Khudepana Mutha Burclve Topapana	Weeding
21.	Sunamgonj	Bishawmvapur	Caterpillar Leaf Rollar Grasshopper Red Mite Leaf Folder	Chemical	Leaf blight Foot rot Rhizome rot	Chemical	Shama Durba Boro Anguli Mutha Helencha Coontail Amrul Mamlocho	Weeding
22.	Sylhet	Golapgonj	Caterpillar Leaf Folder Grasshopper Mite	Chemical	Leaf blight Leaf spot Foot rot	Chemical	Mamlocho Mutha Gitla Ghash Amrul Topapana Khudepana	Weeding
23.	Habigonj	Nabigonj	Caterpillar Spotted Flea Beetle Whitefly	Chemical	Leaf blight Leaf spot Foot rot	Chemical	Kochuripana Coontail Mutha	Weeding

Sl. No.	District	Upazila	Insect pests	Control Measures	Disease	Control Measures	Weeds	Control Measures
			Mite		Mosaic		Amrul	
			Grasshopper				Khudepana	
			Red Mite				Mamlocho	
							Shak Notey	
							Gitla Ghash	
24.	B.Baria	Nabinagor	Caterpillar	Chemical	Leaf blight	Chemical	Mutha	Weeding
			Leaf Folder		Leaf spot		Amrul	
			Mite		Foot rot		Mamlocho	
			Aphid				Nuna Shak	
							Panilong	
							Helencha	
							Khudepana	
25.	Noakhali	Companigonj	Caterpillar	Chemical	Leaf blight	Chemical	Mutha	Weeding
			Leaf Folder		Leaf spot		Burclver	
			Mite		Foot rot		Kolmi	
			Grasshopper				Mamlocho	
			Red Mite				Nuna Shak	
							Boro Dudhia	
							Gitla Ghash	
							Khudepana	
							Durba	
							Bothua Shak	
26.	Chattogram	Boalkhali	Caterpillar	Chemical	Leaf blight	Chemical	Tapa Grass	Weeding
			Aphid		Leaf spot		Gitla Ghash	
			Mite		Mosaic		Kolmi Shak	
			Grasshopper		Collar Rot		Kochuripana	
							Mutha	
							Burclver	
27.	Patuakhali	Kolapara	Aphid	Chemical	Rhizome rot	Chemical	Mutha	Weeding
							Checra	
							Kolmi Shak	

Sl. No.	District	Upazila	Insect pests	Control Measures	Disease	Control Measures	Weeds	Control Measures
							Boro Anguli	
28.	Barishal	Ujirpur	Aphid	Chemical	Mosaic	Chemical	Mutha	Weeding
					Collar Rot		Durba	
							Boro Anguli	
							Shama	
							Kolmi Shak	
29.	Shariotpur	Jajira	Caterpillar	Chemical	Root Lesion	Chemical	Mutha	Weeding
			Aphid		Corm Root		Shama	
			Mite				Badla	
							Khudia	
							burunga	

Appendix IX: Farmers' information on economic loss due to insect pests, diseases and weeds of latikochu

The farmers' opinion on the loss incurred due to insect pests, diseases and weeds of latikochu crop and their impact on environment have been presented in Appendix Table 6. All farmers reported that insect pests, diseases and weed caused considerable loss to latikochu crop. The minimum loss due to insect pests was as reported were 200 taka per hectare and the highest loss was 82000 taka. The highest losses incurred due to diseases was up to Tk. 82,000/ ha as per farmers information. On the other hand, there was no loss reported by the farmers. The loss due to weed, as per farmers opinion varied from Tk. 0-25000/ha. Farmers' opinions on the effect of pests on environment are shown in detail in Appendix Table 6.

Appendix Table 6. Farmers' Information on economic loss due to insect pests, diseases and weeds of latikochu

