SURVEY ON DISEASES OF MAIZE FOR PEST RISK ANALYSIS (PRA) IN BANGLADESH

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SURVEY ON DISEASES OF MAIZE FOR PEST RISK ANALYSIS (PRA) IN BANGLADESH

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CERTIFICATE

This is to certify that the thesis entitled, *"SURVEY ON DISEASES OF MAIZE FOR PEST RISK ANALYSIS (PRA) "*. submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of *MASTER OF SCIENCE IN PLANT PATHOLOGY,* embodies the result of a piece of bona fide research work carried out by *Md. Omar Khaiyam, Registration No. 06-01892,* under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

I further certify that any help or sources of information, as has been availed of during the course of this investigation has been duly acknowledged.

Dated: 5th May, 2013
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CONTENTS

LIST OF RESULTS

LIST OF RESULTS (Cont'd)

LIST OF RESULTS (Cont'd)

LIST OF RESULTS (Cont'd)

LIST OF TABLES

LIST OF TABLES (Cont'd)

LIST OF TABLES (Cont'd)

LIST OF TABLES (Cont'd)

LIST OF PHOTOGRAPH

LIST OF ANNEXES

ABSTRACT

A survey was conducted in major 20 maize growing districts of Bangladesh for pest risk analysis of maize. In the survey program, twenty Farmer, two Sub-assistant Agriculture Officer, two Upazila level Officer, one District Level DAE Officials per district were interviewed through pretested questionnaires for collecting data on maize diseases and diseased sample were collected for identifying causal organism. Isolations of causal organism were done in the M.S. laboratory, Department of Plant

Pathology, Sher-e-Bangla Agricultural University, Dhaka. The major and minor diseases were determined by observing the prevalence of diseases in the field and opinion expressed by the farmer. Considering the opinion expressed by the farmers, field level officers and from field observations the 21 identified diseases of maize were seedling blight, stalk rot, root rot, sheath blight, sheath rot, ear rot, bacterial leaf blight, maydis leaf blight, Brown spot, tarcicum leaf blight, gray leaf spot, sugarcane mosaic, downy mildew, maize streak, maize stripe, maize dwarf mosaic, anthracnose, cob rot, store grain rot, cob sheath rot and cob sheath blight. The prevalent major diseases were stalk rot, leaf spot, root rot, cob rot, sheath blight, sheath rot, cob sheath blight, cob sheath rot, leaf blight, bacterial leaf blight, maize dwarf mosaic virus, corn stunt, leaf virus, maize streak virus. Seedling and reproductive stages of maize plant were found more vulnerable to diseases. There was a positive and high degree of relationship among insect pest and disease incidence with weed infestation. The probable sources of maize diseases were seed borne diseases from outside of the country (cross boundary), imported hybrid seeds and infested soil. The respondent opined seed treatment with bavistin as best method for controlling seed borne diseases and use of fungicide as the best control measure of diseases. According to the opinion of the participants, proper training on quarantine diseases, improvement of quarantine laboratory and strengthening of quarantine law could be the best way for improvement of quarantine disease situation of maize.

INTRODUCTION

Maize is the third most important cereal crop in Bangladesh. The production of maize in Bangladesh is popularizing for its multifarious use for food, feed and edible oil Preparation. It covers 2.02 lakh hectares with a production of 13.17 lakh metric tons in 2010 (BBS, 2011). The maize area has slowly expanded over the past few years due to its diversified use. This area would grow further to meet future food, feed, and other demands, especially in view of the booming livestock and poultry producing sectors in the country. It is expected that in future increases in maize supply will be achieved through the intensification and commercialization of current maize production systems.

Bangladesh lies in the North Eastern part of South Asia between $20^{o}34^{\prime\prime}$ and $26^{o}38^{\prime}$ North latitude and $88^{o}01^{\prime}$ and $92^{o}41^{\prime}$ East. The country is bordered by India on the West, the North, and the Northeast, Burma on the Southeast and the Bay of Bengal on the South. The land area covers 144,000 km^2. There are six administrative divisions, 64 districts and 490 sub-districts (BBS, 2008). The climate of Bangladesh is characterized by a tropical monsoon. In all areas, about 80% of the annual rainfall typically occurs in the monsoon period, which lasts from late May to mid-October.

Maize is a versatile crop grown over a range of agro climatic zones. In fact the suitability of maize to diverse environments is unmatched by any other crop. It is grown from 58^{0}N to 40^{0}S, from below sea level to altitudes higher than 3000 m, and in areas with 250 mm to more than 5000 mm of rain fall per year (Anon. 2009) and with a growing cycle ranging from 3 to 13 months However, the major maize production areas are located in temperate regions of the globe. The United States, China, Brazil and Mexico account for 70% of global production. India has 5% of corn acreage and contributes 2% of world production. The use of maize varies in different countries. In USA, EU, Canada and other developed countries, maize is used mainly to feed animal directly or sold to feed industry and as raw material for extractive/fermentation industries (Anon. 2009). In developing countries use of maize is variable. In Latin America and Africa the main use of maize is for food while in Asia it is used for food and animal feed. In fact in many countries it is the basic staple food and an important ingredient in the diets of people. Globally, it has been estimated that approximately 21% of the total grain produced is consumed as food.

Bangladesh Agricultural Research Institute (BARI) has already released high yielding maize varieties like Bornli, Shuvra, Khai Bhutra, Mohor, BARI Bhutra-5, BARI Bhutra-6, BARI Hybrid variety-1, and then BARI Hybrid variety 9, 10, 11, 12 and more are on the pipe lines (BARI, 2011). This varietal development facilitated the increase cultivation Kharip and Rabi season by the grower. Under the increasing trend of cultivation, the demand for hybrid seed is increasing rapidly and these are being imported from other countries. Again, Bangladesh is surrounded by India and Myanmar from three sides- west, north and east leaving Bay of Bengal on the south. These two neighboring countries, India and Myanmar, are also popular as maize growing countries. As such, there are potential risks of the presence and entry of

harmful quarantine maize pests in our country. Hence, the quarantine pests and diseases are to be identified through Pest Risk Analysis (PRA) study.

The changing global scenario is compelling policymakers to adhere to the regulations and obligations set by the World Trade Organization (WTO). The resulting new economic regime is expected to alter the economics of existing cropping systems, including maize, in terms of production, value added, and trade. To satisfy the prerequisite the WTO for maize trade, it is necessary to conduct pest risk analysis of maize in Bangladesh. Therefore, the present research work was undertaken with the following objectives:

1) To listing diseases of maize in Bangladesh.
2) To analyze the risks of maize diseases

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REVIEW OF LITERATURE

Maize is vulnerable to attack by many pathogens and diseases at different stage of growth. Though maize is a promising crop of Bangladesh, very little attention has been paid to the maize diseases and their management practices. Therefore, very few literature in this context are available in Bangladesh. In this chapter an attempt has been made to review the available literature about maize diseases, mycoflora associated with these disease.

Gonzalez (2008) conducted a laboratory experiment in Asturias to determine the efficacy of 75% chlorothalonil, 25% azoxystrobin, 50% carbendazim, 12.5% epoziconazole, 0.5% flusilaole + 1% carbendazim, 9.4% flutriafol + 20% carbendazim and 16% cyproconazole + 30% carbendazim against Exserobilum tucicum (*Setosphaeria turcica*) casual organism of Northern corn leaf blight on

corn. Flusilazole + carbendazim was the most effective followed by epoiconazole m flutriafol + carbendazim and cyproconazole + carbendazim.

Harlapur *et. al* (2008) conduct a survey in Karnataka and found Turcicum leaf blight (TLB) of maize caused by *Exserohilum turcicum* was major production constraint of maize crop. The symptoms were observed at different stages of growth. Elongated spindle shaped necrotic deep grey lesions on leaves and straw coloured centre with dark margins giving plant ascorched appearance and leading to premature killing of plants with small sized, curved, partially filled malformed chaffy cobs with shriveled grains were observed. Survey indicated that, the disease was noticed in all the maize growing areas of the state in a low to severe form. The highest disease incidence (55.89%) was observed in Belgaum district and the lowest disease incidence (27.64%) in koppal district.

Partridge (2008) reported that Ear rot, stalk rot, root rot and kernel rot disease is caused by the fungus *Fusarium moniliforme*. This species and other *Fusarium* species also cause ear, kernel and root rot and seedling blight. Corn and sorghum are the most economically important hosts of *Fusarium moniliforme*. It is important to note that the fungus has a very broad host range influencing crop production in many areas of the world. Stalk rot is generally thought of as a problem of senescing plants. A higher incidence of stalk rot is common when conditions that tend to encourage early senescence occur. Two such conditions are water stress and foliar diseases. Insect or hail injury may also result in more stalk rot as will high plant populations and imbalanced fertility (high N to K ratio). The infection process occurs when the fungus invades host tissue directly or through wounds. Mycelium and conidia serve as primary inoculum. Common points of entry are roots and stalks at the base of leaf sheaths. Weather conditions that favour stalk rot development are dry weather before silking and warm wet weather after silking. The earliest symptoms of stalk rot are wilted plants in the field. Infected plants take on a greyish green hue then turn tan. Outward symptoms of the disease are indefinite discoloured patches on the lower internodes. The pith disintegrates, leaving vascular strands intact. Stalks feel spongy when squeezed. A pink growth is evident on vascular strands when spores are produced. There is also a reddish-pink discoloration of the roots. These symptoms are best observed by splitting stalks longitudinally. As with many stalk rots, lodging is another common symptom.

FAO (2007) constituted International Standers for Phytosanitary Measure (ISPM) No 2 for framework for pest risk analysis. According to ISPM 2 three interrelated steps such as: (i) disease categorization, (ii) assessment of the probability of introduction and spread, and (iii) assessment of potential economic consequences (including environment and biodiversity at large) are involved in PRA. For disease categorization a list of diseases of targeted crop is required firstly. The list of diseases should be prepared through surveying targeted area. For disease categorization risk of diseases and their incidence should in consideration. During assessment of probability of introduction and spread survey report should in consideration. Finally assessment of potential economic consequence should be done.

Hossain (2007) presented the survey report in the national workshop programme on "Strategic Intervention on Plant Pathological research in Bangladesh" and stated that six seedling diseases viz. leaf blight i.e.,maydis leaf Blight (*Drechslera maydis*) and turcicum leaf blight (*Drechslera turcicum*), bipolaris leaf spot (*Bipolaris maydis*), stalk rot (*Fusarium spp. and Diplodia spp*.), seedling blight (*Aspergillus spp., Penicillium spp*.), foot and root rot (*Fusarium spp*.) and maize dwarf mosaic (maize dwarf mosaic virus) were mostly found in Bangladesh. Incidence levels of those diseases also investigated.

Yasmin (2007) reported that in Bangladesh, so far 28 different diseases of maize have been reported and most of these are caused by fungi. Twenty species of fungi were recorded on maize in Bangladesh.

Casa *et al* .(2006) reported that *Stenocarpella macrospore* and *S. maydis* might be responsible for causing seed rot, seedling blight, stem and car rot and leaf spot in maize. Normally these fungi are the main causal agent of grain rot when ears are inpected. The damage caused exclusively by *Stenocarpella* has not yet been determined. The pathogens are found in practicaiiy all maize-growing regions of Brazil. The major disease intensity occurs under maize is monoculture, mainly in small farms and fields for seed production where maize is continuously cultivated.

Kar (2006) conducted an experiment in Orissa, India to evaluate the yield losses due to bipolaris leaf spot (*Bipolaris maydis*) in three popular high yielding cultivars of maize (Deccan-103, Navjot and VL-16). Plots were sprayed with 0.3% Mancozeb at 30 and 45 days after germination. The results revealed that the fungicidal sprayes wewe effective in reducing disease incidence and increasing yield of 1000-frain weight. The mean disease intensities under protected conditions wew 1.87, 1.78 and

2.12 in Deccan-103, Navjot and VL-16 respectively, and that under unprotected conditions were 3.32, 3.60 and 4.42 respectively. Grain yield in protected Plots were 47.43, 44.43 and 30.82 q/ha in Deccan-103, Navjot and VL-16 respectively, and 42.30, 39.10, and 24.97 q/ha in unprotected Plots. The yield loss was maximum in VL-16 (18.98%) followed by Navjot (12%) and Deccan-103 (1.52%).

Ares *et al.* (2004) conducted a survey of lodged maize plants in 2001 to indentify the main foot and root rot pathogens related to maize lodging in 23 maize filds of Abogondo. From 328 maize plants showing lodging, 33 isolates of the following potential maize pathogens viz. *Fusarium semitectum* (*F. pallidoroseum*), *F. graminearum* (*Gibberella zeae*) were collected. They showed that *F. graminearum* was the most pathogenic fungus considering either foot and root rot symptom or seeding growth reduction. The incidence levels of this disease were also recored.

Bari and Alam (2004) reported 28 diseases of maize. They mentioned seed-borne diseases like leaf blight (*Bipolaris turcicum*) ,leaf spot (*Bipolaris maydis*), banded leaf and sheath spot (Rhizoctonia solani), cob rot (Aspergillus spp), foot and root rot (*Fusarium spp.)* damping off (*Fusarium moniliforme*) and anthracnose (*Colletotrichum spp*.).

CIMMYT (2004) reported that the causal pathogen of Black kernel rot disease is *Botryodiplodia theobromae.* The same fungus can produce stalk rot with a conspicuous black discoloration in moist, hot environments. Affected ears develop deep black, shiny kernels and husk leaves can also turn black and be shredded. It develops in hot, humid environments. Diseased plants dry prematurely. Splitting stalks show some shredding of the pith and a dark gray to black discoloration of the vascular bundles. Abundant greyish mycelia are conspicuous in the rotten areas, confined mostly to the lower internodes above ground. Unlike charcoal rot, *Botryodiplodia* stalk rot does not produce black pinhead-like sclerotia in the rotten areas, but it does produce abundant, gray-blackish, cottony mycelium in cavities formed in the pith of affected internodes.

CIMMYT (2004) also reported that causal organism of seedling blight, stalk rot, brown spot, gray leaf spot, smut, ear rot, anthracnose, sheath blight, turcicum leaf blight, bacterial leaf blight are *Fusarium spp.* or *Pythium spp*. or *Rhyzoctonia spp., Pythium aphanidermarum* or *Fusarium moniliformae , Bipolaris maydis, Cercospora spp., Ustilago maydis, Aspergillus spp.* or *Penicillium spp., Colletotrichum*

graminicola, Rhizoctonia solani, Helminthosporium turcicum and *Pseudomonas rubrilineans* respectively.

Jha et al. (2004) evaluated some fungicide thiram, emissan (2 methoxyethylmercury chloride), captafol 50% wp (captan) and bavistin 50% WP (carbendazim), alon or in combination for their effects on maize leaf blight (*H. maydis*) *in vitro*. The fungicide were applied at 0.01, 0.02, 0.05 and 0.10% , except bavistin, which was applied at 0.01, 0.02, 0.03 and 0.04% . All fungicide showed inhibitory effect on the spore germination at all contentrations. Bavistin at 0.03% showed 100% inhibition of spore germination. Thiram+ Bavistin, Captafol + Bavistin, thiram + cmissan, cmisan + indofil M- 45, captafol+ indofil M-45 and indofil M-45 +Bavistin were statistically similar to their efficacy in controlling fungal sporulation.

Li *et al*. (2004)observed that Sugarcane mosaic virus (SCMV). Wes an important seedborne virus in maize. SCMV was detected in maize seeds by ELISA, electron microscopy, biological assay and tissue culture. The SCMV particales or inclusions were found in the testa, aleuronic layer of endosperm and embryonic tissue, but not in the starch layer of the endosperm. The in aleuronic layer and embryo invade the growing maize seedling.

Marley and Gbenga (2004) conducted a survey of farmers fields in the Savannazone of Nigeria in 1999 and indicated the presence of stalk and cob rots of maize at incidence retas of 15-43% and disease severity of 2.0-6.7. The causal organism was identified as *Stenocarpella maydis* (*Diplodia maydis*) that reduced seed germination by up to 29.2%.

Ali and Alam (2003) reported 30 diseases to occur on maize in Bangladesh. Among them 23 are caused by fungi, 2 by bacteria, 3 by virus/mycoplasma and 2 are caused by nematode. Alam *et al* (2003) reported seven diseases commonly occurred in maize growing period and in storage.

Asran et al. (2003) conducted an experiment to test the pathogenicity of *Fusarium graminearum* isolates on maize cultivars and found that *Fusarium graminearum* was an important pathogen of maize and causes seed rot and seedling blight as well as foot and root rot , stalk rot and ear rot. In growth chamber experiments, inoculation of corn cv. 'Loyel' seeds with six different *F. graminearum* isolates reduced emergence of germ lings and caused seedling death of varying degrees.

King and Hagood (2003) conducted a field experiment in 2000 and 2001 in Virgiana to evaluate the maize dwarf mosaic virus (MDMV) in response to post emergence Johnson grass control in two corn hybrids. The results showed that increased disease incidence resulted from greater transmission of MDMV by insect vectors which moves from dying Johnson grass to the crop. The results also revealed that littler or no disease incidence occurred in the virus tolerant hybrid. With the virus susceptible hybrid, significance increases in disease incidence were observed in response to any herbicide treatment applied to Johnson grass-containing plots relative to the same treatment applied to weed free plots.

Mathur and Kongsdal (2003) reported that Kernel rot and black bundle disease is caused by *Acremonium strictum.* The pathogen survives in the soil, plant debris and seed. The disease is favoured by post flowering water stress. The disease kills the plant prematurely after flowering. Infected plants do not show symptoms until they reach the tasseling stage. Wilting generally starts from the top leaves. Leaves become dull green, eventually loose colour and become dry. In advanced stages the stalk loses its healthy green colour, lower portions become dry, shrunken with or without wrinklings, hardens and turns purple to dark brown which is more prominent on lower internodes. When split open, diseased stalks show brown vascular bundles starting in the underground portion of the roots. Diseased plants produce only ears with undeveloped shrunken kernels. In severe cases affected plants remain abortive causing 100 per cent loss.

Mathur and Kongsdal (2003) also reported that Southern leaf blight disease is caused by *Bipolaris maydis*. Leaves show greyish, tan, and parallel straight sided or diamond shaped 1-4 cm long lesions with buff or brown borders or with prominent colour banding or irregular zonation. Symptoms may be confined to leaves or may develop on sheaths, stalks, husks, ears and cobs. The lesions are longitudinally elongated typically limited to a single inter vascular region, often coalescing to form more extensive dead portions. Young lesions are small and diamond shaped. As they mature, they elongate. Growth is limited by adjacent veins, so final lesion shape is rectangular and 2 to 3cm long. Lesions may coalesce, producing a complete burning of large areas of the leaves. Southern maize leaf blight is prevalent in hot, humid, maize growing areas. The fungus requires slightly higher temperatures for infection.

Wang and Ma (2003) noted that maize dwarf mosaic (MDMV) was one of the world s main virus diseases in producing areas. The domestic and overseas research progress

on the epidemiology of MDMV was reviewed. Topics include occurrence and damage, cultivar resistance, pathogen, viral transmission, cultivation management, environmental conditions, temporal and spatial analysis of epidemics, and forecasting methods.

Zhu *et al.* (2002) conducted a survey in mid-September 2001 and reported that a sporadic symptom typical of gray leaf spots (*Cercospora zeae maydis*) was found in nine fields in Southern Ontario, Canada. Leaf samples with symptoms were placed in Petri dishes and clustered conidiophores arose from stomata on both leaf surfaces. Slightly curved, hyaline conidia with 3 to 5 septa appeared on the top of conidiophores. Upon further testing, gray leaf was re-isolated from inoculated plants. Fulfilling Koch s postulates. This is thought to be the first confirmation report of this pathogen in Canada.

Bohra *et al*. (2001) conducted an experiment during 1995 and 1996 in Udaipur, Rahashtan, India to evaluate the efficacy of different fungicides against Fusarium stalk rot (*F. moniliforme* [*Gibberella fujikuroi*]) in maize under *in vivo* and *in vitro* conditions. In laboratory bioassays, 6 different fungicides, i.e. bavistin (carbendazim), bayleton (triadimefon) , kitazin (iprobenfos), captafol (captan), thiram and dithane M-45 (mancozeb), were used at 50, 100, 200, 400 and 800 ppm concentrations. The results of in vitro bioassays showed that all treatments significantly inhibited the growth of *F. moniliforme.* Maximum growth inhibition (~ 100%) was observed at 50 ppm concentration of bavistin and bayleton. Both the fungicides were evaluated at lower concentrations, i.e. 5, 10, 20, 40 and 50 ppm. Bavistin was highly effective in inhibiting the mycelial growth of *F. moniliformae* even at 5 ppm concentration. While bayleton gave approximately 100% inhibition 40 ppm concentration. The efficacy of bavistin (0.1%) and captaf (0.2%), as soil application, against *F. moniliformae* was evaluated in the field. Bavistin and captaf exhibited 54.5 and 46.9% efficacy of disease control.

