Pest Risk Analysis (PRA) for Maize (*Zea Mays* L.) within East African Countries (Kenya, Burundi, Rwanda, Tanzania and Uganda)

A Qualitative, Pathway-Initiated Risk Analysis

Adopted by the 39th Meeting of the Council of Ministers held on 28th November, 2019

Executive Summary

The Maize PRA was initiated by the need to review the national pest lists and develop strategies for reducing Phytosanitary trade barriers in the East African region as well as develop a harmonized regional pest list for the maize with a view to developing phytosanitary import conditions that will be applied within the Eastern Africa. The objectives of the Regional Pest Risk Analysis (PRA) were to review national pest lists for maize within the East African Community (EAC); develop a harmonized EAC pest list for maize; and develop Phytosanitary import conditions for maize to be applied within the EAC.

This risk analysis was prepared by PRA specialists from five member countries of the EAC namely: Tanzania, Burundi, Rwanda, Uganda and Kenya. However, South Sudan did not participate in the development of the PRA document as the documents were developed before they joined the EAC. It involved comparing and harmonizing pest lists associated with maize in the five countries. As a result, the following outputs were achieved: i) a harmonized EAC quarantine list for maize; ii) EAC PRA for grain and seed Maize and iii) Harmonized Phytosanitary import conditions for maize to be applied in the EAC Region.

A list of pests associated with maize in EAC was developed based on the PRA information from the EAC NPPOs as well as from the search of both print and electronic sources of information, in accordance with ISPM No. 11 and 21. This document presents the list of quarantine pests of concern to the region as well as the import conditions for maize. The consolidated list for pests associated with maize contained 182 pests (6 arachinids, 82 insects, 23 nematodes, 51 fungi, 11 bacteria and 9 viruses) which were then taken through a categorization process as per International Standards for Phytosanitary Measures (ISPM) number 11. Based on the analysis, a total of fifteen (15) (5 insects, 1 nematode, 5 fungi, and 4 viruses) pests associated with maize were considered for risk assessment. *Araecerus fasciculatus* (cocoa weevil), *Prostephanus truncatus* (Larger Grain borer), *Sitotroga cerealella* (Olivier)(grain moth), *Tribolium confusum* (confused flour beetle), *Ahasversus advena* (Waltl, 1832) (Foreign grain beetle), *Ditylenchus dipsaci* (Stem and bulb nematodes), *Cochliobolus heterostrophus* (southern leaf spot), *Cochliobolus sativus* (root and foot rot), *Alternaria brassicae* (dark spot of crucifers), *Curvularia lunata*, *Stenocarpella macrospora*, syn. *Diplodia macrospore* (Macrospora leaf stripe), *Cucumber mosaic virus* (cucumber mosaic), Sugarcane Mosaic Virus (mosaic of abaca), and Maize Dwarf Mosaic Virus were found to be of quarantine importance to the region. Maize Lethal Necrosis Disease is a combination of Sugarcane Mosaic Virus and Maize Chlorotic Mottle Virus. Based on the analysis, the import conditions for trade facilitation were developed for grain and seed maize to be applied within the region.

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Abbreviations

COMPETE	Competitiveness and Trade Expansion Program
COPE	Centre of Phytosanitary Excellence
EAC	East Africa Community
EAPIC	East Africa Phytosanitary Information Committee
IPPC	International Plant Protection Convention
ISPM	International Standards of Phytosanitary Measures
NPPO	National Plant Protection Organization
PRA	Pest Risk Analysis
RNQP	Regulated Non- Quarantine Pests
SPS	Sanitary and phytosanitary
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
FAO	Food and Agriculture Organization

Definition of Terms

Grain maize – maize seeds (in the botanical sense) for processing or consumption but not for planting.