Sl. No.	District	Upazila	Loss due to insect pests (Tk./ha)	Loss due to diseases (Tk./ha)	Loss due toweeds (Tk./ha)	Effect on environment
1.	Dhaka	Savar	600-700	0-5000	0-25000	-
2.	Gazipur	Shripur	40000-66000	40000-66000	-	Pollution, Disease
3.	Narsingdi	Shibpur	12500-70000	12500-70000	-	Pollution
4.	Manikgonj	Singair	400-6000	-	-	-
5.	Rajbari	Sadar	400-2800	-	-	-
6.	Cumilla	Barura	2000-15000	1000-10000	-	-
7.	Tangail	Modhupur	40000-70000	40000-65000	0-20000	Pollution
8.	Sherpur	Nalitabari	70000-80000	70000-80000	-	Pollution, Disease
9.	Jamalpur	Madargonj	50000-75000	50000-75000	-	Pollution
10.	Kishorgonj	Kuliarchar	20000-82000	54000-82000	-	Pollution, Air Pollution
11.	Mymenshingh	Trishal	45000-80000	40000-80000	0-20000	Pollution, Disease
12.	Jhenaidah	Sadar	1000-5000	-	-	-
13.	Joypurhat	Panchbibi	800-5000	500-3000	3000-20000	-
14.	Madaripur	Kalkini	3000-5000	0-3000	-	-
15.	Chuadanga	Sadar	800-5000	-	-	-
16.	Nogaon	Raninagar	200-3500	0-3000	1000-8000	-
17.	Bogra	Shajahanpur	500-3500	200-2500	1000-6000	-
18.	Rangpur	Mithapukur	100-4000	200-2000	500-7000	-
		Gangachara	500-7000	700-7000	300-6000	-
19.	Panchagohr	Boda	350-2000	500-2000	500-3000	-
20.	Khulna	Dumuria	1100-6000	-	-	-
21.	Sunamgonj	Bishawmvapur	500-1200	500-1000	400-600	Hamper Vegetable production
22.	Sylhet	Golapgonj	600-1600	600-1000	400-600	-
23.	Habigonj	Nabigonj	500-1500	300-1000	300-800	Hamper Vegetable production
24.	B. Baria	Nabinagor	500-2000	500-100	500-1000	Harm other fields
25.	Noakhali	Companigonj	500-2000	500-1500	500-800	Hamper Vegetable production

Sl. No.	District	Upazila	Loss due to insect pests (Tk./ha)	Loss due to diseases (Tk./ha)	Loss due toweeds (Tk./ha)	Effect on environment
26.	Chattogram	Boalkhali	500-1800	500-1000	500-1500	, Spread insects,Hamper Vegetable production
27.	Patuakhali	Kolapara	500-2000	500-2000	-	-
28.	Barishal	Ujirpur	1200-4000	1000-8000	0-1500	-
29.	Shariotpur	Jajira	3000-5000	3000-6000	-	-

Appendix X: Farmers' information on new insect pests, diseases and weeds

The farmers of 30 upazilas under 29 districts reported that they did not observe any new insect pests, diseases or weeds in their latikochu fields.

Appendix XI: Information of DAE/BARI Personnel on insect pests, diseases and weeds of latikochu crop

Information on status and management of Insect pests, Diseases and Weeds of Latikochu crop obtained from DAE/BARI are shown in Appendix Table 7.

Appendix Table 7. Information of DAE/BARI personnel on insect pests, diseases and weeds of latikochu crop

Sl. No.	District	Upazila	Insect pests	Status	Management	Disease	Status	Management	Weeds	Status	Management
1.	Dhaka	Savar	Caterpillar	Major	Chemical	Leaf blight	Major	Chemical	Durba		Weeding
			Aphid	Major		Leaf spot	Major		Chechi ghash		
			Red Mite	Major		Rhizome rot	Major		Helencha		
			Snail	Minor					Kochuripana		
			Leaf Roll Insect	Minor							
2.	Gazipur	Shripur	Caterpillar	Major	Chemical	Leaf blight	Major	Chemical	Tapa Grass	Major	Weeding
			Red Mite	Major		Rhizome rot	Major		Boro Anguli	Minor	
			Cotton Aphid	Major		Root Rot	Major		Curly Dock	Minor	
			Whitefly	Minor		Collar Rot	Major		Mutha	Minor	
									Burclver	Major	
									Kak Paya	Minor	
									Caaba	Minor	
									Topapana	Major	
									Gitla Ghash	Minor	
									Helancha	Major	
									Mamlocho	Major	
3.	Narsingdi	Shibpur	Caterpillar	Major	Chemical	Leaf blight	Major	Chemical	Helancha	Major	Weeding
			Red Mite	Major		Stom rot	Major		Kochuripana	Major	
			Leaf Thrips	Minor		Root Lesion	Minor		Tapa Grass	Major	
						Spider Mite	Major		Kolmi	Major	
						Aphid	Minor		Araich	Major	
						Cotton	Major		Burclver	Major	

Sl. No.	District	Upazila	Insect pests	Status	Management	Disease	Status	Management	Weeds	Status	Management
						Aphid					
									Mamlocho	Major	
									Topapana	Major	
4.	Manikgonj	Singair	Caterpillar	Minor	Chemical	Cormo Rot	Minor	Chemical	Mutha	Minor	Weeding
			Aphid	Minor		Leaf blight	Minor		Katanate	Minor	
			Mite	Minor		Leaf spot	Minor		Boro Dudhia	Minor	
			Leaf Roll Insect	Minor					Helancha	Minor	
									Burclver	Minor	
5.	Rajbari	Sadar	Mature	Minor	Chemical	Leaf blight	Minor	Chemical	Gitla Ghash	Minor	Weeding
			Aphid	Minor		Leaf spot	Minor		Mutha	Minor	
									Burclver	Minor	
									Boro Dudhia	Minor	
6.	Cumilla	Barura	Caterpillar	Major	Chemical	Rhizome rot	Minor	Chemical	Buring	Major	Weeding
			Mite	Minor		Foot rot	Minor		Topapana	Major	
			Aphid	Minor		Leaf blight	Major		Arich	Major	
									Burclver	Minor	
									Shama	Major	
									Nuria	Minor	
									Helencha	Minor	
									Susni	Minor	
7.	Tangail	Modhupur	Caterpillar	Major	Chemical	Leaf blight	Major	Chemical	Caaba	Minor	Weeding
			Aphid	Major		Leaf spot	Major		Tapa Grass	Major	
			Spider Mite	Minor		Root Kont	Minor		Canra	Minor	