Egein and Arinze (2001) discovered a new fungal disease of maize on a rubbish dump at Choba, Port Harcourt (Nigeria). The causal agent was identified as *Fusarium oxysporum* causing damping off of seedling with disease manifestation after 9 days after emergence were observed. The damping off disease incidence was found sporadically where domestic and some industrial wastes were damped.

Survey were conducted by Harlapur *et al.* (2000) during 1995-1996, 1996-1997 and 1997-1998 to obtain recent information on maize disease in north Karnataka, India.

Turcicum leaf blight (*Exserohilum turcicum*) was the major disease (53.5% disease incidence) affecting maize particularly during the kharif season of 1995-1997. Carcoal stalk rot (*Macrophomina Phaseolina*) appeared in major proportions during the rabi season (16.5% disease incidence). The incidence of other disease like maydis leaf spot (*Bipolaris maydis*), brown spot *(Physoderma maydis*) and phaeophaeria leaf spot (*Phaeosphaeria maydis)* incidence were observed in traces. During rabi season charcoal stalk rot and fusarium stalk rot (*Fusarium moniliforme*) incidence found to be moderate to severe. All diseases of maize present in India were not seen in same season in same area.

Fakir (2001) listed 11 seed-borne diseases occurring on maize in Bangladesh. The diseases were kernel mould (*Aspergillus flavus, Penicillium spp*.), cob rot (*Aspergillus spp, Gibberella zeae*) seed rot (*Fusarium moniliforme, F. oxysporum, penicillium spp*), germination failure (*Aspergillus spp*.), seedling blight (*Gibberella zeae, penicillium spp*), blue eye (*Penicillium spp*.), brown spot (*Physoderma zeae-maydis*), scutellum rot (*Rhizopus spp.*) and smut (*Ustilago zeae*).

Gawai *et al*. (2000) investigated seed borne mycoflora by making isolations from 200 seeds of each of four maize cultivars (PMH-4, PMH-19, PMH-128 and MMH-69). Fungi were detected on the seeds using agar plate, blotter paper, rplled towel and moist sand methods. *Fusarium moniliforme* (*Gibberella fujikuroi*), *Aspergillus niger, Aspergillus flavus, Alternaria alternate, penicillium spp.* And *Curvularia lunata* (*Cochliobolus lunatus*) were detected from the seed surfaces of all cultivars using all methods. *F. moniliforme, Aspergillus niger penicillium spp.* And *Alternaria alternate* were the most predominant species in cultivars. Seed rot, germination failure and seedling blight were mostly recorded between 7 and 15 days by these pathogens.

Kumar and Jha (2000) determined in vitro effectiveness of nine chemicals to control *Rhizoctonia solani* causing banded leaf and sheath blight of maize. Out of nine fungicides screened in the laboratory, Bavistin, Bengard and Topsin –M proved most effective as they caused the maximum inhibition of mycelial growth. Other fungicide viz., Kitazin, Captafol, Brassicol, Indofil M-45 and Thiram also showed better performance regarding inhibition of mycelial growth of the pathogen in comparison to check.

Commercial maize fields in Southeast Catalonia (Spain) were surveyed by Achon (1999) for maize dwarf mosaic (MDMV) during spring-summer, 1997. Maize dwarf

mosaic virus was present in all surveyed fields, its average incidence in maize being 27.3%. The over wintering hosts of MDMV, Johnson grass (*Sorghum halepense*), was found in all surveyed fields, and 69% of the samples were infected with virus.

Wegary *et al*. (1999) carried out a survey of maize diseases in Ethiopia in 1997 and 1998. Gray leaf spot of maize caused by *Cercospora zeae maydis* was major diseases in the area studied. It is suggested that the development of resistant/tolerant varieties provides the most promising long-term means for controlling the disease, although crop sanitation and good crop management practices would also reduce infection. It is also suggested that fungicides could be used to control the disease when economically feasible.

White (1999) listed some seed-borne fungal diseases on maize plants. The diseases were seed rot, seedling blight, foot and root rot, damping off and leaf spot (*Fusarium moniliforme, Penicillium spp., Rhizoctonia spp.* and *Alternaria spp*.) stalk rots, ear rots and kernel rots (*Gibberella spp., Diplodia spp., Fusarium spp., Pythium spp., Penicillium spp.* and *Aspergillus spp.*).

Symon *et al*. (1998) conducted a survey in all agro ecological zones (65 maize farms) in Kenya during 1995-1996. The final survey results showed that *Exerohilum turcicum* induced blight was observed in all maize producing areas with disease incidence over 45% . Southern leaf blight caused by *Cochliobolus heterostroplus* was most severe in the Kenyan maize granary located in the high lands west Rift Valley where it occurred alone or with *Phacosphaeria maydis* leaf spot. Incidence of over 75% were recorded for southern leaf blight and phaeosphaeria maydis leaf spot in western Kenya and over 85% for *Phaeosphaeria maydis* leaf spot in Thika, Nyeri, Muranga and Kirinyaga District of central Province.

Kumar and Agarwal (1998) conducted an experiment to locate the seed borne fungi in different parts of discolored maize seeds. Seed borne inoculums of *Bipolaris maydis, Botryodiplodia theobromae, Curvularia lunata, Fusarium moniliforme* were detected in all parts (tip cap, pericarp, embryo and endosperm) of maize seeds, where *C. pallescens* and *Bipolaris carbnum* were tip cap and pericarp; and tip cap, pericarp and endosperm, respectively

FAO (1997) constituted International Standers for Phytosanitary Measure (ISPM) No 6 for guidelines for surveillance. For disease categorization a list of diseases of

targeted crop is required and then the list of diseases should be prepared through surveying randomly the targeted area. In the survey, all parties involved in production of that crop should be interviewed and field visit should be done for inspection of present disease condition.

Shahjahan (1993) reported that five diseases viz. leaf blight, stalk rot, mosaic, cob rot and downy mildew seriously affect the maize crop in our country. Talukdar (1974) reported nine diseases viz. Leaf blight, Cob rot, Kernel mould, Smut, Leaf spot, Brown spot, Bacterial streak, Soft rot and Mosaic of maize in Bangladesh.

Chatterjee *et al* (1990) reported that the major maize diseases prevalent in India are eight. These are maydis leaf blight, downy mildews, pythium stalk rot, bacterial stalk rot, common rust, charcoal-rot, brown spot and turcicum leaf blight. Moreover seed-borne diseases cause enormous losses both in storage as well as in the field. Subbaiah *et al*. (1982) reported 35 disease of maize present in India.

USDA (1960) reported that a total of 112 diseases are known to occur on global basis on maize and among them more than 70 are seed-borne. Richardson (1990) reported that important seed borne disease of maize are leaf spot, leaf blight, collar rot, kernel rot, seedling blight, anthracnose and head smut.

MATERIALS AND METHOD

3. Survey on the status of Diseases of Maize in selected locations of Bangladesh

3.1 Study Area

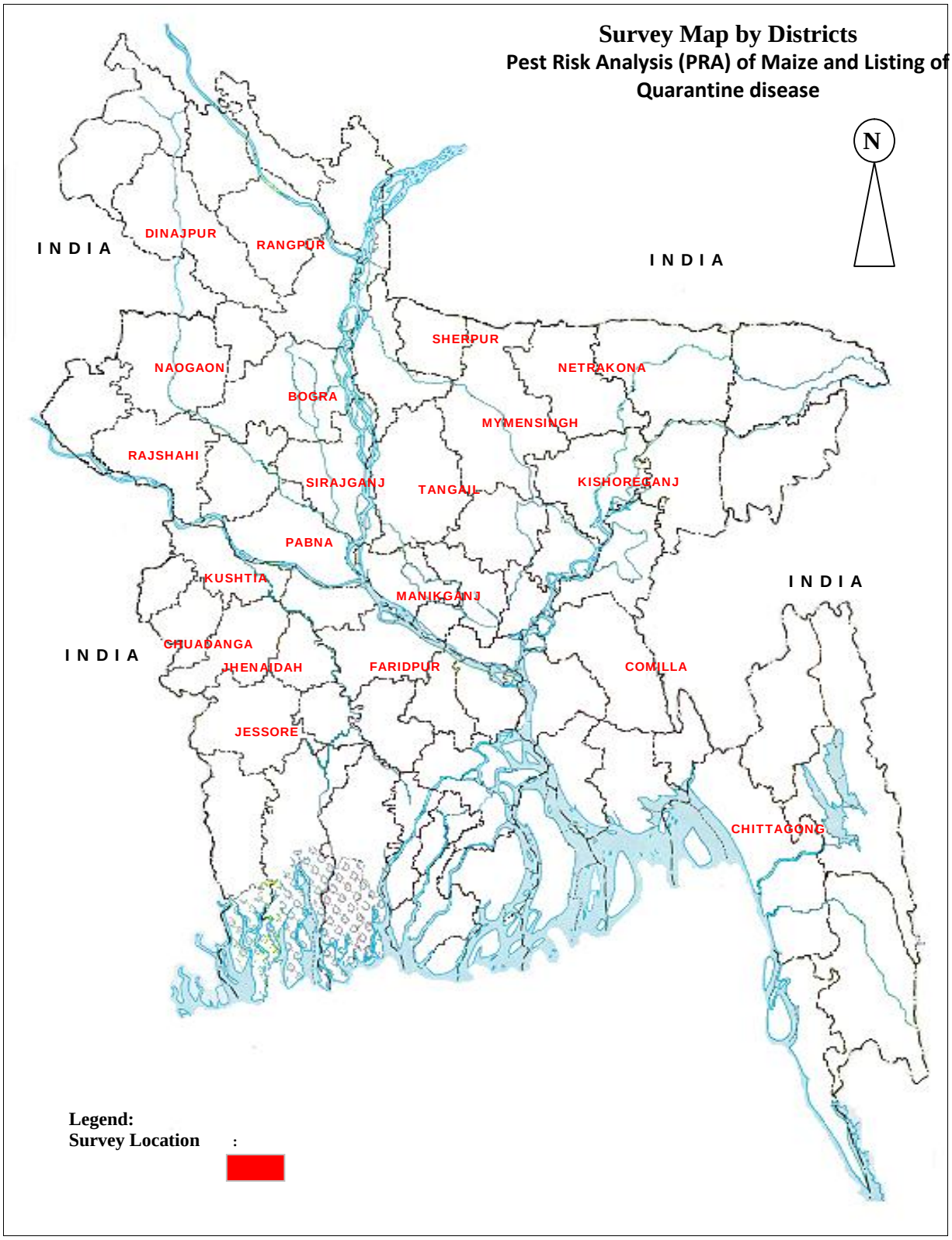
The survey was conducted through a project on "Pest Risk Analysis (PRA) of Maize and listing of Quarantine Pests" was implemented by the "Quarantine Services Strengthening Program (QSSP)" of Plant Protection Wing, DAE. The survey was conducted in 40 upzilla in selected 20 districts.

The questionnaires (Annex 2-7), the instrument for data collection, were formulated and pre-tested in four upzillas of two districts namely Tangail and Manikganj prior to beginning of nationwide survey. The survey locations were as follows:

Sl. No.	Program District(s)	Sample Upazila(s)		
		Name(s) of Sample Upazilas for Survey		Numbers
1	Rangpur	Sadar	Mithapukur	**2**
2	Dinajpur	Sadar	Fulbari	**2**
3	Bogra	Sherpur	Adamdighi	**2**
4	Naogaon	Sadar	Patnitala	**2**
5	Rajshahi	Poba	Godagari	**2**
6	Pabna	Sadar	Atgoria	**2**
7	Sirajgonj	Sadar	Ullapara	**2**
8	Jessore	Sador	Zikorghacha	**2**
9	Kushtia	Sador	Daulatpur	**2**
10	Jhenidah	Sadar	Harinakundu	**2**
11	Chuadanga	Jibon nagor	Damurhuda	**2**
12	Faridpur	Sadar	Nagorkanda	**2**
13	Tangail	Sador	Shakipur	**2**
14	Sherpur	Sadar	Nakla	**2**
15	Mymensingh	Muktagacha	Fulpur	**2**
16	Kishoreganj	Sadar	Kotiadi	**2**
17	Netrokona	Sadar	Purbadhala	**2**
18	Manikgong	Sadar	Paturia	**2**
19	Comilla	Sadar	Dhaudkandi	**2**
20	Chittagong	Mirersarai	Satkania	**2**

Total District 20	Total Upazila 40	40

Survey Map:



3.2 Interview of respondents and Sample Size

In the survey program 20 farmers, two Sub-assistant Agriculture Officer (SAAO), 2 Upazila level Officer (UAO/ Adl. UAO/ AEO/ AAEO/JEO / SAPPO), 1 District Level DAE Officials (DD/DTO/ CPS/PPS) were interviewed in every district under study. Information were also collected from the BARI scientists / Researchers, BADC officials and concerned resource personnel. The sample size was 520 as shown below:

Respondent(s)		Sample Size
1	District Level Officer (DAO)	**20**
2	Upazila Level Officer (UAO)	**40**
3	Sub-assistant Agriculture Officer (SAAO)	**40**
4	Farmers	**400**
5	Additional information taken from the BARI scientists / Researchers / BADC officials and concerned Resource personnel/ seed dealer of the concerned district	**20**
	Total	**520**

3.3 Data collection: Data were collected by interview of the respondents. For collecting data 20 enumerators were involved. Enumerators were chosen from the MS students of SAU and they were trained for three days on the maize diseases and PRA procedure.

3.4 Focus group discussion: 10 participants from among all the respondents were identified based on their potentials for providing more specific and accurate feedback in identifying the pests and rating them as quarantine and non-quarantine in a focus group discussion through group discussions and sharing their experiences.

3.5 Field inspection and Identification of disease

Maize plantation of the selected farmer's field observed carefully and symptoms of the diseases recorded. In each upazilla 2 farmer fields was visited to find out present diseased condition. "Maize disease: A Guide for Field Identification (4^{th} edition, 2004)" by CEMMYT was primarily used for disease identification in field. Data sheet for maize diseases identification has shown in Annex 8.

3.6 Data analysis

Data on different parameters were analyzed through computer software SPSS.

RESULTS

The study was done through questionnaires, interviews and Focus Group Discussion (FGD). The four categories of respondents namely, Farmers, Policy Level Officers, Field Level Officers and Pesticide or Seed Dealers were interviewed. Focus Group Discussion (FGD) was also conducted to assess the knowledge of diseases of maize, their risks and quarantine diseases to make a list through pre-tested questionnaires in the major maize growing districts of Bangladesh. Physical field visits were also conducted to make a real picture of the disease in maize. The data collecting from the field were analyzed through a computer based software SPSS. The results obtained from the studies conducted in the survey areas are presented below sequentially in various forms and thus discussed as to extract the findings systematically in line with the objective of the research work.

4.1. KNOWLEDGE OF FARMERS ON THE PESTS OF MAIZE AND THEIR RISKS

The results of the farmers' knowledge on maize pests and their risks have been discussed under the following sub-headings:

4.1.1. Gender of the farmers

There were 400 maize farmers have been participated in the field survey, among them most (99.00%) of the farmers were male (Table 4.1).

Table 4.1. Gender of the Maize farmers

Gender	No. of the respondent	Response (%)
Male	396	99.0
Female	4	1.00
Total	**400**	**100.0**

4.1.2. Age of Maize Farmers

Most (75.00%) of the farmers participated in the field survey for pest risk analysis (PRA) of maize were 26 to 55 years old, among which the farmers with 36 to 45 years old ranked first (27.50%) (Table 4.2).

Table 4.2. Age of the farmers engaged in maize cultivation

Ages	No. of respondent [N=400]	% Response
15- 25 years	25	6.25
26-35 years	97	24.25
36- 45 years	110	27.50
46- 55 years	93	23.25
56- 65 years	52	13.00
Above 65 years	23	5.75
Total	**400**	**100.0**

4.1.3. Education of the maize farmers

Most (94.50%) of the farmers participated in the survey of maize were illiterate to SSC. Among them Class VI to SSC were ranked first (34.75%) then Class I to V (25.75%). About one fourth of the total farmers were illiterate (Table 4.3). From this finding it was revealed that the intensive training about maize cultivation and maize pests should be adapted to the illiterate and lower educated maize farmers (Table 4.3)

Table 4.3. Education of the maize farmers

Education level	No. of respondent	% Response
Illiterate	96	24.00
Class 1-5	103	25.75
Class 6- SSC	139	34.75
HSC	35	8.75
Degree	24	6.00
Masters	3	0.75
Total	400	100.0

4.1.4. Land utilization pattern of the farmers for maize cultivation

According to the farmers opinion, on an average total land area owned of each farmer was 1.15 ha, of which cultivable land under total land owned was 0.98 ha. The land under maize cultivation was 0.40 ha. From these findings it was revealed that a large portion (40.32%) of the cultivable lands of the maize farmers was engaged under maize cultivation. On an average, the farmers participated under the survey program were engaged in maize cultivation for 5.59 years (Table 4.4).

Table 4.4. Farmers' opinion on the land utilization pattern for maize cultivation

Land utilization pattern	Land size (Trimmed Mean)	
	Decimal	Hectare
1. Total land area owned	282.83	1.15
2. Cultivable land under total land owned	243.04	0.98
3. Land area under maize cultivation	98.01	0.40
4. Duration (year) engaged in maize cultivation	5.69 years	

4.1.5. Selection of the season for maize cultivation

All (100%) the farmers (400) participated in the survey program were engaged in Rabi season for maize cultivation, among them only 13.00% (52) farmers also cultivated maize in Kharif season. Most of the farmers (79.5%) cultivated hybrid variety of maize in their field (Table 4.5).

4.1.6. Source of maize seeds used by the farmers for cultivation

Maize farmers used maize seeds from different sources for cultivation. Among those most (86.75%) of the farmers used maize seeds from seed dealer. Other important

sources were Agricultural Extension Department, Pesticide Dealer, directly from BRAC etc opinion expressed by the 4.25%, 2.75% and 2.25% farmers (Table 4.6).

Table 4.5. Farmers' opinion on the selection of season for maize cultivation

Cultivated maize varieties	Response on the selection of seasons			
	Rabi season		Kharif season	
	No. of respondent [N=400]	% Response	No. of respondent [N=52]	% Response
1. Local variety	30	7.50	4	7.69
2. BARI developed HYV	7	1.75	-	-
3. BARI developed Hybrid variety	87	21.75	13	25.00
4. BRAC developed Hybrid variety	162	40.50	12	23.08
5. Imported Hybrid variety	69	17.25	14	26.92
6. Other variety	45	11.25	9	17.31
Multiple response				

Table 4.6. Farmers' opinion on the source of maize seeds used for cultivation

Source of maize seeds	Response	
	No. of respondent [N=400]	% Response
1. Seed Dealer	347	86.75
2. Pesticide Dealer	11	2.75
3. BADC	2	0.50
4. Directly from BRAC	9	2.25
5. Directly from importer	-	-
6. Agril. Extension Department	17	4.25
7. Research station	4	1.00
8. Local market seed	4	1.00
9. Farmers neighbor seed	2	0.50
10. Other sources	4	1.00

4.1.7. Use of quality seeds by the farmers for cultivation

Out of the farmers participated in the survey; maximum (50.50%) of them checked the expiry date of the seeds used for cultivation, whereas only 8.25% said that they did not check the expiry date (Table 4.7). But a large portion (41.25%) of them did not reply about the checking of expiry date of seeds used for cultivation, i.e., either they were not aware about using quality seeds for cultivation or they ignored it.

On the other hand, among 400 farmers, only 6.25% of them expressed that they examined germination and quality tests of the seeds used for cultivation, whereas the

maximum (48.75%) farmers said that they did not examined the germination and quality tests of the seeds. But a large portion (45.00%) of them did not reply about the germination and quality test of the seeds used for cultivation, i.e., either they were not aware about the germination and quality tests of the seeds for cultivation or they ignored it.

From these findings it was revealed that awareness about checking of the expire date of the seeds should be build up to the farmers as well as necessity of the germination and quality test of the maize seeds should be focused and delivered to the farmers to get better result.