Sl. No.	District	Upazila	Insect pests	Status	Management	Disease	Status	Management	Weeds	Status	Management
			Spotted Flea Beetle	Minor					Araich	Major	
			Whitefly	Minor					Mutha	Major	
									Burclver	Major	
									Kata Notey	Major	
									Gitla Ghash	Minor	
8.	Sherpur	Nalitabari	Caterpillar	Major	Chemical	Leaf blight	Major	Chemical	Shama	Major	Weeding
			Aphid	Major		Leaf spot	Minor		Topapana	Minor	
			Red Mite	Minor		Rhizome rot	Minor		Mutha	Major	
			Whitefly	Minor		Foot rot	Minor		Burclver	Major	
			Grasshopper	Major		Root Kont	Minor		Helencha	Minor	
						Mosaic	Minor		Kata Notey	Major	
									Boro Dudhia	Minor	
									Gitla Ghash	Major	
9.	Jamalpur	Madargonj	Caterpillar	Minor	Chemical	Leaf blight	Minor	Chemical	Durba	Minor	Weeding
			Red Mite	Minor		Leaf spot	Minor		Chapra	Minor	
			Grasshopper	Minor		Stem Rot	Major				
			Leaf Roll Insect	Minor							
			Aphid	Minor							
10.	Kishorgonj	Kuliarchar	Caterpillar	Major	Chemical	Leaf blight	Major	Chemical	Helencha	Major	Weeding
			Red Mite	Major		Rhizome rot	Major		Kochuripana	Minor	
			Cotton Aphid	Major		Collar Rot	Minor		Tapa Grass	Major	
			Whitefly	Minor		Taro Dasheen Mosaic	Major		Kolmi	Minor	
			Spotted Flea	Minor		Root	Minor		Araich	Minor	

Sl. No.	District	Upazila	Insect pests	Status	Management	Disease	Status	Management	Weeds	Status	Management
			Beetle			Lesion					
			Spider Mite	Minor					Burclver	Minor	
									Topapana	Minor	
									Mamlocho	Major	
11.	Mymenshingh	Trishal	Caterpillar	Major	Chemical	Leaf blight	Major	Chemical	Tapa Grass	Major	Weeding
			Cotton Aphid	Major		Leaf spot	Major		Burclver	Major	
			Spider Mite	Minor		Collar Rot	Major		Helencha	Major	
						Foot rot	Major		Mamlocho	Major	
						Taro Dasheen Mosaic	Minor		Kata Notey	Minor	
						Rhizome rot	Major		Khudepana	Minor	
									Bindo Lota	Minor	
									Gitla Ghash	Major	
									Spotted Suprge	Major	
12.	Jhenaidah	Sadar	Mature	Minor	Chemical	Leaf blight	Major	Chemical	Gitla Ghash	Minor	Weeding
			Aphid	Minor		Leaf spot	Minor		Boro Dudhia	Minor	
			Mite	Minor		Rhizome rot	Major		Khudepana	Minor	
						Yellow spot	Minor		Helencha	Minor	
									Durba	Major	
									Burclver	Major	
13.	Joypurhat	Panchbibi	Caterpillar	Minor	Chemical	Leaf blight	Minor	Chemical	Mutha	Major	Weeding
			Cotton Aphid	Minor		Leaf spot	Minor		Khudepana	Major	
			Leaf Minor	Minor		Rhizome	Minor		Topapana	Minor	

Sl. No.	District	Upazila	Insect pests	Status	Management	Disease	Status	Management	Weeds	Status	Management
						rot					
									Kata Notey	Minor	
									Shak Notey	Minor	
									Shanchi Shak	Minor	
									Bishkathali	Major	
									Amrul	Minor	
14.	Madaripur	Kalkini	Caterpillar	Major	Chemical	Leaf blight	Minor	Chemical	Mamlocho	Major	Weeding
			Aphid	Major		Rhizome rot	Major		Kolmi	Major	
			Red Mite	Minor		Foot rot	Major		Mutha	Major	
									Durba	Major	
									Topapana	Minor	
15.	Chuadanga	Sadar	Aphid	Minor	Chemical	Leaf blight	Minor	Chemical	Gitla Ghash	Minor	Weeding
			Mite	Minor		Leaf spot	Major		Burclver	Minor	
			Mature	Minor					Mutha	Minor	
									Boro Dudhia	Minor	
16.	Nogaon	Raninagar	Caterpillar	Major		Leaf blight	Major		Sanchi	Major	
			Mite	Major		Mosaic	Major		Durba	Major	
			Whitefly	Minor		Leaf spot	Major		Amrul	Major	
			Aphids	Minor		Root rot	Minor		Birbira	Major	
									topapana	Minor	
									Shyama	Minor	
									Bishkatali	Minor	
									Khude pana	Minor	
									Shushni	Minor	
17.	Bogra	Shajahanpur	Caterpillar	Minor	Chemical	Leaf blight	Major	Chemical	Shanchi Shak	Major	Weeding
			Mite	Minor		Leaf spot	Major		Bothua Shak	Major	

Sl. No.	District	Upazila	Insect pests	Status	Management	Disease	Status	Management	Weeds	Status	Management
			Whitefly	Minor		Taro Dasheen Mosaic	Minor		Amrul	Minor	
			Aphids	Minor		Rhizome rot	Minor		Nura Shak	Minor	
									Shak Notey	Minor	
									Mutha	Minor	
									Benua	Minor	
									Jhol Kochu	Minor	
									Nune Shak	Minor	
18.	Rangpur	Mithapukur	Caterpillar	Major	Chemical	Leaf blight	Major	Chemical	Cudweed	Major	Weeding
			Red Mite	Major		Leaf spot	Major		Bishkathali	Minor	
			Leaf Rollar	Minor		Rhizome rot	Minor		Nuna Shak	Minor	
			Aphid	Minor					Durba	Major	
			Whitefly	Minor					Boro Anguli	Minor	
			Taro Armyworm	Major					Mutha	Minor	
			Cotton Aphids	Major					Topapana	Major	
									Khudepana	Major	
									Chapra	Major	
									Bothua Shak	Minor	
									Shama	Minor	
		Gangachara	Caterpillar	Major	Chemical	Leaf blight	Major	Chemical	Mutha	Major	Weeding
			Red Mite	Major		Leaf spot	Major		Kata Notey	Major	
			Leaf Rollar	Major		Rhizome rot	Major		Shak Notey	Major	
			Aphid	Major		Collar rot	Major		Khudepana	Minor	
			Whitefly	Minor					Amrul	Minor	
			Spider Mite	Minor					Mamlocho	Minor	

Sl. No.	District	Upazila	Insect pests	Status	Management	Disease	Status	Management	Weeds	Status	Management
			Armyworm	Major					Nuna Shak	Major	
			Grasshopper	Minor					Chapra	Major	
			Cotton Aphids	Major					Bishkathali	Major	
									Bothua Shak	Major	
									Durba	Major	
19.	Panchagohr	Boda	Caterpillar	Major	Chemical	Leaf blight	Major	Chemical	Coontail	Major	Weeding
			Aphid	Major		Leaf spot	Minor		Chapra	Major	
			Whitefly	Minor			Minor		Topapana	Minor	
			Mite	Minor		Taro Dasheen Mosaic	Minor		Hydrilla	Minor	
						Rhizome rot	Minor		Shak Notey	Minor	
									Boro Anguli	Minor	
									Gitla Ghash	Minor	
									Mutha	Minor	
20.	Khulna	Dumuria	Aphid	Minor	Chemical	Leaf blight	Minor	Chemical	Gitla Ghash	Minor	Weeding
			Mite	Minor		Leaf spot	Minor		Khudepana	Minor	
			Mature	Minor					Mutha	Minor	
									Burclve	Minor	
									Topapana	Minor	
21.	Sunamgonj	Bishawmvapur	Caterpillar	Minor	Chemical	Leaf blight	Minor	Chemical	Shama	Minor	Weeding
			Leaf Rollar	Minor		Foot rot	Minor		Durba	Minor	
			Grasshopper	Minor		Rhizome rot	Minor		Boro Anguli	Minor	
			Red Mite	Minor					Mutha	Minor	
			Leaf Folder	Minor					Helencha	Minor	
									Coontail	Minor	
									Amrul	Minor	