Table 4.7. Farmers' response on the quality seeds used for cultivation

Types of Response	Expiry date checked		Germination & quality tested	
	No. of respondents	% Response	No. of respondents	%Response
Yes	202	50.50	25	6.25
No	33	8.25	195	48.75
Not replied	165	41.25	180	45.00
Total	**400**	**100**	**400**	**100**

4.2.8. Incidence of disease infections in the maize field

Considering the opinion expressed by the farmers, the incidence of diseases of maize in field were stem rot, leaf spot, root rot, cob rot, sheath blight, sheath rot, cob sheath blight, cob sheath rot, leaf blight, bacterial leaf blight, maize dwarf mosaic virus, grain rot, store grain rot, Aspergillus ear rot, Fusarium ear rot, Penicillium ear rot, corn stunt, leaf virus, maize streak virus, sugarcane mosaic virus, and downy mildew (Table 4.8).

Among these diseases leaf spot, leaf blight, cob rot, sheath blight and bacterial leaf blight ranked first, second, third, fourth and fifth expressed by the 36.30%, 32.00%, 25.30%, 22.50% and 21.80% farmers, respectively. More or less all stages of the maize crop were attacked by the diseases, where the dominating disease such as leaf spot, leaf blight and sheath blight caused infections at seedling, vegetative and reproductive stages, whereas bacterial leaf blight at vegetative and reproductive stages and cob rot caused infections at reproductive stage of the maize plants in the field. The infestation intensity of the maximum diseases was low to medium expressed by the most of the farmers. On the other hand, Fusarium ear rot caused damage with high intensity expressed by the 66.70% farmers.

Table 4.8. Farmers' response on the incidence of disease infections in the maize field

Name of disease	% Farmers' response on disease infection					
	Presence of disease	Stage of crop infected	Infection intensity			
			High	Medium	Low	Total
1. Stem rot	12.50	Seedling, vegetative, reproductive	8.00	14.00	78.00	100.0
2. Leaf spot	36.30	Seedling, vegetative, reproductive	1.40	31.00	67.60	100.0
3. Root rot	4.00	Seedling, vegetative, reproductive	12.50	12.50	75.00	100.0
4. Cob rot	25.30	Reproductive stage	19.60	20.00	60.40	100.0
5. Sheath blight	22.50	Vegetative and reproductive stage	6.60	35.60	57.80	100.0
6. Sheath rot	9.30	Vegetative and reproductive stage	13.50	32.40	54.10	100.0
7. Cob Sheath blight	10.00	Reproductive stage	-	30.00	70.00	100.0
8. Cob Sheath rot	7.30	Reproductive stage	-	20.70	79.30	100.0
9. Leaf blight	32.00	Vegetative and reproductive	3.10	30.50	66.40	100.0

		stage				
10. Bacterial leaf blight	21.80	Vegetative and reproductive stage	4.60	13.80	81.60	100.0
11. Maize Dwarf Mosaic Virus	18.80	Vegetative stage	-	25.30	74.70	100.0
12. Grain rot	2.00	Reproductive stage	-	62.50	37.50	100.0
13. Store grain Rot	1.80	Reproductive stage	-	42.90	57.10	100.0
14. Aspergillus ear rot	1.30	Seedling, vegetative, reproductive	-	-	100.00	100.0
15. Fusarium ear rot	1.50	Seedling, vegetative, reproductive	66.70	-	33.30	100.0
16. Penicillium ear rot	3.80	Seedling, vegetative, reproductive	-	26.70	73.30	100.0

Name of disease	**% Farmers' response on disease infection**					
	Presence of disease	**Stage of crop infected**	**Presence of disease**			
			High	**Medium**	**Low**	**Total**
17. Stenocarpella ear rot	1.50	Seedling, vegetative, reproductive	-	66.70	33.30	100.0
18. Corn stunt	5.50	Seedling, vegetative, reproductive	4.50	9.10	86.40	100.0
19. Leaf Virus	5.50	Seedling, vegetative, reproductive	4.50	9.10	86.40	100.0
20. Maize streak virus	14.80	Seedling, vegetative, reproductive	3.40	18.60	78.00	100.0
21. Sugarcane mosaic virus	2.00	Seedling, vegetative, reproductive	-	25.00	75.00	100.0
22. Downy mildew	3.80	Seedling, vegetative, reproductive	-	46.70	53.30	100.0
23. Field Corn Nematode	0.50	Seedling, vegetative, reproductive	-	50.00	50.00	100.0
24. Other disease						
Multiple response						

4.1.9. Relationship among insect pest, disease and weed infestation in maize field

Most (80.25%) of the farmers expressed their opinion that the there were positive relationship among insect pest, disease and weed infestation in the maize field, whereas only 19.75% farmers expressed their negative opinion (Table 4.9.).

Table 4.9. Farmers' opinion on the relationship among insect pests, diseases and weed infestation in the maize field.

Types of response	Response on the relationship	
	No. of respondents	% Response
Yes	321	80.25
No	79	19.75
Total	**400**	**100**

4.1.10. Degree of relationship among insect pests, diseases and weed infestation in the maize field

There was a positive and high degree of relationship among insect pest and disease incidence with weed infestation; as well as disease infection with the incidence of insect vector in the maize field (Table 4.10). This result indicates insect infestation and disease infection become high when weed infestation become high expressed by the 44.50% and 45.25% farmers, i.e., insect infestation and disease infection increased with the increase of the weed infestation. Similarly, disease infection become high when insect vector populations become high expressed by the 25.25% farmers, i.e., disease infection was increased with the increase of the vector population. But the maximum (50.75%) farmers did not reply about the degree of relationship between disease infection and vector population. From this finding it was revealed that weed infestation enhanced the insect pest population and disease incidence; similarly, insect vector also enhanced the incidence of disease infection in the maize field.

Table 4.10. Farmers' response on the degree of relationship among insect pest, disease and weed infestation in the maize field

Relationship	Response (%) on the degree of relationship				
	High	Medium	Low	Don't Know	Total
1. Insect infestation high when weed infestation	44.50	20.00	9.20	26.30	100.0

2. Disease infestation high when weed infestation	45.25	15.75	8.50	30.50	100.0
3. Disease infestation high when vector insect	25.25	15.50	8.50	50.75	100.0

4.1.11. Storage of maize seeds by the farmers

Maximum (55.50%) farmers expressed their opinion that they did not preserve maize seeds in storage, whereas only 4.25% farmers said that they store the maize seeds in storage (Table 4.11). On the other hand, 40.25% farmers did not express their opinion about storage of maize seeds. From this finding it was revealed that maize seeds were not preserved in storage, but only a small amount was preserved by the few farmers.

Table 4.11. Farmers' response on the storage of maize seeds

Types of response	**Response**	
	No. of respondent	**% Response[100%]**
Yes	17	4.25
No	222	55.50
Not replied	161	40.25
Total	**400**	**100**

4.1.12. Incidence of diseases in stored maize seeds in storage

Among the 400 farmers only few expressed their positive attitude about the disease infestation in stored maize. However, considering the opinion expressed by the farmers, the incidence of diseases of maize seeds in storage were cob rot, grain rot and Aspergillus ear rot. But most of the diseases caused high damage to maize seeds. Polythene bag and earthen container were the most suitable containers for preventing disease infection of maize seeds in storage than other containers (Table 4.12).

Table 4.12. Farmers' response on the disease attack in stored maize seeds

Name of stored Diseases	**Response (%)**									
	Presence of pests	**Level of damage**			**Types of container used for preventing pest attack**					
		High	**Medium**	**Low**	**Jute bag**	**Poly bag**	**Bamboo *dhole***	**Tin**	**Earthen container**	**Total**
1. Cob rot	1.5	67.0	16.50	16.50	16.25	67.5	-	-	16.25	100.0
2. Grain rot	1.0	50.0	25.0	25.0	-	50.0	-	-	50.0	100.0
3. Aspergill	0.5	100.0	-	-	-	-	-	-	-	

us ear rot										
4. Fusarium ear rot	-	-	-	-	-	-	--	-	-	
5. Penicilliu m ear rot	-	-	-	-	-	-	-	-	-	
6. Store grain Rot	-	-	-	-	-	-	-	-	-	
7. Other diseases	-	-	-	-	-	-	-	-	-	

4.1.13. Control measures taken against pests in stored maize grains

Among 400 farmers, only 2.00% of them said that they took control measures against pests in stored maize seeds, whereas 32.75% farmers expressed their opinion that they did not take any control measures against pests in stored maize seeds. But most (65.25%) of the farmers did not reply about the matter, i.e., they were not aware about taking control measures against pests in stored maize grains or they had no necessity to take action (Table 4.13).

Table 4.13. Farmers' response any control measures taken against diseases in stored maize grains

Types of response	Response on control measures taken	
	No. of respondents	% Response
Yes	8	2.00
No	131	32.75
Not replied	261	65.25
Total	**400**	**100.00**

4.1.14. Types of control measures taken against pest of maize seeds in storage

Among 400 farmers, nobody replied about applying any types of control measures against pest of maize seeds in storage. Because, most of the farmers did not preserve maize seeds in storage (Table 4.14).

Table 4.14. Farmers' response on the types of control measures taken against pest of maize seeds in storage

Types of control measures	Response (%) on the control measures taken	
	No. of respondent	% Response
Not replied	400	100

4.1.15. Types of preventive measures taken against pest of maize seeds in storage

Among 400 farmers, nobody replied about taking any types of preventive measures against pest of maize seeds in storage (Table 4.15).

Table 4.15. Farmers' response on the types of preventive measures taken to control pests of maize seeds in storage

Types of preventive measures	Response (%) on the preventive measures taken	
	No. of respondents	% Response
Not replied	400	100

4.1.16. Types of curative measures taken against pest of maize seeds in storage

Among 400 farmers, nobody replied about taking any types of curative measures against pest of maize seeds in storage(Table 4.16).

Table 4.16. Farmers' response on the types of curative measures taken to control pests of maize seeds in storage

Types of curative measures	Response (%) on the curative measures taken	
	No. of respondent [N=400]	% Response [100%]
Not replied	400	100

4.1.17. Major diseases of maize

According to their opinion the major diseases were stem rot, leaf spot, root rot, cob rot, sheath blight, sheath rot, cob sheath blight, cob sheath rot, leaf blight, bacterial leaf blight, maize dwarf mosaic virus, corn stunt, leaf virus, maize streak virus. Among these diseases, leaf spot, cob rot, leaf blight, sheath blight, bacterial leaf blight, maize dwarf mosaic virus and maize streak virus ranked first to seventh expressed by the 31.75%, 26.50%, 25.25%, 19.25%, 19.25%, 16.0% and 14.75% farmers, respectively. Other important diseases were stem rot, cob sheath blight, cob sheath rot, sheath rot, corn stunt, leaf virus etc (Table 4.17).

Table 4.17. Farmers' response on the major diseases of maize

Name of diseases of maize	Farmers' response on the major diseases	
	No. of respondent [N= 400]	% Response
1. Stem rot	50	12.50
2. Leaf spot	127	31.75
3. Root rot	21	5.25
4. Cob rot	106	26.50
5. Sheath blight	77	19.25
6. Sheath rot	27	6.75
7. Cob Sheath blight	43	10.75
8. Cob Sheath rot	32	8.00
9. Leaf blight	101	25.25
10. Bacterial leaf blight	77	19.25
11. Maize Dwarf Mosaic Virus	64	16.00
12. Grain rot	11	2.75
13. Store grain rot	5	1.25
14. Aspergillus ear rot	8	2.00
15. Fusarium ear rot	5	1.25
16. Penicillium ear rot	9	2.25
17. Stenocarpella ear rot	3	0.75
18. Corn stunt	28	7.00
19. Leaf Virus	28	7.00
20. Maize streak virus	59	14.75

21. Sugarcane mosaic virus	11	2.75
22. Downy mildew	11	2.75
23. Field Corn Nematode	-	
24. Others	34	8.50
Multiple response		

4.1.18. Any measures taken to control disease of maize in the field

Among 400 farmers, majority (47.75%) of them said that they took any measures to control pest of maize in the field. But a large portion of the farmers did not reply the matter, i.e., whether they took any measures or not to control maize pests in the field (Table 4.18).

Table 4.18. Farmers' response on any measures taken to control disease of maize in the field

Types of response	**Response on the measures taken to control pests**	
	No. of respondents	**% Response**
Yes	191	47.75
No	49	12.25
Not replied	160	40.00
Total	**400**	**100**

4.1.19. Types of measures taken to control disease of maize in the field

Among 161 farmers, majority (58.64%) of them taken curative measures to control pests of maize in the field. Whereas 19.37% farmers said that they took preventive measures and 37.17% farmers took both preventive and curative measures for the control maize pest in the field (Table 4.19).

Table 4.19. Farmers' response on the types of measures taken to control disease of maize in the field

Types of measures	**Response (%) on the types of measures taken**	
	No. of respondent [N=191]	**% Response [100%]**
1. Preventive	37	19.37
2. Curative	112	58.64
3. Both	71	37.17

4.1.20. Measures and ways of pest and disease control

Among different methods applied for the management of maize pests in the field, most (95.00%, 86.67 and 31.67%) of the farmers applied pesticides to control insect pests, diseases and weeds, respectively; i.e., application of pesticides was the most widely used method to control maize pests in the field (Table 4.20).

Table 4.20. Farmers' response on the methods of disease control applied in the maize field

Methods of pest control	Response on the methods applied	
	Diseases	
	Nos. [N=240]	% Response
1. Through pesticides	208	86.67
2. Use of resistant variety	93	38.75
3. Use of imported hybrid maize	104	43.33
4. Use seed treatment	50	20.83
5. Cultural practices & control measures	167	69.58
6. Use of barriers to prevent dispersion	119	49.58
7. IPM method	44	18.33
8. Others (if any)	46	19.17

4.1.21 Better management practices for disease control

Considering the farmers' opinion, the better management practices for disease control in maize were the spraying of fungicides such as Dithane M-45, Tilt, Cormil MZ, Acrobat MZ etc. Among these practices spraying of fungicides ranked first expressed by the 24.00% farmers. The most striking matter was that about three-fourth portion (74.50%) of total participated farmers did not reply about the better management practices for disease control of maize, i.e., this large portion of the farmers either did not know about better management practices for disease control or ignored the matter (Table 4.21).

Table 4.21. Farmers' opinion on better management practices for disease control of maize

Better pest management practices	Response on better management of pest	
	No. of respondent [N=400]	% Response
1. Spraying of fungicides such as Dithane M-45, Tilt, Cormil MZ, Acrobat MZ etc	96	24.00
2. Use of IPM	7	1.75
3. Not replied	298	74.50

4.2. KNOWLEDGE OF FIELD LEVEL OFFICERS ON PESTS OF MAIZE AND THEIR RISKS

The results of the Field Level Officers' knowledge on maize quarantine disease including their major categories and sub-categories have been discussed under the following sub-headings:

4.2.1. Status of the participated Field Level Officers' in the study

A total of 80 field level officers of DAE participated in this program as respondent. Among them maximum (70.0%) field level officers were from Upazila Agriculture Extension Officers and SAAO (Sub-assistant Agriculture Officer). They expressed their opinion on Diseases of maize and their risks in Bangladesh, among them both were equal in number (35.0% of total) (Table 4.22). Other participants were UAO (Upazilla Agaricultre officer), AEO (Agricultural Extension Officer), AAEO (Assistant Agriculture Extension Officer) and SAPPO (Sub-assistant Plant Protection Officer).

Table 4.22. Status of the participated field level officers of DAE in study area

Designation	No. of respondents	(%) of Participation
1. UAO	28	35.00

2. AEO	14	17.50
3. AAEO/ JAEO	5	6.25
4. SAPPO	5	6.25
5. SAAO	28	35.00
6. Other (please specify)	-	-
Total	**80**	**100.00**

4.2.2. Experiences on maize diseases of the field level officers of DAE in study area

Highly experienced field level officers were participated in the program to express their opinion regarding maize diseases and their risks in Bangladesh. About 67.5% officers had more than 15 years experience in their discipline under DAE comprising 27.5% officers with their more than 25 years service and they had expressed their valuable opinions **(**Table 4.23**)**.

Table 4.23. Length of services of the participated DAE Field Level Officers

Length of service of participated officers	No. of the respondent	Participation (%)
1. 1- 5 years	4	5.00
2. 6-10 years	9	11.25
3. 11- 15 years	13	16.25
4. 16- 20 years	16	20.00
5. 21- 25 years	16	20.00
6. Above 25 years	22	27.50
Total	**80**	**100 %**

4.2.3. Major problems for maize cultivation

The major problems of maize cultivation were the insect attack, disease attack, weed attack, lack of HYV variety, use of imported hybrid varieties and lack of irrigation facilities (Table 4.24). Among those most prominent problems were the insect attack, weed attack and disease attack identified by the maximum (86.3%), 76.3%, and 73.8% field level officers respectively.

Table 4.24. Field level officers' opinion on the major problems for maize cultivation

Major problems	Response	
	No. of respondent [N=80]	% Response
1. Insect attack	69	86.25
2. Weed attack	61	76.25
3. Disease attack	59	73.75
4. Lack of HYV variety	51	63.75

5. Use of imported hybrid variety	32	40.0
6. Lack of irrigation facilities	19	23.75
7. Store grain pest attack	10	12.50
8. Lack of marketing facilities	5	6.25
9. Lack of farmers training facilities on Maize	3	3.75
10. Pesticides and pest control measures	1	1.25
11. Use of imbalanced doses of chemical fertilizers	0	0.0

4.2.4. Knowledge about the presence of harmful diseases of maize those were not seen earlier in the study area

Most of the field level officers (85%) expressed that they had no idea about the currently presence of harmful diseases of maize those were not seen earlier (Table 4.25). On the other hand only 15% officers expressed their positive opinion about the presence harmful diseases of maize those were not seen earlier. This result indicates that the most of the officers were not aware about the quarantine diseases of maize in Bangladesh.

Table 4.25. Knowledge of the Field level officers on presence of harmful diseases those were not seen earlier

Types of response	Response	
	No. of respondents	% Response
Yes	12	15
No	68	85
Total	80	100

4.2.5. Status on current maize diseases those were not seen earlier, their damage and sources of maize seeds used.

The harmful diseases of maize those were not seen earlier were leaf blight, leaf spot, mosaic virus and cob blight (Table 4.26). These diseases mainly attacked hybrid varieties of maize such as Pacific, Uttoron, 900M, 900M gold etc. All these diseases attacked maize at both vegetative and reproductive stages. The main sources of maize seeds were the seed dealer and BADC.

Table 4.26. Field level officers response on the existing quarantine diseases, variety & stage attacked, and source of maize seed

Quarantine Diseases	Maize variety attacked	Crop stages attacked	Source of seeds
1. Leaf blight	Pacific (hybrid), Uttaron, 900M	Vegetative & reproductive	Dealer, BADC
2. Leaf spot	Pacific (hybrid),	Vegetative &	Dealer,

	Uttaron, 900M	reproductive	BADC
3. Mosaic virus	Uttaron, 900M	Vegetative & reproductive	Dealer, BADC
4. Cob blight	Uttaron, 900M	Reproductive	BADC

4.2.6. Incidence of disease in the maize field

Considering the opinion expressed by the field level officers of DAE, regarding the incidence of disease of maize in field were stem rot, leaf spot, root rot, cob rot, sheath blight, sheath rot, cob sheath blight, cob sheath rot, leaf blight, bacterial leaf blight, maize dwarf mosaic virus, grain rot, store grain rot, Aspergillus ear rot, Fusarium ear rot, Penicillium ear rot, corn stunt, leaf virus, maize streak virus, sugarcane mosaic virus, and downy mildew (Table 4.27).

Among these diseases leaf spot ranked first followed by leaf blight, sheath rot expressed by 35.0%, 32.5% and 22.5% officers, respectively. More or less all stages of the maize crop were attacked by the diseases, where the dominating disease leaf spot, leaf blight and sheath blight caused infections at vegetative and reproductive stages of the maize crops. The infestation intensity of the most of the diseases was low expressed by the most of the officers. Whereas cob sheath blight, store grain rot, Fusarium ear rot and sugarcane mosaic virus caused medium infection intensity expressed by the maximum field level officers.