Sl. No.	District	Upazila	Insect pests	Status	Management	Disease	Status	Management	Weeds	Status	Management
									Mamlocho	Minor	
22.	Sylhet	Golapgonj	Caterpillar	Minor	Chemical	Leaf blight	Minor	Chemical	Mamlocho	Major	Weeding
			Leaf Folder	Minor		Leaf spot	Minor		Mutha	Major	
			Grasshopper	Minor		Foot rot	Minor		Gitla Ghash	Minor	
			Mite	Minor					Amrul	Minor	
									Topapana	Major	
									Khudepana	Major	
23.	Habigonj	Nabigonj	Caterpillar	Major	Chemical	Leaf blight	Major	Chemical	Kochuripana	Major	Weeding
			Spotted Flea Beetle	Major		Leaf spot	Minor		Coontail	Major	
			Whitefly	Minor		Foot rot	Major		Mutha	Major	
			Mite	Major		Mosaic	Major		Amrul	Minor	
			Grasshopper	Major					Khudepana	Minor	
			Red Mite	Minor					Mamlocho	Major	
									Shak Notey	Minor	
									Gitla Ghash	Major	
24.	B.Baria	Nabinagor	Caterpillar	Major	Chemical	Leaf blight	Major	Chemical	Mutha	Minor	Weeding
			Leaf Folder	Minor		Leaf spot	Minor		Amrul	Major	
			Mite	Minor		Foot rot	Minor		Mamlocho	Major	
			Aphid	Minor					Nuna Shak	Minor	
									Panilong	Minor	
									Helencha	Major	
									Khudepana	Major	
25.	Noakhali	Companigonj	Caterpillar	Major	Chemical	Leaf blight	Major	Chemical	Mutha	Major	Weeding
			Leaf Folder	Major		Leaf spot	Minor		Burclver	Major	
			Mite	Minor		Foot rot	Minor		Kolmi	Minor	
			Grasshopper	Minor					Mamlocho	Minor	

Sl. No.	District	Upazila	Insect pests	Status	Management	Disease	Status	Management	Weeds	Status	Management
			Red Mite	Major					Nuna Shak	Minor	
									Boro Dudhia	Minor	
									Gitla Ghash	Minor	
									Khudepana	Minor	
									Durba	Minor	
									Bothua Shak	Minor	
26.	Chattogram	Boalkhali	Caterpillar	Major	Chemical	Leaf blight	Major	Chemical	Tapa Grass	Minor	Weeding
			Aphid	Minor		Leaf spot	Major		Gitla Ghash	Major	
			Mite	Major		Mosaic	Minor		Kolmi Shak	Minor	
			Grasshopper	Minor		Collar Rot	Minor		Kochuripana	Minor	
									Mutha	Major	
									Burclver	Minor	
27.	Patuakhali	Kolapara	Aphid	Minor	Chemical	Rhizome rot	Minor	Chemical	Mutha	Minor	Weeding
									Checra	Minor	
									Kolmi Shak	Minor	
									Boro Anguli	Minor	
28.	Barishal	Ujirpur	Aphid	Minor	Chemical	Mosaic	Minor	Chemical	Mutha	Minor	Weeding
						Collar Rot	Minor		Durba	Major	
									Boro Anguli	Minor	
									Shama	Minor	
									Kolmi Shak	Minor	
29.	Shariotpur	Jajira	Caterpillar	Minor	Chemical	Root Lesion	Minor	Chemical	Mutha	Minor	Weeding
			Aphid	Minor		Corm Root	Minor		Shama	Minor	
			Mite	Minor					Badla	Minor	
									Khudia	Minor	
									burunga	Minor	

Appendix XII: Questionnaire for collecting information from the farmers

Pest Risk Analysis (PRA) of latikochu under the Tuber Crops Development Project (TCDP), DAE, Dhaka.

Interview Schedule 1: Questionnaire for Collecting Information on insect pests, diseases and weeds of Latikochu from the Farmers

(লতিকচু ফসলের পোকা, রোগ ও আগাছা সম্পর্কে কৃষকের নিকট হতে তথ্য সংগ্রহের প্রশ্নমালা)

তথ্য সংগ্রহের তারিখঃ .....

A. Farmers Interview

১. কৃষকের নামঃ ..... মোবাইল নংঃ .....

গ্রামঃ ..... ব্লকঃ .....ইউনিয়ন ঃ .....উপজেলাঃ..... জেলাঃ .....

২. পুরুষ = ১, মহিলা = ২ [ ]

৩. বয়স ঃ ..... বছর

৪. শিক্ষাগত যোগ্যতা ঃ অশিক্ষিত = ১, প্রাথমিক = ২, মাধ্যমিক = ৩, উচ্চ মাধ্যমিক/ তার বেশী = ৪ [ ]

৫. কৃষি কাজের অভিজ্ঞতা ঃ ..... বছর

৬. আপনার লতিকচু চাষের আওতায় জমির পরিমাণ ঃ..... শতাংশ

৭. আপনার লতিকচু জীবনকাল কত দিনের? ..... দিন

৮. কোন কৃষক সংগঠনের সদস্য কিনা ? (হ্যাঁ = ১, না = ২) [ ]

হ্যাঁ হলে, সংগঠনের নামঃ .....

৯. লতিকচু চাষের উপর কোন প্রশিক্ষন আছে কিনা ? (হ্যাঁ = ১, না = ২) [ ]

হ্যাঁহলে, লতিকচুর কোন বিষয়ের উপর প্রশিক্ষন আছে ঃ.....

১০. আপনি কত বছর ধরে লতিকচু চাষ করেন? ..... বছর

১১. এ বছর আপনি কি কি জাতের লতিকচু চাষ করেছেন?.....

১২. লতিকচু চাষে আপনার বীজের উৎস কি কি ? নিজস্ব =১, প্রতিবেশী =২, আত্মীয়=৩, এনজিও=৪, কোম্পানী=৫, বিএডিসি=৬, বাংলাদেশ কৃষিগবেষণা ইনষ্টিটিউট= ৭, অন্যান্য= ৮ [ ]

১৩. সংগৃহীত বীজে কোন পোকা-মাকড় ও রোগ-বালাই দেখা যায় কি ? (হ্যাঁ = ১, না = ২) [ ]

হ্যাঁ হলে,

১৩. (ক) পোকা-মাকড়/রোগের নাম বলুনঃ ....., ..., ..., ...

১৩. (খ) কি দমন ব্যবস্থা নিয়েছিলেন?....., ..., ..., ...

১৪. আপনার লতিকচু ফসলে বিগত কয়েক বছরে কোন কোন ধরনের পোকার আক্রমণ হয়েছিল এবং সেগুলো দমনের জন্য কি কি পদ্ধতি ব্যবহার করে ছিলেন?

পোকার নাম	ফসলের কোন পর্যায়ে এ পোকা দেখা যায়	গাছের কোন অংশে এ পোকা আক্রমণ করে	দমনপদ্ধতি	ক্ষতির পরিমাণ (%)

১৫. আপনার লতিকচু ফসলে বিগত কয়েক বছরে পোকা দমনের জন্য কি কি কীটনাশক ব্যবহার করেছিলেন?

পোকার নাম	কীটনাশকের নাম	কতবার ব্যবহার করা হয়	ব্যবহারের মাত্রা (%)

১৬. এ সকল পোকার কারণে কি পরিমাণ আর্থিক ক্ষতির সম্মুখীন হচ্ছেন ? ..... টাকা

১৭. এ সকল পোকার কারনে পরিবেশগত কি ধরনের সমস্যা হচ্ছে ? ....., ..., ...

১৮. বিগত কয়েক বছরে লতি কচু ফসলে কোন নতুন পোকা দেখেছেন কিনা ? (হ্যাঁ = ১, না = ২) [ ]

হ্যাঁ হলে, পোকার নাম বলুন ?

পোকার নাম	ফসলের কোন পর্যায়ে এ পোকা দেখা যায়	গাছের কোন অংশে এ পোকা আক্রমণ করে	দমন পদ্ধতি	ক্ষতির পরিমাণ (%)

১৯. আপনারলতি কচু ফসলে বিগত কয়েক বছরে কোন কোন রোগের প্রাদুর্ভাব ঘটেছিল এবং সেগুলো দমনের জন্য কি কি পদ্ধতি ব্যবহার করেছিলেন?

রোগের নাম	ফসলের কোন পর্যায়ে এ রোগ দেখা যায়	গাছের কোন অংশে এ রোগ দেখাযায়	দমন পদ্ধতি	ক্ষতির পরিমান (%)

২০. আপনার লতিকচু ফসলের মাঠে Nematode এর লক্ষণ দেখা যায় কিনা ? (হ্যাঁ = ১, না = ২) [ ]

হ্যাঁ হলে, কোন জাতীয় Nematode:

২১. এ সকল রোগের কারণে কি পরিমাণ আর্থিক ক্ষতির সম্মুখীন হচ্ছেন? ..... টাকা

২২. এ সকল রোগের কারণে পরিবেশগত কি ধরনের সমস্যা হচ্ছে? ....., ..., ...

২৩. গত কয়েক বছরে লতিকচু ফসলে নতুন কোন রোগ দেখাগিয়েছে কিনা ? (হ্যাঁ = ১, না = ২) [ ]

হ্যাঁ হলে রোগের নাম বলুন?

রোগেরনাম	ফসলের কোন পর্যায়ে এ রোগ দেখা যায়	গাছের কোন অংশে এ রোগ দেখা যায়	দমন পদ্ধতি	ক্ষতির পরিমান (%)

২৪. আপনার লতিকচু ফসলে বিগত কয়েক বছরে কোন কোন আগাছা দেখা গিয়েছিল এবং সেগুলো দমনের জন্য কি কি পদ্ধতি ব্যবহার করেছিলেন?