Table 4.27. Field Level Officers' opinion on the incidence of diseases of maize

Name of diseases	% Response officers on disease incidence					
	Presence of diseases	Stage of crop infection	Infection intensity			
			High	Medium	Low	Total (%)
1. Leaf spot	35.0	Vegetative and reproductive stage	-	21.4	78.6	100
2. Leaf blight	32.5	Vegetative and reproductive stage	3.8	7.7	88.5	100
3. Sheath blight	22.5	Vegetative and	-	11.1	89.9	100

		reproductive stage				
4. Stem rot	17.5	Seedling and vegetative stage	-	14.3	85.7	100
5. Root rot	16.3	Seedling and vegetative stage	-	18.8	69.2	100
6. Cob rot	12.5	Reproductive stage	-	10.0	90.0	100
7. Sheath rot	6.3	Vegetative and reproductive stage	-	-	100.0	100
8. Cob Sheath blight	10.0	Reproductive stage	-	50.0	50.0	100
9. Cob Sheath rot	3.8	Reproductive stage	-	-	100.0	100
10. Bacterial leaf blight	10.0	Vegetative and reproductive stage	-	12.5	87.5	100
11 Maize Dwarf Mosaic Virus	8.8	Vegetative stage	14.3	-	85.7	100
12. Grain rot	8.8	Reproductive stage	-	14.3	85.7	100
13. Store grain Rot	5.0	Reproductive stage	-	50.0	50.0	100
14. Aspergillus ear rot	3.8	Reproductive stage	-	-	66.7	66.7
15. Fusarium ear rot	2.5	Reproductive stage	-	50.0	50.0	100
16. Penicillium ear rot	2.5	Reproductive stage	-	-	100.0	100
17. Stenocarpella ear rot	-	Reproductive stage	-	-	-	-
18. Corn stunt	1.3	Vegetative stage	-	-	100.0	100
19. Leaf Virus	10.0	Vegetative stage	-	-	100.0	100
20. Maize streak virus	3.8		-	33.3	66.7	100
21. Sugarcane mosaic virus	6.3	Vegetative stage	-	60.0	40.0	100
22. Downy mildew	3.8	Vegetative stage	-	33.3	66.7	100
23. Field Corn Nematode	-	Vegetative stage	-	-	-	-
24. Other diseases	2.5		-	100.0	-	100

Diseases of maize seeds in storage

Among the 80 respondent officers, only a few expressed their positive attitude about the disease infection for stored maize. However, considering the opinion expressed by the officers of DAE, the incidence of disease of maize seeds in storage were cob rot, grain rot, Aspergillus ear rot, Fusarium ear rot, Penicillium ear rot and store grain rot.

Polythene bag was the best container for preventing disease infection of maize seeds in storage than other containers (Table 4.28).

Table 4.28. Field Level Officers' response on the pests attack in stored maize seeds

Name of stored Grain Diseases of maize	Response (%)								
	Presence of pests	Level of damage			Types of container used for preventing pest attack				
		High	Medium	Low	Jute bag	Poly bag	Bamboo *dhole*	Tin	Earthen container
1. Grain rot	7.5	-	16.7	83.3	20.0	60.0	20.0	40.0	40.0
2. Aspergillus ear rot	5.0	25.0	-	50.0	50	-	50	50	-
3. Store grain Rot	5.0	-	25.0	25.0		100			
4. Penicillium ear rot	2.5	-	-	100		100			
5. Cob rot	1.3	100	-	-	-	100.0	-	-	--
6. Fusarium ear rot	1.3	-	-	100	-	100	-	-	-
7. Stenocarpella ear rot	-	-	-	-	-	-	-	-	-
8. Corn stunt	-	-	-	-	-	-	-	-	-
9. Other diseases	-	-	-	-	-	-	-	-	-

4.2.7. Relationship among insect pests, diseases and weed infestation in maize field

Most of the field level officers (76.3%) said there were positive relation among insect pests, diseases and weed infestation in the maize field, only 23.8% officers expressed their negative opinion (Table 4.29).

Table 4.29. Field level officers' opinion on the relationship among insect pests, diseases and weed infestation in the maize field

Types of response	Response on the relationship	
	No. of respondents	% Response
Yes	61	76.25
No	19	23.75
Total	**80**	**100**

4.2.8. Degree of relationship among insect pests, diseases and weed infestation in the maize field

There were positive and high degree relationships of insect infestation and disease infection with weed infestation, respectively; as well as disease infection with the incidence of insect vector in the maize field (Table 4.30). This result indicates insect infestation and disease infection become high when weed infestation become high expressed by the 45.0% and 35.0% field level officers, i.e., insect infestation and disease infection increases with the increase of the weed infestation. Similarly,

disease infection become high when insect vector population become high expressed by the 33.8% officers, i.e., disease infection increases with the increase of the vector population. From this finding it was revealed that weed infestation enhanced the insect infestation and disease as well as insect vector enhanced the disease infection in the field of maize.

Table 4.30. Field level officers' response on the degree of relationship among insect pests, diseases and weed infestation in the maize field

Relationship	Response (%) on the degree of relationship			
	High	Medium	Low	Don't Know
16.1. Insect infestation high when weed infestation	45	25	8.8	21.2
16.2. Disease infection high when weed infestation	35	22.5	13.8	28.7
16.3. Disease infection high when vector insect	33.8	21.3	11.2	33.7

4.2.9. Probable sources of maize pests comings

The probable sources of diseases were from seed borne diseases in seeds, outside country (cross boundary), imported hybrid seeds, within country, soil borne, local seeds, use of imbalanced fertilizer (Table 4.31). Among these seed borne source was ranked first which played role as source of pest infestation on maize expressed by the maximum (36.3%) field level officers participated in the program. Second most important source was the cross boundary (outside country) expressed by the maximum (11.3%) officers.

Table 4.31. Field level officers' response on the probable sources of maize disease

Probable sources	Response	
	No. of respondents	% Response
1. Seed borne	29	36.3
2. Outside country (cross boundary)	9	11.3
3. Imported hybrid seeds	6	7.5
4. Within country	5	6.3
5. Soil borne	5	6.3
6. Local seeds	3	3.9
7. Farmers' owned seeds	2	2.5
8. Use of imbalanced fertilizer	1	1.3
9. Through irrigation water	0	0
10. Ineffectiveness of Pesticides	0	0
11. Other sources (if any)	19	23.9

4.2.10. Probable ways of spreading of maize disease

Among the probable ways of spread out of maize diseases as depicted in Table 4.32, affected seeds and imported seeds were the most important ways those were ranked first and second respectively expressed by the maximum (53.8% and 50.0%, respectively) field level officers. Other important ways of spread of maize pests were weeds, wind, grasses, and imported seeds from India expressed by the 36.3%, 32.5%, 30.0% and 23.8% field level officers. Irrigation water, plant debris, birds, rain water, pulse seeds were also played role as probable ways in spreading maize pests.

Table 4.32. Field level officers' response on the probable ways of spread of maize disease

Probable ways of spread of maize disease	Response	
	No. of respondents [N=80]	% Response
1. Affected seeds	43	53.8
2. Imported seeds	40	50.0
3. Weed	29	36.3
4. Wind	26	32.5
5. Grasses	24	30.0
6. Imported seeds from India	19	23.8
7. Irrigation water	15	18.8
8. Crop debris	15	18.8
9. Bird	9	11.3
10. Rain water	4	5.0
11. Pulses seeds	4	5.0
12. Rice seed	2	2.6
13. spreads through human being	-	-
14. Other source		

4.2.11. Any idea about the presence of maize pests in neighboring countries

Most of the field level officers (76.3%) expressed their positive idea about pests of maize presence in neighboring countries, i.e., the neighboring countries might play role as sources from where they come in Bangladesh (Table 4.33).

Table 4.33. Field level officers' response on the idea about the maize pests in neighbouring countries

Types of response	Response	
	No. of respondents	% Response
Yes	61	76.25
No	19	23.75
Total	80	100.0

4.2.12.1. Any idea about quarantine pest of maize coming from neighboring countries in Bangladesh

Most of the field level officers (76.3%) expressed their positive idea about quarantine pests of maize coming from neighboring countries in Bangladesh, i.e., the neighboring countries were the main sources of quarantine pests those coming through crossing boundary and infesting maize crops in Bangladesh **(**Table 4.34**)**.

Table 4.34. Field level officers' opinion on any idea about quarantine pests of maize coming from neighboring countries in Bangladesh

Types of response	**Response**	
	No. of respondents	**% Response**
Coming from neighboring countries	61	76.25
Not coming from neighboring countries	19	23.75
Total	**80**	**100**

4.2.12.2. Knowledge about quarantine diseases of maize coming from neighboring countries in Bangladesh

According to the field level officers' opinion, the quarantine diseases of maize coming from neighboring countries were leaf blight, seed rot, stem rot, bacterial leaf blight and mosaic virus **(**Table 4.35**)**. Among them, bacterial leaf blight and leaf blight ranked first and second expressed by the 24.59% and 16.39% officers. On the other hand, the respondents who had given positive idea, most of them (80.33%) did not reply about the name of quarantine diseases which were coming in Bangladesh through crossing boundary of neighboring countries.

Table 4.35. Field level officers' opinion on the knowledge of quarantine diseases of maize coming from neighboring countries in Bangladesh

Name of Quarantine Diseases	**Response**	
	No. of respondent [N=61]	**% Response**
1. Bacterial leaf blight	15	24.59
2. Leaf blight	10	16.39
3. Mosaic virus	5	8.20

4. Seed rot	2	3.28
5. Stem rot	2	3.28
6. Not replied	49	80.33

4.2.13. Possible reasons for coming of quarantine disease of maize from neighboring countries in Bangladesh

According to the field level officers' opinion, the possible reasons for coming of quarantine pests from neighboring countries were illegal introduction of seeds, relax of quarantine law, weakness of the existing quarantine stations, lack of proper seed health test, seed importation. Among them, relax of quarantine law and weakness of the existing quarantine stations ranked first and second, respectively expressed by the 11.3% and 8.8% officers **(**Table 4.36**)**. On the other hand, the respondents who had given positive idea, most of them (58.8%) did not reply about the reasons for coming of quarantine pests from neighboring countries in Bangladesh through crossing boundary of neighboring countries.

Table 4.36. Field level officers' response on the possible reasons for coming of quarantine pests of maize from neighboring countries in Bangladesh

Possible reasons	Response	
	No. of respondent [N=61]	% Response
1. Not replied	47	58.8
2. Relax of quarantine law	9	11.3
3. Weakness of the existing quarantine stations	7	8.8
4. Illegal introduction of seeds	6	7.5
5. Lack of proper seed health test	6	7.5
6. Seed importation	6	7.5

4.2.14. Method of ascertain about the disease of maize

The significant methods through which the field level officers can ascertain the specific disease of the maize were observation, symptom analysis and listening from farmers expressed by the 56.3%, 55.0% and 55.0% officers **(**Table 4.37**)**. On the other hand, only 5.0% officers expressed their opinion that they dependent on the laboratory test for the confirmation of about the disease of maize, although the laboratory test is the real method of confirmation.

Table 4.37. Field level officers' opinion on the method of ascertain about the disease of maize crops

Method of confirmation	Response	
	No. of respondents [N=80]	% Response
1. Observation	45	56.3
2. Symptom analysis	44	55.0
3. Listening from farmers	44	55.0

4. Laboratory test	4	5.0
5. Other (if any)	0	0.0

4.2.15. Frequency of field visit for monitoring disease of maize

Maximum (56.25%) field level officers expressed their opinion that they visited the farmers' field weekly for monitoring pests and other purposes of the maize. Whereas, 20.0% officers said that they visited the maize field quarterly **(**Table 4.38**)**.

Table 4.38. Field level officers' response on the frequency of field visit for monitoring pests of maize

Types of response	Response (%) on the field visit	
	No. of respondents	**% Response**
1. Weekly	45	56.25
2. Quarterly	16	20.00
3. Monthly	9	11.25
4. Occasionally	7	8.75
5. Frequently	3	3.75
Total	**80**	**100**

4.2.16. Spread of diseases of maize occurred through imported seeds

Maximum (53.8%) field level officers expressed their opinion that the spreading of disease pests of maize occurred through imported seeds (Table 4.39).

Table 4.39. Field level officers' opinion on the spread of diseases occurred through imported seeds

Types of response	Response	
	No. of respondents	**% Response**
Yes	43	53.75
No	37	46.25
Total	80	100

4.2.17. Methods of control for quarantine pests of maize

Most of the field level officers (70.0%) expressed that seed treatment was the best method of quarantine pest control of maize than other methods viz. pest free imported hybrid variety of maize (61.3%) and cultural practices as control measures (58.8%) (Table 4.40).

Table 4.40. Field level officers' opinion on methods of control for quarantine diseases of maize

Methods of control	Response	
	No. of respondent	**% Response**

	[N=80]	
1. Through seed treatment	56	70.0
2. Pest free imported hybrid variety	49	61.25
3. Cultural practices as control measures	47	58.75
4. Farmers Training	36	45.0
5. Using pesticides	30	37.5
6. Barriers to dispersion	22	27.5
7. Using resistant variety	16	20.0

4.2.18. Alternate hosts of maize diseases in the field

The alternate hosts of leaf blight and stem rot were vegetables; as well as sheath blight and bacterial leaf blight used wheat and paddy. (Table 4.41)

Table 4.41. Field level officers' opinion on the alternate hosts of maize Diseases

Maize pests	Alternate hosts
1. Leaf blight	Vegetables
2. Stem rot	Vegetables
3. Sheath blight	Wheat, paddy
4. Bacterial leaf blight	Wheat, paddy

4.3. KNOWLEDGE OF POLICY LEVEL OFFICERS ON THE DISEASES OF MAIZE AND THEIR RISKS

A total of 20 Policy level officers of DAE participated as respondent one from each district of the study area. The results of the Policy Level Officers' knowledge on the Pest Risk Analysis including quarantine diseases of maize have been discussed under the following sub-headings:

4.3.1. Status of the participated Policy Level Officers in the study

Among 20 Policy level officers of DAE participated in the study, majorities (60.0%) of them were Crop Protection Specialist (CPS) and PPS, in which PPS ranked first (35.0%). Other participants were BADC seed dealer, District Training Officer (DTO), BARI scientist, and Deputy Diretor (DD) of DAE (Table 4.42).

Table 4.42. Designation of the Policy level officer in the study

Designation	No. of respondent [N=20]	Participation (%)
1. Deputy Director (DD)	1	5.0
2. District Training Officer (DTO)	2	10.0
3. Crop Protection Specialist (CPS)	5	25.0
4. Plant Protection Specialist (PPS)	7	35.0
Researcher	-	-

5. BARI Scientist	2	10.0
6. BADC Seed Officer	3	15.0
7. Others	-	-

4.3.2. Quarantine diseases of maize

According to the opinion expressed by the Policy level officers of DAE, the quarantine diseases of maize were stem rot, leaf spot, root rot, cob rot, sheath blight, sheath rot, cob sheath blight, cob sheath rot, leaf blight, bacterial leaf blight, maize dwarf mosaic virus, grain rot, store grain rot, Aspergillus ear rot, Fusarium ear rot, Penicillium ear rot, corn stunt, leaf virus, maize streak virus, sugarcane mosaic virus, and downy mildew (Table 4.43). Among these ranked order of top ten diseases were leaf blight, stem rot, leaf spot, cob rot, Aspergillus ear rot, sheath blight, downy mildew, stored grain rot, grain rot, and leaf virus expressed by the 55.0%, 50.0%, 45.0%, 35.0%, 35.0%, 30.0%, 30.0%, 25.0%, 20.0% and 20.0%, respectively.

Table 4.43. Opinion of the Policy Level Officers on quarantine diseases of maize

Name of the diseases	Response on quarantine diseases	
	No. of respondent]	% Response
1. Stem rot	10	50.0
2. Leaf spot	9	45.0
3. Root rot	3	15.0
4. Cob rot	7	35.0
5. Sheath blight	6	30.0
6. Sheath rot	3	15.0
7. Cob sheath rot	3	15.0
8. Cob sheath blight	3	15.0
9. Leaf blight	11	55.0
10. Bacterial leaf blight	3	15.0
11. Maize dwarf mosaic virus	3	15.0
12. Grain rot	4	20.0
13. Stored grain rot	5	25.0
14. Aspergillus ear rot	7	35.0
15. Fusarium ear rot	3	15.0
16. Penicillium ear rot	2	10.0
17. Corn stunt	1	5.0
18. Leaf virus	4	20.0
19. Maize streak virus	2	10.0
20. Downey mildew	6	30.0

4.3.3. Knowledge about the incidence of the harmful diseases of maize those were not seen earlier

Most (90.0%) of the Policy level officers expressed that they had no idea about the currently presence of harmful diseases of maize those were not seen earlier (Table 4.44). On the other hand only 10%.0 officers expressed their positive opinion about the presence harmful diseases of maize those were not seen earlier. This result indicates that the most of the officers were not aware about the quarantine pests of maize in Bangladesh.

Table 4.44. Knowledge of the Policy level officers on presence of disease pests those were not seen earlier in the study area

Types of response	Response	
	No. of respondents	% Response
Yes	2	10.0
No	18	90.0
Total	**20**	**100**

4.3.4. Current status of the quarantine pests of maize, their damage and sources of maize seeds used

The existing quarantine pests of maize were designated by the policy level officers of DAE during study period.

Existing quarantine diseases

The policy level officers expressed their opinion that the existing quarantine diseases of maize were leaf blight, leaf spot, mosaic virus, cob blight and cob sheath blight (Table 4.45). Considering the opinion expressed by the officers, all hybrid varieties of maize especially Pacific hybrid, Uttoron, 900M etc were attacked by these quarantine diseases. Among these diseases, leaf blight, leaf spot, mosaic virus attacked maize at vegetative and reproductive stages of the crops; cob blight attacked at reproductive stage. The sources of maize seeds cultivated by the farmers were seed dealers and BADC expressed by the policy level officers of DAE.

Table 4.45. Policy level officers' opinion on the existing quarantine pests, variety & stages of maize attacked, and source of maize seed used for cultivation

Quarantine Pests	Maize variety attacked	Crop stages attacked	Source of seeds
Disease			
1. Leaf blight	All hybrid varieties- Pacific hybrid, Uttaron	Vegetative & reproductive	Dealer, BADC
2. Leaf spot	Pacific hybrid, Uttaron, 900M	Vegetative & reproductive	Dealer, BADC
3. Mosaic virus	Uttaron, 900M	Vegetative & reproductive	Dealer, BADC
4. Cob blight	Uttaron, 900M	Reproductive	Dealer, BADC
5. Cob sheath blight	Uttaron, 900M	Reproductive	Dealer, BADC

4.3.5. Major diseases of stored maize

The major diseases of stored maize seeds were designated by the policy level officers during the study. The major diseases were cob rot, grain rot and stored grain rot. Among them grain rot and cob rot ranked first and second expressed by the 100.0% and 90.0% officers (Table 4.46).

Table 4.46. Policy level officers' opinion on the major diseases of stored maize seed.

Diseases	Response on the major diseases	
	No. of respondent [N=20]	% Response [100%]
1. Cob rot	18	90.0
2. Grain rot	20	100.0
3. Aspergillus ear rot	-	-
4. Fusarium ear rot	-	-
5. Penicillium ear rot	-	-
6. Stenocarpella ear rot	-	-
7. Corn stunt	-	-
8. Stored grain rot	8	40.0
9. Others	-	-

4.3.6. Idea about the presence of maize diseases in neighboring countries

Most of the policy level officers (90.0%) expressed their negative opinion about the presence of maize diseases in neighboring countries, but only 10.0% officers expressed their positive opinion about diseases of maize presence in neighboring countries from where the maize diseases might come in Bangladesh (Table 4.47).

Table 4.47. Policy level officers' opinion on any idea about the maize diseases in neighboring countries

Types of response	Response	
	No. of respondents [N=20]	% Response [100%]
Yes	2	10.0
No	18	90.0
Total	20	100.0

4.3.7. Any idea about quarantine diseases of maize coming from neighboring countries in Bangladesh

Maximum (60.0%) policy level officers expressed that they had idea about quarantine pests of maize coming from neighboring countries through crossing boundary in Bangladesh (Table 4.48).

Table 4.48. Policy level officers' opinion on quarantine diseases of maize coming from neighboring countries in Bangladesh

Types of response	Response	
	No. of respondents	% Response
Coming from neighboring countries	12	60
Not coming from neighboring countries	8	40
Total	**20**	**100.0**

4.3.8. Relationship among insect pests, diseases and weed infestation in maize field

Most of the policy level officers (90.0%) expressed their opinion that there were positive relationships among insect pest, disease and weed infestation in the maize field, i.e., level of infestation of one pest depended on other pest population in the maize field. On the other hand only 10.0% officers expressed that there was no relationship among them (Table 4.49).

Table 4.49. Policy level officers' opinion on the relationship among insect pests, diseases and weed infestation in the maize field

Types of response	Response on the relationship	
	No. of respondents	% Response
Presence of relationship	18	90.0
No relationship	2	10.0
Total	20	100

4.3.9. Degree of relationship among insect pests, diseases and weed infestation in the maize field

There was positive and high degree of relationships among insect and disease incidence with weed infestation, respectively; similarly disease incidence with the incidence of insect vector population in the maize field (Table 4.50). This result indicated that the insect infestation and disease infection become high when weed infestation become high expressed by the 65.0% and 55.0% policy level officers, i.e., the incidence of insect infestation and disease infection increased with the increase of weed infestation. Similarly, incidence of disease infection become high when insect vector population become high expressed by the 75.0% officers, i.e., incidence of disease infection increased with the increase of the vector population. From this finding it was revealed that incidence of weed infestation enhanced the incidences of

insect infestation and disease infection; similarly population of insect vector enhanced the incidence of disease infection in maize field.

Table 4.50. Policy level officers' opinion on the degree of relationship among insect pests, diseases and weed infestation in the maize field

Types of relationship	%Response on the degree of relationship				
	High	Medium	Low	Don't Know	Total
1. Insect infestation high when weed infestation	65.0	35.0	-	-	100
2. Disease infection high when weed infestation	55.0	20.0	15.0	10.0	100
3. Disease infection high when vector insect	75.0	10.0	15.0	-	100

4.3.10. Infestation severity of maize pests in different growing seasons

According to the policy level officers' opinion, infestation severity of different disease pests of maize comparatively higher in Rabi season than Kharif season.

Disease infection in Rabi and Kharif seasons

According to the policy level officers' opinion, the most important diseases of maize those caused infection in Rabi season and Kharif seasons were stem rot, sheath blight, leaf spot, sheath rot, corn leaf blight, bacterial leaf blight, maize dwarf mosaic virus and cob rot (Table 4.51). Among which sheath blight and leaf spot caused damage with high infection intensity; stem rot medium intensity; sheath rot, corn leaf blight, bacterial leaf blight, maize dwarf mosaic virus and cob rot caused damage with medium to low infestation intensity during Rabi season. On the other hand, all these diseases caused damage in maize crops with low infestation intensity during Kharif season.

Table 4.51. Policy level officers' opinion on the infestation severity of maize pests in different seasons

Maize diseases	Infestation severity	
	Rabi season	Kharif season
1. Stem rot	Medium	Low
2. Sheath blight	High	Low
3. Leaf spot	High	Low
4. Sheath rot	Medium to low	Low
5. Corn leaf blight	Medium to low	Low
6. Bacterial leaf blight	Medium to low	Low
7. Maize dwarf mosaic virus	Medium to low	Low
8. Cob rot	Medium to low	Low

4.3.11. Any effect of weather factors on the increase of maize disease population

All the policy level officers (100.0%) participated in the study expressed their opinion that weather factors have effect on the maize disease population, i.e., weather factors influenced on the increase of the incidence of maize pest population (Table 4.52).

Table 4.52. Policy level officers' opinion on any effect of weather factors on the increase of maize disease population

Types of response	Response on the effect of weather factors	
	No. of respondents	% Response \
Yes	20	100
No	-	-
Total	**20**	**100**

4.3.12. Degree of relationship among the weather factors and maize disease population

(a) Degree of relationship between temperature and maize disease population

According to the opinion expressed by the policy level officers, the degree of relationship between disease infection with temperature maintaining high opined by the 55.0% officers (Table 4.53).

(b) Degree of relationship between relative humidity and maize disease population

According to the opinion expressed by the policy level officers, the degree of relationship between disease infection with relative humidity were medium opined by the 75.0% officers (Table 4.53).

(c) Degree of relationship between rainfall and maize disease population

According to the opinion expressed by the policy level officers, the degree of relationship between disease infection with rainfall were medium opined by the 80.0% officers (Table 4.53).

Table 4.53. Policy level officers' opinion on the degree of effect of weather factors on the increase of disease population

Weather factors	The degree of effect on Disease population		
	High	Medium	Low
1. Temperature	55	45	-
2. Relative humidity	25	75	-
3. Rainfall	20	80	-

4.3.13. Any idea about the imported hybrid seeds of maize are the source of quarantine diseases

Maximum (60.0%) policy level officers expressed their opinion that the imported hybrid seeds of maize were the source of quarantine diseases, i.e., the quarantine pests of maize were coming from outside of Bangladesh through the importation of hybrid seeds of maize (Table 4.54).

Table 4.54. Policy level officers' opinion on any idea about the imported hybrid seeds of maize are the source of quarantine diseases

Types of response	Response	
	No. of respondents	% Response
Yes	12	60
No	8	40
Total	**20**	**100**

4.3.14. Any preventive measures taken to keep free from quarantine diseases of maize

Maximum (70.0%) policy level officers said no preventive measures were taken to keep free from quarantine pest of maize. But only 30.0% officers said that the curative measures were taken to keep free from quarantine pest of maize (Table 4.55).

Table 4.55. Policy level officers' opinion on any preventive measures taken to keep free from quarantine diseases of maize

Types of response	Response	
	No. of respondents	% Response
Yes	6	30
No	14	70
Total	**20**	**100**

4.3.15. Types of preventive measures taken to keep free from quarantine disease of maize

Maximum (50.00%) policy level officers expressed their opinion that the seed treatment as well as use of locally developed hybrid variety of maize might be the most effective preventive measures to keep free from quarantine disease of maize. Other important preventive measures were use of disease free seeds and application of pesticides in the maize field expressed by the 33.33% and 16.67% officers, respectively (Table 4.56).

Table 4.56. Policy level officers' opinion on types of preventive measures taken to keep free from quarantine diseases of maize

Types of preventive measures	Response	
	No. of respondents	% Response
1. Use of pest free seeds	2	33.33
2. Seed treatment	3	50.00
3. Use of pesticides	1	16.67
4. Use of locally developed hybrid seeds	3	50.00
Multiple response [N=6]		

4.3.16. Effectiveness of protective measures against quarantine diseases of maize

Most (75.0%) policy level officers expressed their opinion that they had no any idea about the effectiveness of protective measures against quarantine disease of maize; whereas only 25.0% officers opined that they had idea about the effectiveness of protective measures against quarantine disease of maize (Table 4.57).

Table 4.57. Policy level officers' opinion on any idea about the effectiveness of protective measures against quarantine disease of maize

Types of response	Response	
	No. of respondents	% Response
Yes	5	25.0
No	15	75.0
Total	**20**	**100**

4.3.17. Reasons for non-effectiveness of the protective measures against quarantine diseases of maize

Among the officers who had idea (25.0% of total) about the protective measures taken against quarantine disease of maize, all (100.0%) of them did not reply about the reasons for non-effectiveness of the protective measures against quarantine disease of maize. This result indicated that the policy level officers did not know the reasons for non-effectiveness of the protective measures taken against quarantine disease of maize in Bangladesh (Table 4.58).

Table 4.58. Policy level officers' opinion on the reasons for non-effectiveness of the protective measures against quarantine pest of maize

Reasons	Response	
	No. of respondent	% Response
Replied	0	0.0
Not replied	20	100.0
Total	**20**	**100.0**

4.3.18. Major threats due to introduction of quarantine diseases of maize

Considering the opinion expressed by the policy level officers, most of officers opined that the major problems would be created due to introduction of quarantine pest of maize were outbreak of new disease and disease biotype; and high intensity of crop damage. Among these problems, outbreak of new disease infection, high intensity of crop damage and outbreak of new disease biotype ranked first, second and third expressed by the 90.0%, 85.0% and 70.0% officers (Table 4.59).

Table 4.59. Policy level officers' opinion on the major problems would be created due to introduction of quarantine diseases of maize

Major problems/threats	Response

	No. of respondent	% Response
1. Outbreak of new disease infection	18	90.0
2. Outbreak of new disease biotype	14	70.0
3. High intensity of crop damage	17	85.0
4. Other damage	-	-
Multiple response **[N=20]**		

4.3.19. Any direct action taken or monitoring of quarantine diseases of maize

Maximum (65.0%) policy level officers said that no direct actions were taken against quarantine diseases of maize or no monitoring was done for quarantine diseases of maize. On the other hand, only 35.0% officers expressed that they took direct actions against quarantine diseases or monitoring was done for quarantine diseases of maize (Table 4.60).

Table 4.60. Policy level officers' opinion on any direct action taken or monitoring of quarantine diseases of maize

Types of response	Response	
	No. of respondents	% Response
Yes	7	35.0
No	13	65.0
Total	**20**	**100**

4.3.20. Types of direct action taken to keep maize free from quarantine diseases

Among the policy level officers who (35.0% of total) had taken direct action to keep maize free from quarantine diseases, maximum (42.86%) of them took training of farmers, and visited the maize field and then gave advice to the farmers. Other important actions were advice to use the treated maize seeds, training of staffs and advice to use resistant variety of maize expressed by the 28.57%, 14.29% and 14.29% policy level officers (Table 4.61).

Table 4.61. Policy level officers' opinion on the types of action taken to keep maize free from quarantine diseases

Types of action taken	Response	
	No. of respondent	% Response
1. Training of farmers	3	42.86
2. Training of staffs	1	14.29
3. Field visit and advice given	3	42.86
4. Advice to use treated seeds	2	28.57
5. Advice to use resistant variety	1	14.29
Multiple response [N=7]		

4.3.21. Adequacy of the existing quarantine services to control the quarantine diseases of maize in Bangladesh

Most (90.0%) of the policy level officers expressed their opinion that the existing quarantine services were no adequate to control the quarantine diseases of maize in

Bangladesh, but only 10.0% officers said that existing quarantine services were adequate (Table 4.62).

Table 4.62. Policy level officers' opinion on the adequacy of the existing quarantine services to control the quarantine disease of maize in Bangladesh

Types of response	Response on adequacy of existing quarantine services	
	No. of respondents	% Response
Adequate	2	10.0
Not adequate	18	90.0
Total	**20**	**100**

4.3.22. Suggestions for the improvement of the quarantine Diseases control in Bangladesh

Considering the opinion expressed by the policy level officers, the improvement strategies to control quarantine diseases of maize in Bangladesh would be the strengthening of existing quarantine station laboratories, establishment of new quarantine laboratory with modern equipment facilities, increase of skilled manpower regarding quarantine pests, proper identification of quarantine pests, training of DAE officials on pest management especially quarantine pests, updating and strengthening of existing quarantine law, proper application of quarantine law, strengthening of quarantine services, enhancement of in-country production of hybrid seed for maize. Among these strategies strengthening of existing quarantine station laboratories, training of DAE officials on pest management especially quarantine pests and increase of skilled manpower regarding quarantine pests ranked first, second and third, respectively expressed by the 55.0%, 40.0% and 30.0% policy level officers participated in the study as respondent (Table 4.63).

Table 4.63. Policy level officers' opinion for the improvement of the quarantine Diseases control strategies in the country

Improvement strategies	Response on improvement strategies	
	No. of respondent	% Response
1. Strengthening of quarantine station laboratory	11	55.0
2. Establishment of modern quarantine laboratory	3	15.0
3. Increase of skilled manpower	6	30.0
4. Proper identification of quarantine diseases	5	25.0
5. Training of DAE officials on diseases management	8	40.0

6. Updating/strengthening of quarantine law	5	25.0
7. Proper application of quarantine law	6	30.0
8. Strengthening of quarantine service	2	10.0
9. Enhancement of in-country production of hybrid seeds	1	5.0
Multiple response [N=20]		

4.4. KNOWLEDGE OF SEED DEALERS ON THE DISEASE OF MAIZE AND THEIR RISKS

The results of the Seed Dealers' knowledge on the diseases of maize and their risks have been discussed below under the following sub-headings:

4.4.1. Status of the participated Seed Dealers in the study

A total of 40 Seed Dealers were participated as respondents, of which two from each district of the survey area. Among them most (80.0%) of the participants were the owner of the enterprise. On the other hand 22.50% dealers were the managers and only 2.5% were sale representatives (Table 4.64).

Table 4.64. Status of the participated seed dealers

Designation	No. of respondent	Participation (%)
1. Owner of enterprise	32	80.0
2. Manager	7	17.5
3. Sale representative	1	2.5
4. Others	32	80.0
Total	**40**	**100.0**

4.4.2. Experience of the seed dealers on maize seed business

Highly experienced seed dealers were participated in the study to express their opinion regarding selling maize seeds, their pests and risks in Bangladesh. About 75.0% seed dealers had more than six years experience in their discipline comprising 50.0% seed dealers with their more than 6 to 10 years in selling maize seeds and they had expressed their valuable opinions (Table 4.65).

Table 4.65. Seed dealers' opinion on the duration involved in selling maize seeds

Duration involved in seed business	No. of the respondent	Participation (%)
1. 1- 5 years	10	25.0
2. 6-10 years	20	50.0
3. 11- 15 years	4	10.0
4. 16- 20 years	3	7.5
5. 21- 25 years	1	2.5
6. Above 25 years	2	5.0
Total	**40**	**100.0**

4.4.3 Sources of maize seed collection for selling

Majority (57.50%) seed dealers collected maize seeds for selling from the importer expressed by their opinion. Other important sources were farmers and BADC expressed by the 40.0% and 32.0% seed dealers. (Table 4.66)

Table 4.66. Seed dealers' opinion on the sources of maize seed collection

Sources	Response on sources of seed collection	
	No. of the respondent	Response (%)
1. Farmers	16	40.00

2. Hole sale dealers	4	10.00
3. Importer	23	57.50
4. BADC	13	32.50
5. Others	14	35.00
Multiple response [N=40]		

4.4.4. Variety of maize seeds selling to the farmers

Most (82.50%) of the seed dealers expressed that they sold hybrid variety of maize to the farmers. Other important varieties were BRAC variety, BADC variety, HYV, BARI variety of maize expressed by the 17.50%, 17.50%, 10.0% and 5.0% dealers. From this finding it was revealed that the hybrid maize varieties were most popular variety of used by the farmers for cultivation (Table 4.67).

Table 4.67. Seed dealers' opinion on variety of maize seeds selling to the farmers

Maize variety	**Response**	
	No. of respondent	**% Response**
1. Local variety	-	-
2. BARI variety	2	5.00
3. HYV	4	10.00
4. Hybrid variety	33	82.50
5. BADC variety	7	17.50
6. BRAC variety	7	17.50
7. Others	5	12.50
Multiple response [N=40]		

4.4.5. Principal basis for selling maize seeds to the farmers

Most (87.5%) of the seed dealers expressed their opinion that they sold the maize seeds to the farmers on the basis of the farmers' demand. Other bases were request from farmers and as usual expressed by the only 5.0% and 2.5% seed dealers (Table 4.68).

Table 4.68. Seed dealers' opinion on the principal basis for selling maize seeds to the farmers

Basis for selling	**Response**	
	No. of respondent	**% Response**
1. Request from farmers	2	5.0
2. On farmers' demand	35	87.5
3. As usual	1	2.5
4. Others	2	5.0
Total	**40**	**100.0**

4.4.6. Any occurrence of crop damage after selling seeds in the area

Most (82.50%) of the seed dealers said they did not hear any occurrence of crop damage after selling maize seeds in they area. But 17.5% dealers expressed their

opinion on the hearing of occurrence of crop damage after selling maize seeds. From this finding it was revealed that the seeds sold by the most of the dealers either were free from pest attack or the objection did not come from the farmers to the seed dealers about the reasons behind the crop damage in the field. (Table 4.69).

Table 4.69. Seed dealers' opinion on the any occurrence of crop damage after selling seeds in the area

Types of response	Response	
	No. of respondents	% Response [100%]
Yes	7	17.5
No	33	82.5
Total	**40**	**100**

4.4.7. Possible reasons for crop damage using seeds from the dealers

Among the seed dealers who (17.5% of total) heard the occurrence of crop damage after selling seeds to the farmers, most (71.43%) of them expressed that insect pest attack was top most reason for crop damage in the field of maize. Other important reasons were bad quality of seeds, unsuitable for environment, disease and weed infestation, expiry validity opined by the 42.86%, 28.57%, 14.29%, 14.29% and 14.29%, respectively. (Table 4.70).

Table 4.70. Seed dealers' opinion on the possible reasons for crop damage after selling seeds to the farmers

Possible reasons	Response	
	No. of respondents	% Response [100%]
1. Bad quality of seed	3	42.86
2. Unsuitable for environment	2	28.57
3. Expired validity	1	14.29
4. Attacked by insect pests	5	71.43
5. Infected by disease	1	14.29
6. Infested by weeds	1	14.29
7. Others	3	42.86
Multiple response [N=7]		

4.4.8. Any seed health test done by the dealers to identify seed borne diseases of maize

Most (85.0%) of the seed dealers opined that they did not do any seed health test to identify the seed borne diseases of maize during storage. On the other hand, 15.0% seed dealers said that they tested the seed health to identify the seed borne diseases of maize during storage. (Table 4.71).

Table 4.71. Seed dealers' opinion on any seed health test done to identify seed borne diseases of maize

Types of response	Response	
	No. of respondents	% Response
Yes	6	15.00
No	34	85.00
Total	**40**	**100**

4.4.9. Any idea about spreads of disease pest of maize from sold seeds

Maximum (52.50%) seed dealers opined that they had no idea about spreads of disease pests of maize from sold seeds. On the other hand, 47.50% seed dealers said that they had idea about spreads of disease pests of maize from sold seeds (Table 4.72).

Table 4.72. Seed dealers' opinion on any idea about spreads of disease pest of maize from sold seeds

Types of response	Response	
	No. of respondents	% Response
Yes	19	47.50
No	21	52.50
Total	**40**	**100**

4.4.10. Any idea about the attack of disease pests of maize by imported hybrid

Most (77.50%) of the seed dealers opined that they had no idea about the attack of insect, disease and weed pests of maize by imported hybrid. On the other hand, 22.50% seed dealers said that they had idea about the attack of insect, disease and weed pests of maize by imported hybrid (Table 4.73).

Table 4.73. Seed dealers' opinion on any idea about the attack of disease pests of maize by imported hybrid

Types of response	Response	
	No. of respondents	% Response
Yes	9	22.50
No	31	77.50
Total	**40**	**100**

4.4.11. Types of maize pest attack by imported hybrid

Among the seed dealers who (22.50% of total) had idea about the attack of insect, disease and weed pests of maize by imported hybrid, all (100.0%) of them opined that insect infestation might be occurred by means of imported hybrid seeds. Other attacks were new weed infestation and disease infection opined by the 44.44% and 11.11%

seed dealers. From this finding it was revealed that the imported hybrid seed might be major sources of insect pest attack in maize. (Table 4.74).

Table 4.74. Seed dealers' opinion on the types of maize pest attack by imported hybrid

Types of attack	Response	
	No. of respondent	% Response
1. Disease infection	4	44.44
2. Insect infestation	9	100.00
3. New weed infestation	1	11.11
Multiple response [N=9]		

4.5. KNOWLEDGE OF PESTICIDE DEALERS ON THE PEST OF MAIZE AND THEIR RISKS

The results of the Pesticide Dealers' knowledge on the pests of maize and their risks have been discussed below under the following sub-headings:

4.5.1. Status of the participated Pesticide Dealers in the study

A total of 40 Pesticide Dealers were participated as respondents, of which two from each district of the survey area. Among them most (77.50%) of the participants were the owner of the enterprise and 22.50% were the managers (Table 4.75).

Table 4.75. Status of the participated pesticide dealer

Designation	No. of respondent	Participation (%)
5. Owner of enterprise	31	77.50
6. Manager	9	22.50
7. Sale representative	-	-
8. Others	-	-
Total	**40**	**100.0**

4.5.2. Suggestions for the improvement of quarantine disease management in maize crops

The suggestions for the improvement of quarantine disease management in maize crops were use of fungicide such as Dithane m-45, Tilt, Cormil MZ, Acrobat MZ, Mencozeb, Metaxyl etc, clean cultivation with weeding, importation of treated seeds and seed treatment before use. Among these suggestions, use of fungicides ranked first expressed by the maximum (58.82%) pesticide dealers (Table 4.76).

Table 4.76. Pesticide dealers' suggestions for the improvement of quarantine disease management in maize crops

Suggestions for disease management	Response	
	No. of respondent	% Response
1. Use of fungicide such as Dithane M-45, Tilt, Cormil MZ, Acrobat MZ, Mencozeb, Metaxyl etc	20	58.82
2. Clean cultivation with weeding	3	8.82
3. Importation of treated seeds	3	8.82
4. Seed treatment before using	1	2.94
5. Not replied	12	35.29
Multiple response [N=34]		

4.6. Findings of the Focus Group Discussion (FGD)

The Focus Group Discussion (FGD) for the "Pest Risk Analysis (PRA) of Maize and Listing of Quarantine Disease**"** in the target areas covering 20 districts of Bangladesh. One FGD was organized for each district/target area with 10 participants/respondents. Accordingly, covering the districts/target areas under the project altogether 200 respondents were participated to express their opinion regarding the pests of maize

and their risks. The major findings of the FGD comprising focal points are briefly mentioned here.