আগাছার নাম	ফসলের কোন পর্যায়ে এ আগাছা দেখা যায়	দমন পদ্ধতি	ক্ষতির পরিমাণ (%)

২৫. বিগত কয়েক বছরে লতিকচু ফসলে নতুন কোন আগাছা দেখেছেন কিনা ? (হ্যাঁ = ১, না = ২) ☐

হ্যাঁ হলে, আগাছার নাম বলুনঃ

আগাছার নাম	ফসলের কোন পর্যায়ে এ আগাছা দেখ যায়	দমন পদ্ধতি	ক্ষতির পরিমাণ (%)

২৬. এ সকল আগাছার কারণে কি পরিমাণ আর্থিক ক্ষতির সম্মুখীন হচ্ছেন? ..... টাকা

২৭. এ সকল আগাছার কারণে পরিবেশগত কি ধরনের সমস্যা হচ্ছে? ....., ..., ...

তথ্য সংগ্রহকারীর নামঃ.....

তারিখঃ.....

Appendix XIII: Format for collecting information from DAE/BARI Personnel

Pest Risk Analysis (PRA) of latikochu under the Tuber Crops Development Project (TCDP), DAE, Dhaka.

Interview Schedule 2: Questionnaire for Collecting Information from DAE/BARI Personnel

Name of the DAE/BARI Officials: ……

Designation: …… Mobile No: ……

Name of Block/Upazila: …… District: ……

1. Total cultivated area (ha) of `atikochu in your Block/Upazila/District: ……
2. Number ofLatikochugrowersin Block/Upazila/District: ……
3. Latikochugrowing locations in your Block/Upazila/District:

Sl. No.	Area (ha)	Growing locations (Village, Block, Union)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

4. What are the varieties of Latikochu grown in your Block/Upazila/District

Sl. No.	Name of varieties
1.	
2.	
3.	
4.	
5.	

5. Recorded insect pests of latikochu in the field and control measures taken

Sl. No	Name of Insect Pests	Plant Parts Infested	Pest Status (Major/minor)	Control measures
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

6. Recorded insect pests of latikochu in the storage and control measures taken

Sl. No.	Name of Insect Pests	Pest Status (Major/minor)	Control measures
1.			
2.			
3.			
4.			
5.			

7. Recorded diseases of latikochu in the field and control measures taken

Sl. No.	Name of Diseases	Plant Parts Infested	Status (Major/minor)	Control measures
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

8. Recorded diseases of latikochu in the storage and control measures taken

Sl. No.	Name of Diseases	Status (Major/minor)	Control measures
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

9. Recorded weeds of latikochuin the field and control measures taken

Sl. No.	Name of weeds	Time of occurrence	Status (Major/minor)	Control measures
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

10. Major insect pests, diseases and weeds of latikochu in your Block/Upazila/District

Sl. No.	Name of insect pests	Name of diseases	Name of weeds
1.			
2.			
3.			
4.			
5.			
6.			
7.			

11. Name of new pest observed in last five (05)years

Name of Insect pests	Status (Major/minor)	Name of Diseases	Status (Major/minor)	Name of Weeds	Status (Major/minor)

12. Are there any unidentified pests, diseases and weeds of latikochu observed in last five (05) years in your Block/Upazila/District?

    If any, what measures were taken?

Name of Insect pests	Control measures	Name of Diseases	Control measures	Name of Weeds	Control measures

Is there any new latikochu variety introduced in this area? (Yes= 1, No= 2) ☐

If yes, name and source. Name _____Source _____

Name of Interviewer:

Date:

Appendix XIV: Format for Field Data Collection of Insect pests of Latikochu

Checklist of Field Observation3: Format for Field Data Collection of Insect Pests of Latikochu

Sl. no.	Cultivated Variety	Insect pest with Scientific name	Affected Plant Parts	Nature of injury	Infestation (%)	**Distribution** 1= Rare 2= Common 3= Widespread	**Effect** 1= Low 2=Medium 3= High	**Status** Major=1 Minor=2
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								

Appendix XV: Format for Field Data Collection of Diseases of Latikochu

Checklist of Field Observation 4: Format for Field Data Collection of Diseases of Latikochu

Sl. no	Cultivated Variety	Disease with causal organism	Affected Plant Parts	Disease symptoms	Occurrence (%)	**Distribution** 1= Rare 2= Common 3= Widespread	**Severity** 1 =Low 2=Medium 3=High	**Status** Major=1 Minor=2
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								

Appendix XVI: Format for Field Data Collection of Weeds of Latikochu

Checklist of Field Observation 5: Format for Field Data Collection of Weeds of Latikochu

Sl. no	Weeds with scientific name	Time of Incidence	Incidence (%)	Distribution 1= Rare 2= Common 3= Widespread	Effect 1=Low 2= Medium 3= High	Status Major=1 Minor=2
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

Appendix XVII: Persons met during Information collection

List of persons met during data collection from the field.
(PRA on `atikochu)

A. DAE Head Quarter, Khamarbari, Dhaka.

1. Md.Zahidul Amin, Director, CW, DAE, Khamarbari, Dhaka.
2. Dr. A. S. M. Abdur Razzak, DD (Import), Khamarbari, Dhaka.
3. Dr. Md. Rezaul Karim, DD (Export), Khamarbari, Dhaka.
4. Md. Mukhlasure Rahman, Project Director, TCDP Project, Khamarbari, Dhaka.
5. Dr. Md. Azhar Ali, Consultant, PRA.TCDP Project, DAE, Khamarbari, Dhaka.
6. Mrs. Ferdousi Ysamin, Deputy Project Director, TCDP Project, DAE, Khamarbari, Dhaka.