Total 100068 hectare area was covered by maize in those targeted district. Most of the farmer collected their maize seed from seed dealer and most used variety was NK-40. Leaf blight was most common disease in those areas. Seedling and reproductive stages were more vulnerable to disease then vegetative stage. Most of time pesticides were used as control measure. Stored maize seeds were infested by a number of diseases like seed rot, aspergillus rot and ear rot etc. Most of the participant agreed that use of disease free seeds is the best preventive measure. They believed that there was a strong relationship among disease, insect and weed. They also believed that imported hybrid seed were not vector of diseases (Table 4.77).

Table 4.77. Information collected through Focus Group Discussion covering all target areas/20 districts under the survey area

Sl. No.	Broad discussion points	Findings	% Opinion
1.	How much Area covered by Maize in this Area? (ha)	100068	100.00
2.	What are the sources of seeds used by the farmers?	Seed Dealer	100.00
		BRAC	28.57
		BADC	50.00
		NGO	7.14
		DAE	7.14
3.	What are the varieties of maize used by the Farmers?	Uttoron	21.43
		Pacific 984	42.86
		NK 40	57.14
		Sushalin	21.43
		Hybrid 981	14.29
		Miracle	7.14
		BARI hybrid	14.29
		Khai bhutta	7.14
		Pacific	7.14
		Pacific11	28.57
		OP khai bhutta	7.14
		70001k	7.14

		PG	7.14
		OP bhutta	7.14
		NK 987	7.14
		NK 984	7.14
		Agro 900	14.29
		M Gold	7.14
		Pacific 827	7.14
		NT 621	7.14
		Pacific 339	7.14
		Agro 9897	7.14
		900M	14.29
		981	14.29
		Pinacle	7.14
		BRAC hybrid	7.14
		M Gold 900	14.29
		MK 40	7.14
		Pioneer	7.14
4.	Are there disease pests outbreaks in the maize field?	Yes	100.00
		No	0.00
4.1	What types of diseases of Maize are usually seen in your area?	Steam rot	7.14
		Sheath rot	7.14
		Sheath blight	21.43
		Leaf spot	7.14
		Root rot	7.14
		Cob rot	7.14
		Ear rot	14.29
		Mosaic virus	7.14
		Foot and root rot	7.14
		Bacterial blight	7.14
		Leaf blight	42.86
		Virus	7.14
		Leaf trust	7.14
		Red rot	7.14
		Rust	7.14
		Cob Sheath blight	14.29
		Shooty mold fungus	7.14
		Aspergillus's rot	7.14
		Downy mil dew	7.14
5.	What might be the sources of diseases?	Seed borm	7.14
		Seed	28.57
		Soil	28.57
		Air	14.29
6.	Is hybrid variety more vulnerable to Diseases in comparison with local variety?	Yes	14.29
		No	78.57
7.	What are your suggestions for controlling disease and insect	Training	85.71
		Increasing awareness	78.57
		Use of Pesticides	64.29
		Mutual Cooperation	28.57

	pest of maize?	Use of instruments	28.57
		Acquiring experience	21.43
8.	How maize disease disseminate from field to field?		0.00
	Disease	Seed	57.14
		Weed	35.71
		Water	7.14
		Soil	7.14
		Indigenous	35.71
		Other	35.71
9.	Which stages of maize is vulnerable to disease?	Seedling	64.29
		Vegetative	57.14
		Reproductive	64.29
10.	What type of controlling measure is taken at high level of pest infestation?	Pesticide	42.86
		Granular	7.14
		Liquid pesticide	7.14
		Cypermethrin	7.14
		Granular fungicide	7.14
		Basudin	7.14
		Furadin	7.14
11.	Which crops are infested by maize disease? Mention crops name:	Sugarcane	7.14
		Potato	14.29
		Mustard	7.14
		Rice	21.43
		Vegetable	14.29
		Chilly	14.29
		Wheat	7.14
12.	Is stored maize infested by disease?	Yes	78.57
		No	21.43
13.	If infest, what are the types of disease?		
	Disease	Seed rot	14.29
		Seed spot	7.14
		Black point	7.14
		Aspergillus	14.29
		Grain rot	7.14
		Mold fungus	7.14
		Aspergillus rot	7.14
		Ear rot	7.14
14.	What control measures can be taken against pest of stored maize?		
	Preventive	Sevin Powder	7.14
		Pesticides	7.14
		Drying of seeds	21.43
		Fumigant	7.14
		Well drying	14.29
		Sun drying cleaning	21.43
		Well Ventilation	14.29
		Neem leaves	7.14

	Curative	Chemical treatment	7.14
		Use of pesticides	21.43
		Proves	7.14
		Sevin 10	7.14
		Fumigant	14.29
		Phostoxin	14.29
15.	What types of preventive measures can be taken against disease in maize field?	Disease free seed	92.86
		Use of pesticides	57.14
		Use of resistant variety	28.57
		Use of pest resistant	57.14
		Others	21.43
16.	What types of controlling measures (insect/disease/weeds) are effective in farmer's field against maize? Mention the methods	Pesticide	28.57
		Hand picking	7.14
		Baits	7.14
		Seed treatment with provex or bavistin	7.14
		Use of sex pheromon	7.14
		Mollases trap	7.14
		Use of trap crop like sunflower	7.14
		Use of light trap	7.14
		Modern cultivation	7.14
		Healthy seed	7.14
		Treated seed	14.29
		Treated seed	7.14
		Protection of crow	7.14
		Use of repellant	7.14
		Mechanical	7.14
		Chemical	14.29
		Crop rotation	7.14
		IPM	7.14
		Increasing awareness of farmers	7.14
		Use of herbicide	7.14
		Use of pesticide like carbofuran, furadan, chloropyriphos	7.14
		Clean cultivation	14.29
		Weeding	14.29
		Use of balanced fertilizer	14.29
		Regular monitoring	7.14
		Optimum irrigation	7.14
17.	Is there any relationship among the incidence/present of insect, disease and weeds in the maize field?	Yes	92.86
		No	7.14
18.	What is the relationship among insect, disease and weed incidence in maize field?	The number of insect is high, when weed infestation is high.	92.86
		The intensity of diseases is high, when weed infestation is high.	71.43
		The intensity of diseases is high, when the number of vectors is high.	57.14
		The intensity of diseases is high,	7.14

		when the number of vectors is medium.	
		The intensity of diseases is high, when weed infestation is low	7.14
		The intensity of diseases is high, when weed infestation is medium	7.14
		Unknown	21.43
19.	Is there any relationship between weather and disease for attack or dissemination in maize field?	Yes	92.86
		No	0.00
20.	If yes, What are the relationships?	Temperature	35.71
		Humidity	28.57
		Rainfall	50.00
		Cloudy	14.29
		Rainy weather	7.14
		Wind	21.43
21.	Does hybrid variety of maize carry out new disease in our country?	Yes	14.29
		No	78.57
22.	If yes, write the name of disease	Leaf blight	7.14
		Leaf	7.14
		Mosaic curling	7.14
		Bacterial blight	7.14
23.	How we can further improve quarantine disease control strategy? Put your comments in judiciously	Training	21.43
		Development of manpower,	14.29
		Increasing the cooperation between GO and NGO,	7.14
		We have to self capable to produce hybrid maize seed,	7.14
		The role of SCA should be stronger to certify hybrid maize seed.	7.14
		Use of healthy seed,	7.14
		Increasing awareness of farmers by training,	7.14
		By recruiting plant quarantine officer at upazilla level,	7.14
		By strengthening quarantine system	35.71
		Execution of quarantine law appropriately	7.14
		Check the quarantine standard of seed before import	14.29
		Monitoring at district level	7.14
		Trials should be done at least three years at regional level,	7.14
		Increasing the facilities of quarantine station,	7.14

		Policy should be made to marketwise corn seed	7.14
24.	What is your consultancy and opinion for PRA (Pest Risk Analysis) of maize and quarantine pest listing?	Increasing the production of maize in char area	7.14
		Use of OM in maize field	7.14
		Collection of information at least three stages of crops(seedling, vegetative, reproductive)for three years consequently	7.14
		Follow the rule of ISTA	7.14
		Training should be done for field level officer	7.14
		Enlist the important pest and reach to the farmer	7.14
		It is emergency to enlist pests	7.14
		Enlisting after details survey, sample collection and lab analysis	7.14
		Enlisting after surveying by pest specialist and diagnosis	7.14
		Considering maize as notify crop	7.14

4.7. Maize diseases found in major maize growing area during Field visit.

Amount of disease incidence and severity vary from season to season. Four (4) farmers field in each district was visited during survey period. "Maize disease: A Guide for Field Identification (4th edition, 2004)" by CEMMYT was primarily used for disease identification in field. Then those disease symptoms were collected from field and causal organisms were isolated from the diseased plant materials. After confirmation those diseases were listed (Table: 4.78) in this paper.

Table 4.78: **List of major disease found in maize growing area in Bangladesh**

Pathogenic group	Disease	Plant Parts affected	Disease incidence
Fungi	Seedling Blight	Root and whole plant	Medium
	Stalk rot	Stalk (Internode & node)	Low
	Brown spot	Leaf	Low
	Gray leaf spot	Leaf	Medium

	Ear rot	Cob	Low
	Anthracnose	Leaf	Low
	Sheath blight	Sheath and leaf	High
	Turcicum leaf blight	Leaf	Medium
	Maydis leaf Blight	Leaf	Medium
Bacteria	Leaf blight	leaf	Low
Virus	Mosaic	Stalk and leaf	Low
	Leaf stripe	leaf	Low

4.7.1. Seedling Blight

The disease was recognized by the presence of cottony mycelium at decayed base of young seedling which leaves were red-yellow colored. It was serious problem in maize field.

Plate 1. Symptom of Seedling blight

4.7.2. Stalk rots

The disease was recognized by presence of water soaked, soft and dark brown lesions in lowest internodes at wilted plant and browning of phloem tissue. Internode was twisted and distorted. In infected field some plants were subjected to lodging.

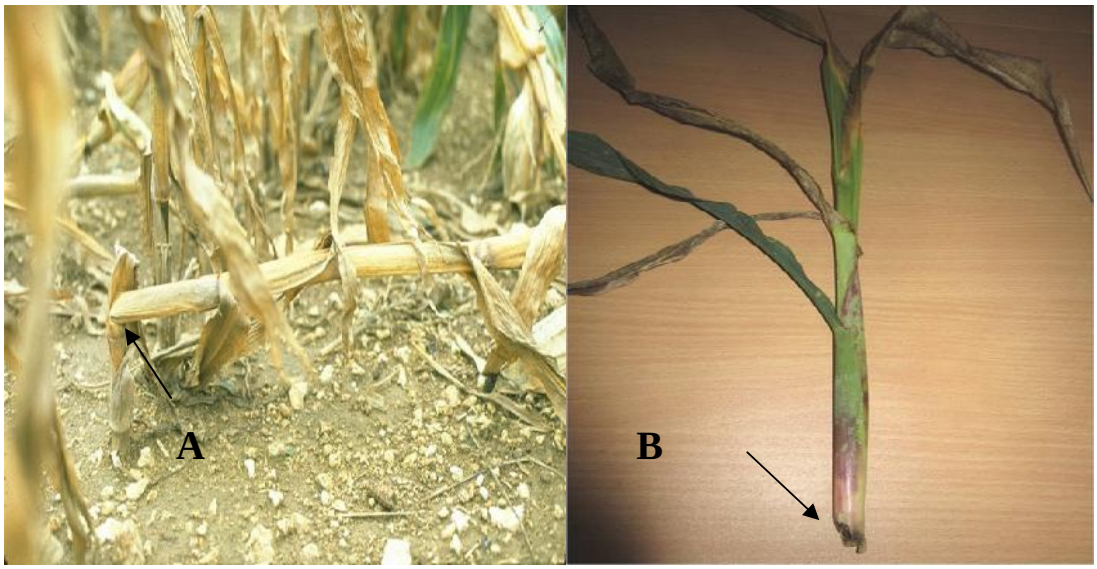


Plate 2. A & B Showing symptom of stalk rot of maize

4.7.3. Brown spot

The disease was recognized by the presence of circular and dark brown spots on mid ribs while lesions on the laminae continue as chlorotic spots. It was observed that at primary stage symptoms develop on leaf blades and consist of small chlorotic spots, arranged as alternate bands of diseased and healthy tissue.

Plate 3. Brown spot symptoms on leaf of Maize

4.7.4. Gray leaf spot

The disease was recognized by the elongated brown-gray necrotic spots which grown parallel to the veins. But it was observed that at primary stage those spots were small and regular.

Plate 4. Gray leaf spot symptoms on leaf of Maize

4.7.5. Anthracnose

The disease was recognized by the presence of irregular, oval-to-elongated lesions up to 15 mm long and had tan centers with reddish-brown borders and entire leaf became blighted later. But at early stage water-soaked and oval lesions were present in lower leaf. This disease was present at all major maize growing area in Bangladesh.

Plate 6: Symptom of Anthracnose of Maize

4.7.6. Ear rots

The disease was recognized by the presence of black, powdery masses of spores that cover both kernels and cob. Several species of *Aspergillus* were found in infected maize in the field. *Aspergillus niger* was the most common. This disease more or less present at major maize growing area in Bangladesh.

Plate 7. Symptom of Ear rot of Maize

4.7.7. Sheath Blight:

The disease was recognized by presence of concentric spots that cover large areas of infected leaves, husks and conspicuous, light brown, cottony mycelium with small, round, black sclerotia on brownish rotting ears.

Plate 8. Symptom of Sheath Blight

4.7.8. Turcicum leaf blight: The disease was recognized by slightly oval, water-soaked, small spots produced on the leaves at primary stage and then it was turned elongated, spindle-shaped necrotic lesions on leaf blade at advance stage.

Plate 9. Symptom of Turcicum leaf blight

4.7.9. Maydis leaf Blight: The disease was recognized by the presence of rectangular and 2 to 3 cm long lesions on the leaf. It was small and diamond shaped at primary stage. At advance stage it was produced a complete burning of large areas of the leaves.

Plate 10. Symptom of Maydis leaf Blight

. **4.7.10. Bacterial leaf Blight:** The disease was recognized by the presence of several small, pale-green lesions and dry-brown conspicuous striping along with the veins. It was observed that top most leaves are more susceptible to this disease.

Plate 11. Symptom of Bacterial Blight

4.7.11. Mosaic of maize: The disease was recognized by dwarfing and striping along the veins. The stripes were dark yellow and finally became necrotic. It was present in all major maize growing area.

Plate 12. Symptom of Mosaic of maize

4.7.12. Maize stripe: The disease was recognized by the presence of narrow parallel chlorotic stripes along the younger leaves. The chlorotic bands were dissimilar in width and were extended from the base to the tip of the leaves.

Plate 13. Maize stripe symptoms on maize leaf

DISCUSSION

Maize is third most important cereal crop in our country. Production of maize is increasing day by day due to using hybrid seeds. Most of the hybrid seeds used in Bangladesh are imported from other country. But to satisfy the prerequisite the World Trade Organization (WTO) for maize trade, it is necessary to conduct pest risk analysis (PRA) of maize in Bangladesh. . According to International Standers for Phytosanitary Measure (ISPM) No.2 three interrelated steps such as: (i) disease categorization, (ii) assessment of the probability of introduction and spread, and (iii) assessment of potential economic consequences (including environment and biodiversity at large) are involved in PRA (FAO, 2007). ISPM No. 2 also gives emphasis on survey for data collection about pests (disease, Insects and weeds). So the survey was done nationwide at selected location for collecting data about maize disease. According to ISPM No. 6, all parties (farmer, field level officer, policy level officer, seed dealer and pesticide dealer) who involve in maize production were interviewed during survey period (FAO, 1997). Field visit also done for inspection of present disease condition. From the findings of the study, the incidences and the damage risks of maize diseases, listing of quarantine diseases, their stages of attack, measures taken for management diseases and suggestion of field level officer are furnished below:

There were 400 maize farmers have been participated in the field survey, among them 75.00% of the farmers were 26 to 55 years old those could take right decision. Most (94.50%) of the farmers were illiterate to SSC and 34.75% farmers were Class VI to SSC. On an average, each farmer was engaged in maize cultivation for 5.59 years. All (100%) farmers selected in Rabi season for maize cultivation, among them 13.00% farmers also selected Kharif season. Most of the farmers (79.5%) cultivated hybrid variety of maize in their field. Among them maximum (40.50%) farmers were familiar with the cultivation of BRAC developed hybrid variety, 21.75% farmers cultivated BARI developed hybrid variety and 17.25% farmers cultivated imported hybrid variety. Most (86.75%) of the farmers used maize seeds from seed dealer. Maximum (50.50%) farmers checked the expiry date of the seeds used for cultivation.

A total of 80 field level officers of DAE participated in this program as respondent. Among them maximum (70.0%) field level officers were from Upazila Agriculture Extension Officers and SAAO. Highly experienced field level officers were participated in the program to express their opinion regarding maize diseases and their risks in Bangladesh. About 67.5% officers had more than 15 years experience in their discipline under DAE.

A few research works were done for listing maize diseases in Bangladesh. But list of existing diseases is primarily required for PRA. According to Bari and Alam (2004) and Yasmim (2007) there are 28 different disease of maize present in Bangladesh. Ali and Alam (2003) also reported 30 diseases to occur on maize in Bangladesh. But during survey period, it was found only 12 different disease of maize. Those diseases were seedling blight, stalk rot, brown spot, gray leaf spot, ear rot, anthracnose, sheath blight, tarcicum leaf blight, maydis leaf blight, bacterial leaf blight, mosaic, leaf stripe of maize. According to Harlapur *et al.* (2000) disease incidences vary from season to season and all diseases are not appeared at same season. So according to farmer and field level officers opinion and observation, the incidence of disease of maize in Bangladesh were seedling blight, stalk rot, root rot, sheath blight, sheath rot, ear rot, bacterial leaf blight, maydis leaf blight, Brown spot, tarcicum leaf blight, gray leaf spot, sugarcane mosaic, downy meldew, maize streak, maize stripe, maize dwarf mosaic, anthracnose, cob rot, store grain rot, cob sheath rot and cob sheath blight (Total 21 diseases).

Major and minor diseases of maize were classified based on farmers' opinion. According to their opinion the major diseases were stalk rot, leaf spot, root rot, cob rot, sheath blight, sheath rot, cob sheath blight, cob sheath rot, leaf blight, bacterial leaf blight, maize dwarf mosaic virus, corn stunt, leaf virus, maize streak virus. Among these diseases, leaf spots, cob rot, leaf blight, sheath blight, bacterial leaf blight, maize dwarf mosaic virus and maize streak virus ranked first to seventh expressed by the 31.75%, 26.50%, 25.25%, 19.25%, 19.25%, 16.0% and 14.75% farmers, respectively. Other important diseases were stem rot, cob sheath blight, cob sheath rot, sheath rot, corn stunt, leaf virus etc.

A lot of literature and research work are present about maize disease in the world basis. USDA (1960) reported that a total of 112 diseases are known to occur on global basis on

maize and among them more than 70 are seed-borne. Richardson (1990) reported that important seed borne disease of maize are leaf spot, leaf blight, collar rot, kernel rot, seedling blight, anthracnose and head smut. Chatterjee *et al* (1990) reported that the major maize diseases prevalent in India are eight. These are maydis leaf blight, downy mildews, pythium stalk rot, bacterial stalk rot, common rust, charcoal-rot, brown spot and turcicum leaf blight. Moreover seed-borne diseases cause enormous losses both in storage as well as in the field. Subbaiah *et al*. (1982) reported 35 disease of maize present in India. But only 10.0% policy level officers had idea about the presence of maize pests in neighboring countries from where the maize pests might come in Bangladesh. This result indicated that the shortage of knowledge about maize pests in neighboring countries. On the other hand most of the field level officers had positive idea about the presence of maize pests in neighboring countries.