B. DAE Field Level Officers

1. **Rangpur**
   Md. Obaidur RAhman Mondol, DD
   Md. Shaiful Islam, UAO, Gangachor
   Md. Saiful Abedin, UAO, Mithapukur
2. **Bogura**
   Md. DUlal Hossain, DD
   Md. Nure ALam, UAO, Shahjahanpur
3. **Dhaka**
   Md. Abdul Awal, DD
   Md. NAziat Ahmed, UAO Sadar
4. **Gazipur**
   Md. Saiful Islam, DD
   A.S.M Moidul Hasan, UAO, Sripur
5. **Norsingdi**
   Dr. Md. Saidur Rahman, DD
   Md. Bin Sadek, UAO, Shibpur
6. **Manikgonj**
   Md. Enaet Ullah, DD
   Md. Tipu Sultan, UAO, SIngair
7. **Rajbari**
   S.M Shahid Nur Akber, DD
   Md. Bahauddin Shikh, UAO, Sadar
8. **Cumilla**
   Md. Mizanur Rahman, DD
   Md. Nazmul Islam,UAO, Barura
9. **Tangail**
   Md. Ahsanul Bashar, DD,
   Md. Al Mamun Russel, UAO, Modhupur
10. **Sherpur**
    Dr. Mohit Kumar Dey, DD
    Md. Alamgir Kabir, UAO, Nalitabari
11. **Jamalpur**
    Nitai Chandra Banik, DD
    Md. Shahadul Islam, UAO, Madargonj
12. **Kishorgonj**
    Md. Saiful Alam, DD
    Md. Abdullah Al Mamun, UAO, Madargonj

13. Mymensingh
Mrs. Tania Rahman, UAO, Trishal
14. Jhenaidah
Md. Asgor Ali, DD, Jhenaidah
Md. Zahidul Karim, UAO, Sadar
15. Joypurhat
Md. Lutfur Rahman, UAO, Panchbibi
16. Chuadanga
TAlha Jubair Mashrur, UAO, Sadar
17. Khulna
Md. Hafizur Rahman, DD,
Md. Mosaddek Hossin, UAO, Dumuria
18. Sunamganj
Md. Faridul Hasan, DD
Md. Nayem Mia, UAO, Bishawmvapur
19. Sylhet
Md. Salauddin, DD
Md. Anisuzzaman, UAO, Golapgonj
20. Madaripur
Md. Moazzem Hossain, DD
Md. Shashati Chandra Debnath, UAO, Kalkini
21. Habiganj
Md. Tamijuddin Khan, DD, Nabigonj
Md. A.K.M Maksudul Alam, UAO
22. B.Baria
Md. RAbiul Haq Mojumdar, DD
Md. Juglul Haider, UAO, Nabinagor
23. Naogaon
Shamsul Wadud, Deputy Director
Md. Shahidul Islam, UAO, Raninagar
24. Patuakhali
A.K.M Mahiuddin, DD
AKM Saifullah, UAO, Kolapara
25. Noakhali
Md. Shahidul Haque, DD
A.R.M Saifullah, Companigonj
26. Chittagong
Md. Aktaruzaman.DD
Md. Atik Ullah, UAO, Boalkhali
27. Barishal
Md. Harunur Rashid, DD
Md. Touhid, UAO, Ujirpur
28. Ponchogarh
Al-Mamunur Rashid, UAO, Boda
29. Shariatpur
Md. Abdus Sattar, DD
Md. Jamal Hossain, UAO, Jajira

C. BARI Research Centres

Sl. No.	Name	Designation
1	Dr. Sohela Akhter	Director, TCRC, BARI, Gazipur
2	Dr. Md. Shamsul Alam	SSO, TCRC, BARI, Gazipur
3	Dr. Mst. Mahbuba Begum	SSO, TCRC, BARI, Gazipur
4	Dr. Md Zulfikar Haider Prodhan	PSO, TCRC, Sewizgari, Bogura
5	Dr. Ashis Kumur Shaha	PSO, RARS, Burirhat, Rangpur
6	Md. Nazrul Islam	Scientific Officer, OFRD, Patuakhali, BARI

D. Others

1. Prof. Dr. Mohsin Hossain Khan, Dept. of Entomolgoy, PSTU
2. Md. Manjurul Hannan,
   MD, Hortex Foundation, Dhaka
3. Md. Helal Uddin, Librarian, EPB, Dhaka
4. Md. Lutfor Rahman,
   DD, Central Packing House, Shampur, Dhaka

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