According to International Standards for Phytosanitary Measure (ISPM) No. 2, listing of quarantine diseases (A disease of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled) is required for PRA. During survey policy level officer opined that the quarantine diseases of maize were stalk rot, leaf spot, root rot, cob rot, sheath blight, sheath rot, cob sheath blight, cob sheath rot, leaf blight, bacterial leaf blight, maize dwarf mosaic virus, grain rot, store grain rot, Aspergillus ear rot, Fusarium ear rot, Penicillium ear rot, corn stunt, leaf virus, maize streak virus, sugarcane mosaic virus, and downy mildew. Among these ranked orders of top ten diseases were leaf blight, stem rot, leaf spot, cob rot, Aspergillus ear rot, sheath blight, downy mildew, stored grain rot, grain rot, and leaf virus. So according to field level officer and policy level officer, the quarantine diseases of maize were leaf stalk rot, leaf spot (gray leaf spot, Brown spot), root rot, cob rot, sheath blight, sheath rot, cob sheath blight, cob sheath rot, leaf blight (maydis leaf blight, turcicum leaf blight), bacterial leaf blight, maize dwarf mosaic virus, grain rot, store grain rot, Aspergillus ear rot, Fusarium ear rot, Penicillium ear rot, corn stunt, leaf virus, maize streak virus, sugarcane mosaic virus, and downy mildew. Field levels officers were believed that illegal introduction of seeds, relax of quarantine law, weakness of the existing quarantine stations, lack of proper seed health test and seed

importation were the possible reasons for coming of quarantine pests from neighboring countries

For PRA stages of disease attack is required. Hossain (2007) stated that six seedling diseases viz. leaf blight i.e.,maydis leaf Blight and turcicum leaf blight , bipolaris leaf spot, stalk rot, seedling blight, foot and root rot and maize dwarf mosaic were mostly found in Bangladesh. Considering the opinion expressed by the farmers and field level officers, more or less all stages of the maize crops were attacked by the diseases, where the dominating disease leaf spot, leaf blight and sheath blight caused infections at vegetative and reproductive stages of the maize crops. But during field visit it was observed that, in vegetative stage those diseases can't causes serious damage of crop. According to Focus Group Discussion (FGD), seedling stage and reproductive stage are more vulnerable then vegetative stage of maize. So seedling and reproductive stages of maize crop were more vulnerable to diseases.

Most of the farmer, field level officer and policy maker believe that there was a positive and high degree of relationship among insect pest and disease incidence with weed infestation; as well as disease infection with the incidence of insect vector in the maize field. This result indicated that insect infestation and disease infection become high when weed infestation become high, i.e., insect infestation and disease infection increased with the increase of the weed infestation. Similarly, disease infection become high when insect vector populations become high, i.e., disease infection was increased with the increase of the vector population. From this finding it was revealed that weed infestation enhanced the insect pest population and disease incidence; similarly, insect vector also enhanced the incidence of disease infection in the maize field.

According to ISPM No. 2 assessment of way introduction and spread of diseases is very important in PRA process. Fakir (2001) reported that, 11 seed-borne diseases occurring on maize in Bangladesh. Field level officers opined that the harmful diseases of maize those were not seen earlier were leaf blight, leaf spot, mosaic virus and cob blight. These diseases mainly attacked hybrid varieties of maize such as Pacific, Uttoron, 900M, 900M gold etc. The main sources of maize seeds were the seed dealer and BADC. Field level officers believed that, the probable sources of maize diseases were seed borne diseases

from outside of the country (cross boundary), imported hybrid seeds and infested soil. irrigation water, plant debris, birds, rain and water were also played role as probable ways in spreading maize diseases. So a large number of diseases are seed borne and infected seed are main way of disease spreading.

Risk management is last stage of PRA process. According to field level officer seed treatment was the best method of quarantine disease control of maize than the use of disease free imported hybrid seeds and cultural practices as control measures. Jha *et al.* (2004) and Bohra *et al*. (2001) recommended Bavistin as best seed treating chemical. Majority (47.75%) of the farmers took curative measures to control pests of maize in the field. Considering the opinion expressed by farmer, seed dealer and pesticide dealer, use of fungicide was the best control measure of maize diseases. They also gave emphasis on clean cultivation with weeding, seed health test, inhibition of illegal importation of seeds, seed treatment. They also recommended some fungicide such as Dithane M-45, Tilt, Cormil MZ, Acrobat MZ, Mencozeb, Metaxyl etc. Most of the farmer received the assistance and services to control maize diseases from DAE. Other important sources were the NGO and neighbors.

During survey period, suggestions for disease management were also taken from respondents. Field level officers were gave emphasis on proper training on quarantine pests, improvement of quarantine laboratory and strengthening of quarantine. The major suggestions given by the policy level officers for the improvement of maize diseases control in Bangladesh were the strengthening of existing quarantine station laboratories, training of DAE officials on pest management especially quarantine pests, establishment of new quarantine laboratory with modern equipment facilities, increase of skilled manpower regarding quarantine pests, proper identification of quarantine pests, updating and strengthening of existing quarantine law, proper application of quarantine law, strengthening of quarantine services and enhancement of in-country production of hybrid seed for maize. So it was easy to say that, proper training on quarantine diseases, improvement of quarantine laboratory and strengthening of quarantine law were the best way of improvement quarantine disease control of maize.

SUMMARY AND CONCLUSION

Hybrid maize seed are being imported from abroad because its high demand, and thus there is risk of introducing quarantine diseases from other countries through seeds. The quarantine diseases are those which upon introduction from abroad can cause catastrophic losses to crops and those might be most dangerous for the host country because escaped from their natural enemies in the native country. The incidences of disease of maize in field were stalk rot, gray leaf spot, brown spot, root rot, cob rot, sheath blight, sheath rot, cob sheath blight, cob sheath rot, maydis leaf blight, tarcicum leaf blight, bacterial leaf blight, maize dwarf mosaic virus, grain rot, store grain rot, Aspergillus ear rot, Fusarium ear rot, Penicillium ear rot, corn stunt, maize stripe, maize streak, sugarcane mosaic, and downy mildew. Among these diseases leaf spots ranked first followed by leaf blights, sheath rot. Major diseases of stored maize in Bangladesh were grain rot, cob rot, and stored grain rot. The existing quarantine diseases of maize were leaf stalk rot, leaf spot (gray leaf spot, Brown spot), root rot, cob rot, sheath blight, sheath rot, cob sheath blight, cob sheath rot, leaf blight (maydis leaf blight, turcicum leaf blight), bacterial leaf blight, maize dwarf mosaic virus, grain rot, store grain rot, Aspergillus ear rot, Fusarium ear rot, Penicillium ear rot, corn stunt, leaf virus, maize streak virus, sugarcane mosaic virus, and downy mildew. All hybrid varieties of maize especially Pacific hybrid, Uttoron, 900M etc were attacked by these quarantine diseases. Seed treatment was the best method of quarantine pest control of maize than the use of

pest free imported hybrid seeds and cultural practices as control measures. The better management practices for disease control in maize were the spraying of fungicides such as Dithane M-45, Tilt, Cormil MZ, Acrobat MZ etc, use of integrated Disease management (IDM) method. It is difficult to control quarantine disease but maintaining regular field visit, seed health test, proper training on quarantine diseases, strengthening of quarantine law, improvement of quarantine laboratory, increase skilled quarantine manpower and proper application of existing quarantine law we can prevent entry of quarantine disease of maize.

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Annex -1

Sher-e-Bangla Agricultural University

Department of Plant Pathology

Questionnaire for **Farmers** on Conducting Pest Risk Analysis (PRA) of Maize and listing of Quarantine Pest

Serial					Cell Phone											

Name of Respondent:…… Village:……..… Agri Block ……

Upazila…….……. District: ……..… Education: ……..……..

Age-------- Sex-------- Profession ……..…….

1. Land Use Pattern by Maize

Land Use Pattern(s)	**Area (decimal)**
1. Total land owned	
2. Cultivable land under total land owned	
3. Land cultivated by Maize	
4. How long cultivating maize	

2. Cultivation of Maize by Variety in Rabi and Kharif Season

Name of Variety Used	Area (Decimal)		Time of Planting		Time of harvesting		Yield (ton/ acre)	
	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif
1. Local Variety								
2. BARI HYV Variety								
3. BARI Hybrid variety								
4. Imported Hybrid variety								
5. Other Variety(if any)								

3. Sources of purchasing seeds

Sources	Amount of seeds used per bigha	Expiry of date checked	Germination and Quality tested by you (√)	
			Yes	No
1. From Seed Dealer				
2. From Pesticide Dealer				
3. From BADC				
4. Directly from Importer				
5. From Agril. Extension Dept.				
6. From Research Station				
7. Farmers seed: put (Tick mark) (1) Own seed (2) Neighbor seed				

(3) Local market seed				
8. Other sources(if any)				

* 1 bigha =33 decimals

4. Cost involved for pest management

Total Maize cultivated Land	Rabi pests control cost/ bigha (Taka)			Kharif pests control cost/ bigha (Taka)			Other pest control cost /bigha (TK
	Insects	Diseases	Weeds	Insects	Diseases	Weeds	
Total cost							

5. Insects infestation in Maize field (please put √)

Name of Insects pest	Incidence of insect pest (Y/N)	Stage of infestation of maize crop			Incidence/severity		
		Seedling	Vegetative	Reproductive	High	Moderate	Low
1. Termites							
2. Cutworm							
3. Corn borer							
4. Com leaf aphid							
5. Fall Armyworm							
6. Grasshoppers							
7. African pink borer							
8. African maize stem borer							
9. Corn stunt leafhopper							
10. European corn borer							
11. Diabrotica beetle and rootworms							
12. Maize bill bug and billbug grub							
13. Spider mites							
14. Southwestern maize borer							
15. Sugarcane borer							
16. Spotted sorghum stem borer							
17. White grub							
18. Wireworm							
19. Others (if any)							

6. Disease infestation in Maize field (please put √)

Name of Diseases	Incidence of diseases (Y/N)	Infestation stage of maize crop			Incidence/severity		
		Seedling	Vegetative	Reproductive	High	Moderate	Low
1. Stem rot							
2. Leaf spot							
3. Root rot							
4. Cob rot							
5. Grain rot							
6. Downy mildew							
7. Leaf Virus							
8. Aspergillus ear rot							
9. Fusarium ear rot							
10. Penicillium ear rot							
11. Stenocarpella ear rot							
12. Corn stunt							
13. Maize streak virus							
14. Sugarcane mosaic virus							
15. Field Corn Nematode							
16. Store grain Rot							
17. Others (if any)							

7. Weeds Infestation in Maize field crops (please put √)

Name of Weeds	Incidence of weeds (Y/N)	Infestation stage of maize crop			Incidence/severity		
		Seedling	Vegetative	Reproductive	High	Moderate	Low
1. Broadleaf							
2. Sedge							
3. Aquatic weeds							
4. Grass							
5. Others (if any)							

8. Is there any relationship among insect, disease and weed pest infestations in the maize field? ☐
Yes = 1, No=2]

9. **If yes, what is the relationship among insect, disease and weed incidence in maize field?**

9.1 Insect population high when weed incidence is: ☐

1. high, 2. medium, 3. low and 4. don't know

9.2 Disease incidence high when weed incidence is: ☐

1. high, 2. medium, 3. low and 4. don't know

9.3 Disease incidence high when incidence of insect vector is: ☐

1. high, 2. medium, 3. low and 4. don't know

10. When the pest infestations become high in the maize field? (please put √)

Pests	Season	
	Rabi	Kharif
1. Insect		
2. Disease		
3. Weed		

11. Pests infestation in Stored Grain Maize (please put √)

Insect pests/ Diseases	Incidence of pests (Y/N)	Extent of Damage			Types of container used for storing maize grains					
		High	Medium	Low	Poly bag	Jute bag	Bamboo dhole	Tin	Earthen container	Plastic container
A. Insect pests										
1. Corn earworm										
2. Ear maggot										
3. Grain borers										
4. Grain weevils										
5. Indian meal moth										
6. Angoumois grain moth										
7. Seedcorn maggot										
8. Rats and birds										
9. Others (if any)										
B. Diseases										
10. Cob rot										
11. Grain rot										
12. Aspergillus ear rot										
13. Fusarium ear rot										
14. Penicillium ear rot										
15. Stenocarpella ear rot										
16. Corn stunt										
17. Store grain Rot										
18. Others (if any)										

12. Whether any control measures taken against pests in your store maize? ☐
[Yes=1, No=2]

If yes please tell

13. What preventive/curative measures are taken against these stored pests?

a. Preventive (name):
…….

b. Curative (name):

……...

14. What are the Major Diseases of maize in your area? Put no. upto 10 according to severity

High → Low

Seed rot =**1**	Downy mildew =**7**	Corn stunt =**13**
Stem rot =**2**	Leaf Virus =**8**	Maize streak virus =**14**
Leaf spots =**3**	Aspergillus ear rot =**9**	Sugarcane mosaic virus =**15**
Root rot =**4**	Fusarium ear rot =**10**	Field Corn Nematode =**16**
Cob rot =**5**	Penicillium ear rot =**11**	Store grain Rot =**17**
Grain rot =**6**	Stenocarpella ear rot =**12**	Other =**18**

15. What are the Major Insects of maize in your area? Put number upto 10 according to severity

High → Low

Cutworm =**1**	African maize stem borer = **8**	Southwestern maize borer = **14**
Corn borer = **2**	Corn stunt leafhoppers = **9**	Sugarcane borer =**15**
Com leaf aphid = **3**	European maize borer = **10**	Spotted sorghum stem borer =**16**
Termites = **4**	Diabrotica beetles and rootworms =**11**	White grubs =**17**
Fall Armyworm = **5**	Maize billbugs and billbug grubs =**12**	Wireworms =**18**
Grasshoppers = **6**	Spider mites =**13**	Others (if any) =**19**
African pink borer = **7**		

16. What are the Major Weeds of maize in your area? Put no. according to severity

High → Low

Broadleaf =**1;** Sedge =**2;** Aquatic weeds =**3;** Grass = **4;** Others (if any) =**5**

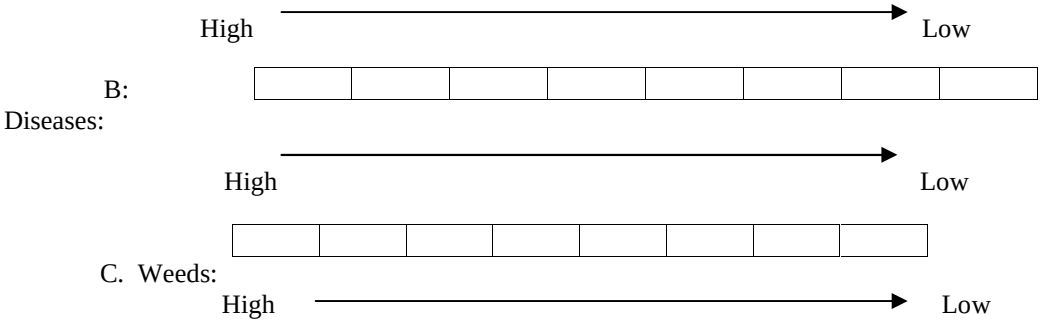
17. When Termites attacks the maize plants?
[At tillering stage = 1, seedling = 2, elongation = 3, others (please specify) = 4]

18. Whether any control measures taken against the pests of maize in the field?
[Yes = 1, No=2]

19. If yes, what control measure is used against the pests in maize field?
[Preventive=1, Curative=2, Both=3]

20. How do you control pests in the maize field? Put numbers

A: | | | | | | | | | Insects:



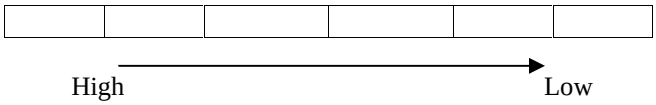
[Through pesticides = 1, use resistant variety = 2, use imported hybrid maize = 3, seed treatment method = 4, cultural practices and control measures = 5, barriers to dispersion = 6, IPM method = 7, others (please specify) = 8]

21. What curative measures are taken against these diseases, insects & weeds in maize field?

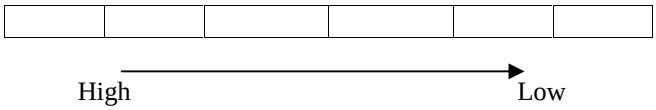
Pests	Dose/bigha	Frequency (No.)	Measure is effective	
			Yes	No
1. Insect				
2. Disease				
3. Weed				
4. Other pest (if any)				

22. From where You receive Assistance and Services in controlling the pests and diseases of maize?

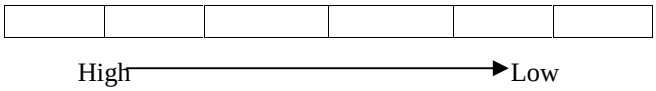
A: Insects:



B: Diseases:



C. Weeds:



[From DAE= 1, From Research =2, From Dealers =3, from Ngo=4, from neighbors=5, Others=6]

23. Put your suggestions for better management of Insect and disease of maize.

A. Insect Management

1……
…

2……
…

3……
…

4……
…

5……
…

B. Disease Management

1……
…

2……
…

3……
…

4……
…

5……
…

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Signature of Surveyor Signature of Supervisor

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Name of Surveyor Name of Supervisor:

Date: / /2012 Date: / /2012

Annex-2

Sher-e-Bangla Agricultural University

Department of Plant Pathology

Questionnaire for **Field Level Officers** on Conducting Pest Risk Analysis (PRA) of Maize and listing of Quarantine Pest

Serial						Cell Phone											

Name of Respondent:…… ……. Position: ……

Upazila……..……. Union: ……. Block ……. District:……

1. **Position:** [UAE=1, AEO=2, AAEO/JAEO=3, SAPPO=4, SAAO=5, Other (please specify) =6] ☐
2. **Total length of your service in the field level under the department of Agricultural Extension:** [Years] ☐
3. **What is the acreage of Maize in your upazila** [area in hectare?] ☐
4. **How many farmers cultivate Maize in your Upazila** [Numbers of farmers?] ☐
5. **What is the level of your interaction with maize farmers for improvement of Maize production and maize crops protection?** ☐

   [Very good = 1, good = 2, Average=3, Not good = 4]

6. **What are the major problems of Maize cultivation in your area? Please tick (√) marks**

Insect attack =1		Disease attack =2		Weed attack=3,		HYV variety =4	
Imported Hybrid variety =5		Irrigation =6		Store grain pest attack=7		Marketing facilities = 8	
Farmers training		Pesticides and pest		Use of unbalanced		Others (if any) =12	

facilities on Maize =9		control measures =10		doses of Chemical Fertilizers =11			

7. Was there any insect pest infestation or disease infection occurred that were not seen previously? [Yes No]

8. If yes, please mention the name of variety, source of seed used and stage of attack?

Pests	Occurred in maize variety	Sources of seeds	Stages of attacks
1. Insects			
2. Diseases			

9. Pests infestation in Maize (Please put √ mark)

Name of Insects pest	Varity	Damage Symptoms	Infestation stage of maize crop			Incidence/severity		
			Seedling	Vegetative	Reproductive	High	Moderate	Low
A. Insect infestation in Maize								
1. Cutworm								
2. Corn borer								
3. Com leaf aphid								
4. Termites								
5. Fall Armyworm								
6. Grasshoppers								
7. African pink borer								
8. African maize stem borer								
9. Corn stunt leafhoppers								
10. European maize borer								
11. Diabrotica beetles and rootworms								
12. Maize billbugs and billbug grubs								
13. Spider mites								
14. Southwestern maize borer								
15. Sugarcane borer								
16. Spotted sorghum stem borer								
17. White grubs								
18. Wireworms								
19. Others (if any)								

B. Disease infestation in Maize	Varity	Presence of disease (Y/N)						
20. Seed rot								
21. Leaf spot								
22. Root rot								
23. Cob rot								
24. Grain rot								
25. Downy mildew								
26. Leaf Virus								
27. Aspergillus ear rot								
28. Fusarium ear rot								
29. Penicillium ear rot								
30. Stenocarpella ear rot								

31. Corn stunt								
32. Maize streak virus								
33. Sugarcane mosaic virus								
34. Field Corn Nematode								
35. Store grain Rot								
36. Others (if any)								

Name of Insects pest	Varity	Presence of weed (Y/N)	Infestation stage of maize crop			Incidence/severity		
			Seedling	Vegetative	Reproductive	High	Mode rate	Low
C. Weeds Infestation in Maize								
37. Broadleaf								
38. Sedge								
39. Aquatic weeds								
40. Grass								
41. Others (if any)								

10. Pests infestation in store grain Maize (Please put √ mark)

Insect pests/Disease	Variety	Presence of pest (Y/N)	Extent of Damage			Types of Store Material used				
			High	Mode rate	Low	Poly bag	Jute bag	Bam boo dole	Tin	Earth en pot
A. Insect pests										
1. Corn earworm										
2. Ear maggot										
3. Grain borers										
4. Grain weevils										
5. Indian meal moth										
6. Angoumois grain moth										
7. Seedcorn maggot										
8. Seedcorn maggot										
9. Rats and birds										
10. Others (if any)										
B. Diseases										
11. Stem rot										
12. Leaf spot										
13. Root rot										
14. Cob rot										
15. Grain rot										
16. Downy mildew										
17. Leaf Virus										
18. Aspergillus ear rot										

19. Fusarium ear rot										
20. Penicillium ear rot										
21. Stenocarpella ear rot										
22. Corn stunt										
23. Maize streak virus										
24. Sugarcane mosaic virus										
25. Field Corn Nematode										
26. Store grain Rot										
27. Others (if any)										

11. Whether any control measures are taken against store maize pest? Put number [ ]
[Yes=1, No= 2]

If yes: Name Control Methods:……

12. What are the Major and minor diseases of maize in your area? Put no. into 7 blank cells according to severity

Major							
Minor							

High → low

Seed rot=1
Stem rot=2
Leaf spots=3
Root rot =4
Cob rot =5
Grain rot =6
Downy mildew=7
Leaf Virus=8
Aspergillus ear rot=9
Fusarium ear rot =10
Penicillium ear rot =11
Stenocarpella ear rot =12
Corn stunt =13
Maize streak virus =14
Sugarcane mosaic virus =15
Field Corn Nematode=16
Store grain Rot=17
Other =18

13. What are the Major and minor insects of maize in your area? Put no. into 7 blank cells according to severity

Major							
Minor							

High → Low

Cutworm=1
Corn borer=2
Com leaf aphid=3
Termites=4
Fall Armyworm=5
Grasshoppers=6
African pink borer=7
African maize stem borer=8
Corn stunt leafhoppers=9
European maize borer=10
Diabrotica beetles and rootworms=11
Maize billbugs and billbug grubs=12
Spider mites=13
Southwestern maize borer=14
Sugarcane borer=15
Spotted sorghum stem borer=16
White grubs=17
Wireworms=18
Others (if any)=19

14. What are the Major and minor weeds of maize in your area? Put no. according to severity

Major							
Minor							

High ⟶ Low

Broadleaf =1, Sedge=2, Aquatic weeds=3, Grass=4, Others (if any)=5

15. Is there any relationship among insect, disease and weed pest infestations in the maize field? [Yes = 1, No=2] ☐

16. If yes, what is the relationship among insect, disease and weed incidence in maize field?

16.1. Insect population high when weed incidence is: ☐
[1. high, 2. medium, 3. low, 4. don't know]

16.2 Disease incidence high when weed incidence is: ☐
[1. high, 2. medium, 3. low, 4. don't know]

16.3 Disease incidence high when incidence of insect vector is: ☐
[1. high, 2. medium, 3. low, 4. don't know]

17. What are the probable sources of diseases of Maize in your area? Put no. into 7 blank cells according to severity

High ⟶
Low

[Within country = 1, Outside country (cross boundary) = 2, Seed = 3, Seeds purchase from locality = 4, imported hybrid seeds = 5, Use of farmers in house seeds =7, Non uses of Balanced Fertilizer =8, Soil born = 9, Through irrigation water =10, Pesticide does not react=11 Other sources (please specify = 12]

18. How the Maize pests spread? Put no. into 7 blank cells according to severity

High ⟶
Low

[Through: wind =1 birds=2, irrigation water=3, planting materials = 4, affected seeds = 5, availability of suitable host plants/ debris = 6, potential movement outside the zone via trade or people movement or natural transmission = 7, potential vectors of pests = 6, imported seeds = 7, through rains = 8, use wheat/Sorgom or other seed = 9 Weed =10, grasses = 11, Rice seeds =12, potatoes seeds =13, tomatoes field=14 , some legumes seeds = 15, cross boundary border seeds of India =16, cross boundary border seeds of Burma =17 others (please specify) = 19]

19. Do you know the pests of Maize in neighboring countries? [Yes = 1, No = 2] ☐

If yes, please tell name

19.1 Insects: ……. …….. ……

19.2 Diseases: ……. …… …….

19.3 Weeds : …… ……. ……..

19. 4 Others (if any) ……. …….

20. Do you think that quarantine pest of maize are coming from neighboring countries in Bangladesh? [Yes = 1, No = 2] ☐

If yes, please tell name

20.1 Insects: ……. …….. ……

20.2 Diseases: ……. …… …….

20.3 Weeds : ……. ……. ……..

20. 4 Others (if any) ……. …….

21. What are the possibilities of coming quarantine pests of maize from neighboring Countries? Possibilities are:

21.1.
……..……..……..
21.2.
……..……..……..
21.3.
……..……..

22. How do you ascertain the diseases? Please Put Nos. into 5 blank cells
[Observation = 1, laboratory test=2, symptom analysis=3, hearing of farmers = 4, others = 5]

High → Low

23. What are the probable sources of diseases of Maize in your area? Please Put Nos. into 7 blank cells

High → Low

[Within country = 1, Outside country (cross boundary) = 2, Seed =3, Seeds purchase from locality = 4, Imported hybrid seeds = 5, Use of farmers in house seeds = 7, Non uses of Balanced Fertilizer =8, Soil born = 9, Through irrigation water =10, Pesticide does not react=11 Other sources (please specify = 12]

24. How often do you go for field visit? Please Put Nos. into 5 blank cells

High → Low
(Frequently=1, weekly =2, quarterly=3, monthly=4, sometimes=5)

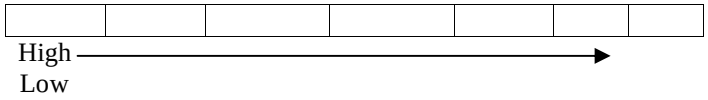
25. Do you think the insects, diseases and weeds are spread from imported seeds? ☐
[Yes=1, No=2]

26. How the quarantine diseases can be controlled? Please Put Nos. into 7 blank cells

High → Low

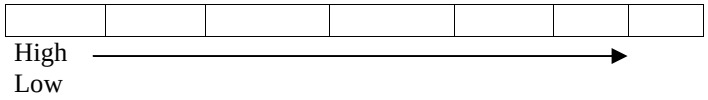
[Through seed treatment = 1, Using pesticide = 2, Using resistant variety = 4, Imported hybrid variety = 5, Cultural practices and control measures = 5, Barriers to dispersion = 6, IPM = 7, Farmers Training =8, Others (please specify) = 9]

27. What are the risks of Maize pest control? Please Put Nos. into 7 blank cells



[Highly toxic pesticide use = 1, the dose is too high = 2, prevention and treatment is not timely = 3, control more often = 4, miss the control period = 5, the label does not match the standard mark = 6. does not prescribe the right remedies are quite common = 7, not to take joint control chip = 8, climate is not conducive to prevention and treatment = 9, others (please specify) = 10].

28. What are the following counter measures may be taken for suitable Maize pest control?



[Improve the laws and regulations of quarantine = 1, strengthen law enforcement = 2, forecasting and providing technical training to concerned persons for enhancement=3, agricultural control=4, chemical control of the goods = 5. others (please specify) = 6]

29. Have you taken any direct steps or monitored the attack of quarantine pests of maize in the field to safe the crop timely? [Yes = 1, No = 2] ☐

If yes, what are the steps you have taken?
1. ……
2.……
3.……..

30. Do you think the existing facilities of quarantine service are sufficient to cope with the diseases and pest control of Maize in our country? [Yes = 1, No = 2] ☐

If not, please give your suggestions for the improvement of control quarantine pest in our country
1……
2…….
3…….

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Signature of Surveyor Signature of Supervisor

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Name of Surveyor Name of Supervisor:

Date: / /2012 Date: / /2012

Annex-3

Sher-e-Bangla Agricultural University

Department of Plant Pathology

Checklist for FGD on Conducting Pest Risk Analysis (PRA) of Maize and listing of Quarantine pest for policy level officers

Serial					Cell Phone											

Respondent Name: …… Designation: ……..……..

Upazila : ……..…… District ……..……

1. Position: [Deputy Director =1, District Training Officer=2, CPS=3, PPS=4, Researcher=5, Scientist of BARI =6, BADC seed officials =7, Other (please specify) = 8]

2. What are the major and minor diseases of Maize in your area? Put numbers into 8 blank cells

2.1 Major								
2.2 Minor								

Seed rot =1
Stem rot =2
Leaf spots=3
Root rot =4
Aspergillus ear rot =5
Penicillium ear rot =6
Corn stunt =7
Sugarcane mosaic virus =8
Grain rot =9
Cob rot =10
Fusarium ear rot =11
Stenocarpella ear rot =12
Maize streak virus =13
Field Corn Nematode =14
Downy mildew= 15
Leaf Virus =16
Store grain Rot=17
Other =18

3. What are the major and minor insect pests commonly attack in Maize crops of your area? Put nos. into 8 blank cells

3.1 Major								
3.2 Minor								

Termites =1
Corn borer = 2
Grasshoppers =3
Cutworms =4
Fall Armyworm =5
Spotted sorghum stem borer =6
White grubs =7
Corn leaf aphid =8
African pink borer =9
African maize stem borer =10
Corn stunt leafhoppers =11
European maize borer =12
Diabrotica beetles and rootworms=13
Maize billbugs and billbug grubs =14
Spider mites =15
Southwestern maize borer =16
Sugarcane borer =17
Wireworms =18,
Others (if any) =19

4. What are the major and minor weeds attack in Maize crops as per information received? Put number into 5 blank cells

4.1 Major						
4.2 Minor						

[Broadleaf weed=1, Sedge=2, Aquatic weeds=3, Grass=4, Other (if any) =5]

5. Was there any insect pest infestation or disease infection occurred that were not seen previously? 1=Yes, 2= No

6. If yes, please mention the name of variety, source of seed used and stage of attack?

Pests	Occurred in maize variety	Sources of seeds	Stages of attacks
6.1 Insects			
6.2 Diseases			

7. What is the major and minor store grain pests attack in stored Maize as per information received? Put nos. into 6 blank cells

7.1 Major						
7.2 Minor						

Corn earworm =1, Ear maggot =2, Grain borers =3 , Grain weevils =4, Indian meal moth =5, Angoumois grain moth =6, Seedcorn maggot =7, Seedcorn maggot =8, Others (if any)=9

8. **Do you know the pests of Maize in neighboring countries?** [Yes = 1, No = 2], **If yes, please tell name**

8.1 Insects: ……. ……..
……

8.2 Diseases: ……. ……
……..

8.3 Weeds : …… ……..
……

8.4 Others (if any) …….
……..

9. Do you think that quarantine pest of maize are coming from neighboring countries in Bangladesh ?
[Yes = 1, No = 2],

If yes, please tell name

9.1 Insects: ……. ……..
……

9.2 Diseases: ……. ……
……..

9.3 Weeds : …… ……..
……

9.4 Others (if any) …….
……..

10. Is there any relationship among insect, disease and weed infestations in the maize field?
[Yes=1, No=2]

11. If yes, what is the relationship among insect, disease and weed incidence in maize field?

11.1 Insect population high when weed incidence is:

1. high, 2. medium, 3. low, 4. don't know

11.2 Disease incidence high when weed incidence is:

1. high, 2. medium, 3. low, 4. don't know

11.3 Disease incidence high when incidence of insect vector is:

1. high, 2. medium, 3. low, 4. don't know

12. In which the pest infestations become high in the maize field? Please put (√) tick

Pests	Season	
	Rabi	Kharif
12.1 Insect		
12.2 Disease		
12.3 Weed		

13. Is there any influence of weather factors (temperature, rainfall and rainfall) on the population of insects, diseases and weeds in maize field? [Yes = 1, No = 2]

14. If yes, what type of influence of weather factors is observed on the population of insects, diseases and weeds in maize field? [Put tick (√) mark in the blank cells]

Pests	Influence of weather factors								
	Temperature			Relative humidity			Rainfall		
	High	Moderate	Low	High	Moderate	Low	High	Moderate	Low
1. Insect									
2. Disease									
3. Weed									

15. Do you think that imported hybrid varieties are the sources of coming Quarantine pests in our country? [Yes = 1, No = 2]

16. Do you take any preventive measures for intercepting from new coming quarantine pests in your area? [Yes = 1, No = 2]

If yes, Please Specify----------

17. Do you think the preventive measures taken are effective? [Yes = 1, No = 2]

If No, Please Specify----------

18. What are the major risks/threat of coming new quarantine pests in our country? (Put √)

1. Introduction of new insects/diseases/weeds,
2. New biotypes of pests (Insects/pathogen),
3. Increase intensity of crop damage,
4. Others--------

19. Have you taken any steps or supervised or monitored the quarantine pests of maize in the field? [Yes = 1, No = 2]

If yes, how ……..……

……..

20. Do you think the existing facilities of quarantine service are sufficient to cope with the diseases and pest control of Maize in our country? [Yes = 1, No = 2] ☐

If not, please give your suggestions for improvement of control of quarantine pests in our country

1……

2……..…….

3…….

4…….

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Signature of Surveyor Signature of Supervisor

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Name of Surveyor Name of Supervisor:

Date: / /2012 Date: / /2012

Annex-4

Sher-e-Bangla Agricultural University

Department of Plant Pathology

Questionnaire for **Seed Dealer** on Conducting Pest Risk Analysis (PRA) of Maize and listing of Quarantine Pest

Serial						Cell Phone											

Name of Respondent:……..…… Village:…… Agri Block …….

Upazila……. District:……..……

1. Position of respondents: ☐
[Owner of enterprise=1, Manager=2, Sale representative=3, other (please specify)=4]

2. How long have you been involved in selling Maize seed? ☐
[Years]

3. What are the sources of your seed collection? ☐
Farmers =1, Hole sale dealers =2, Importer =3, BADC=4 and Others =5

4. Which varieties of maize seed you sell to farmers? LV, HYV, Hybrid and Others

5. Was there any incidence of major crop damage in your selling area after using seeds? ☐

[Yes = 1, No = 2]

6. **If yes, what are the possible reasons?** ☐
[Bad quality = 1, unsuitable for the environment = 2, Expired validity = 3,
Attack by the pests = 4 and other (please specify) = 5]

7. **How do you determine quality of seeds?** ☐
[Label of packet of suppliers=1, information of suppliers=2, validity expired seeds=3 and other (please specify)=4]

8. **How do you store your purchased seeds? [Please tick mark]**
Normal condition =1 and Control condition (with controlled Light, temperature and humidity)=2

9. **Do you check quality of seeds in your store time to time?**

10. **Do you take any control measures against store pest? [Yes =1, No=2]** ☐

If yes, how ……...

11. **Have you noticed any insect and diseases out break in your sold seeds? [Yes=1, No=2]** ☐

12. **Have any out breaks of Diseases or Insect pests in imported hybrid seeds? [Yes=1, No=2]** ☐

13. **Do you maintain communication with local agriculture officers for collecting updated information on Maize seed, pests and pesticides? [Yes=1, No=2]** ☐

14. Please put your suggestions for improvement or control of quarantine pests?

1……

2……..

3…….

4…….

Signature of Surveyor

Signature of Supervisor

Name of Surveyor
Date: / /2012

Name of Supervisor:
Date: / /2012

Annex-5

Sher-e-Bangla Agricultural University

Department of Plant Pathology

Questionnaire for **Pesticide Dealer** on Conducting Pest Risk Analysis (PRA) of Maize and listing of Quarantine Pest

Serial					Cell Phone											

Respondent:……..…… District:……..……

Upazila :…….. Village:…….

1. **Position of respondents:**
   [Owner of enterprise=1, Manager=2, Sales representative=3,Other (please specify)=4] ☐

2. **How long are you been involved in dealing in pesticides?**
   [Years] ☐

3. **Do you sell pesticides to the Maize farmers [Yes=1/No=2]** ☐

4. **If yes, how do you sell pesticide to farmers?**
   [On farmers demand = 1, listening the symptom from farmers = 2,
   As per available in the stock = 3, Other (please specify) = 4] ☐

5. **What are the pesticides you sell commonly to maize farmers?**
   [Systemic insecticides = 1, Contact insecticides = 2, Granular insecticides=3,
   Fungicides = 4, Rodenticides =5, Weedicides= 6 (other please specify) = 4] ☐

6. **Was there any major incidence of Maize crop damage in the area in spite of using** Pesticides? [Yes=1/No = 2] ☐

7. **If yes, what are the possible reasons?**
   [Improper diagnosis=1, Improper dose=2, Improper insecticide=3, Other (please specify)=4] ☐

8. **How do you determine the validity of pesticides?**
   [Label of packet of suppliers=1, Information of suppliers=2, Efficacy to kill the pests=3,
   Other (please specify) =4] ☐

9. **What do you dispose of validity expired pesticides?**

10. **Do you maintain communication with local agriculture officers for collecting updated information on** pests and pesticides? [Yes=1/No=2] ☐

☐

11. Do you sell stored grain pesticides to Maize farmers [Yes=1/No=2]

12. If yes, how do you sell pesticide to farmers? ☐
[On farmers demand = 1, listening the symptom from farmers = 2,
As per available in the stock = 3, Other (please specify) = 4]

13. Do you have any suggestions for the improvement of control of quarantine pests? ☐
[Yes=1/No=2]

14. If yes, please list important suggestions.

1……

2…….

3…….

4…….

Signature of Surveyor

Name of Surveyor

Date: / /2012

Signature of Supervisor

Name of Supervisor:

Date: / /2012

Annex-6

Sher-e-Bangla Agricultural University

Department of Plant Pathology

Checklist for FGD on Conducting Pest Risk Analysis (PRA) of Maize and listing of Quarantine Pest

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Location of FGD:

Name …….. …….. Designation ……..

Village:……..…… Ward …….

Upazila:……. District:……..……

1. **How much Area covered by Maize in this Area?**

2. **What are the sources of seeds used by the farmers?**

3. **What are the varieties of maize used by the Farmers?**

4. **Are there any Insect, diseases, weeds and other pests outbreaks in the maize field?**
   (Put √) Yes =1 or No =2, if yes

   i. **What type of Insect of Maize is usually seen in your area? (Put √)**
      a. Major:
      b. Minor:

   ii. **What type of disease is seen in Maize in your area? (Put √)**
      a. Major:
      b. Minor:

iii. What type of weed of Maize is usually seen in your area? (Put √)

a. Major:
b. Minor:

iv. At what stages of maize usually pest and disease attacks?

a. Stage of insect pests attacks
b. Stage of disease pests attacks

vi. Was there any occurrence of pest/ diseases attacks that could not identify?

5. Is there any relationship among the incidence/present of insect, disease and weeds in the maize field? (Put √) Yes =1 or No =2, if yes

6. What is the relationship among insect, disease and weed incidence in maize field? (Put √)

6.1 Insect population high when weed incidence is high / medium / low
6.2 Disease incidence high when weed incidence is high / medium / low
6.3 Disease incidence high when incidence of insect vector is high/medium / low

7. What might be the sources of diseases?

8. What might be the sources of Insects?

9. What might be the sources of weeds?

10. Whether insects, diseases and weeds spread from field to field? (Put √) Yes =1 or No =2, if yes, how

10.1 Insect: (Through weeds/ seeds / indigenous / others)

10.2 Disease: (Through weeds/ seeds / indigenous / others)

10.3 Weed: (Through weeds/ seeds / indigenous / others)

11. Whether diseases / insects/weeds cause yield loss in maize field? (Put √) Yes =1 or No =2, if yes how much?

11.1 Insect: Severe (%) / moderate (%) / low (%) / no damage (%)
11.2 Disease: Severe (%) / moderate (%) / low (%) / no damage (%)
11.3 Weeds: Severe (%) / moderate (%) / low (%) / no damage (%)

12. What steps are usually taken as control measures in case of high level of pest infestation?

13. What preventive measures may be taken against these diseases, insects and weeds in the maize field? [Use of pests free seeds, pesticides, resistant variety and others------]

14. Whether the pests (insects/diseases) attack the maize grains in storage? (Put √) Yes =1/No =2, if yes,

14.1 Insects (name):

14.2 Diseases (name):

15. What preventive/curative measures may be taken against these stored pests?

15.1 Preventive (name):

15.2 Curative (name):

16. Whether the used control measures by the growers effective? (Put √) Yes =1 or No =2, if yes

Name the method(s): a. ……..……..……..
b. ……..……..……..
c. ……..……..
d. ……..……..……..
e. ……..……..……..

17. How can we improve the control measures of quarantine pests for maize?

18. Suggestions for pest risk analysis and listing of quarantine pests?

Annex-7

Data Sheet for Maize Diseases Identification

Farmers Name …… Variety……

Village……. Season……..

Union…….. Farm size …….

Upazila……..

District…… Date of Collection……

Sample collection sheet for Maize diseases identification on standing Maize crops.

Name of diseases	Variety	Number of plants		Percent of infected plant	Severity (Low, Medium, High)
		Diseased	Healthy		
Leaf blight/spot					
Seed rot & seedling disease					
Downy mildew					
Stalk rot					
Cob rot					
Storage rot					
Corn mosaic virus					
Curvularia leaf spot					
Sheath blight					
Corn stunt virus					
Nematode					
Unknown					
Others					