Seed maize - maize seeds (in the botanical sense) for planting but not for processing or consumption

Quarantine pest-a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled

Endangered area - An **area** where ecological factors favour the establishment of a pest whose presence in the **area** will result in economically important loss (see Glossary Supplement 2) [FAO, 1995]

Official control - The active enforcement of mandatory phytosanitary regulations and the application of mandatory phytosanitary procedures with the objective of eradication or containment of quarantine pests or for the management of regulated non-quarantine pests (see Glossary Supplement 1) [ICPM, 2001]

Pest free place of production - Place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period [ISPM 10:1999]

Pest free area- An area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained [FAO, 1995]

Pest free production site - A defined portion of a place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period and that is managed as a separate unit in the same way as a pest free place of production [ISPM 10:1999]

Non-regulated pests- Pest that is not a quarantine pest for an area [FAO, 1995]

Regulated non-quarantine pest-A non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party

A **commodity** is a plant or plant product being moved for trade or other purposes

Consignment-A quantity of plants, plant products or other articles being moved from one country to another and covered, when required, by a single phytosanitary certificate (a consignment may be composed of one or more commodities or lots) [FAO, 1990; revised ICPM, 2001]

Pathway -Any means that allow the entry or spread of a pest; could be an imported commodit**y,** a means of transportation or storage, packaging, or other articles associated with the commodity and a natural means of spread (e.g. wind).

A pest -is any species, strain or biotype of plant, animal or pathogenic agent, injurious to plants or plant products" an insect, fungus, bacterium, virus, nematode, invasive plant

PRA-The process of evaluating biological or other scientific and economic evidence to determine whether a **pest** should be regulated and the strength of any phytosanitary measures to be taken against it

PRA area-Area in relation to which a pest risk analysis is conducted [FAO, 1995]. PRA area could be whole country, part of a country or several countries together

Pest risk management -is a systematic way of analysing potential mitigation measures to determine which would be most appropriate means by which to minimize the identified risks.

Practically free - Of a consignment, field, or place of production, without pests (or a specific pest) in numbers or quantities in excess of those that can be expected to result from, and be consistent with good cultural and handling practices employed in the production and marketing of the commodity [FAO, 1990; revised FAO, 1995]

1.0. Introduction

To reduce Phytosanitary trade barriers existing in the Eastern African region there was need to review the national pest lists and develop strategies to reduce trade barriers as well as develop a harmonized regional pest lists with a view to developing phytosanitary import conditions for the crops that will be applied within the region. To achieve this, a Regional Pest Risk Analysis workshop to coordinate the harmonization of pest lists for pests associated with commonly traded commodities in the region was held.

This analyis documents risks associated with the movement of grain and seed maize, *Zea mays* L within EAC member countries namely: Kenya, Burundi, Rwanda, Tanzania and Uganda.

The national pest lists evaluated by the team developed a consolidated pest list for maize for the region. In order to come up with regional quarantine pest list, all pests associated with the maize commodity and reported in any and/or all of the EAC countries were taken through the Pest Risk Analysis (PRA) process. The process involved categorization of the pests associated with maize (harmonized pest list), giving their distribution in the region, parts of the plant affected and whether the pest can follow the pathway (traded form of the commodity). The pathway considered in this case is the traded forms of maize within the region i.e. seed maize and grain maize. All pests of maize found to be of concern to the region (likely to follow the pathway) were identified for further analysis.

2.0. Pest Risk Analysis of for maize

Quarantine pests that are likely to follow the pathway on commercial shipment of grain and seed maize traded within the five countries, were subjected to PRA. FAO (1996) defines pest risk analysis as the "determination of whether a pest is a quarantine pest and evaluation of its introduction potential." Quarantine pest is defined as "a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled" (FAO, 1996).

The risk analysis is "pathway-initiated" in that it is based on the potential pest risks associated with the commodity as it crosses from one country within the region to the other. Estimate of risks are expressed in the qualitative terms of high, medium, or low. The International Plant Protection Convention (IPPC) of the Food and Agriculture Organization (FAO), provide guidance for conducting pest risk analysis. The methods used to initiate, conduct, and report this plant pest risk analysis is consistent with guidelines provided by IPPC and FAO. Biological and phytosanitary terms (e.g., introduction, quarantine pest) conform to the Definitions and Abbreviations (Introduction Section) in International Standards for Phytosanitary Measures: Guidelines for Pest Risk Analysis (FAO, 1996). Thus, pest risk analysis should consider the likelihood of introduction of quarantine pests, the consequences and mitigation measures to prevent the introduction and spread of the pests to new areas.

2.1. SCOPE OF PRA

The PRA was initiated to review national pest lists for maize within the EAC region, develop a harmonized EAC pest list for maize and develop Phytosanitary import conditions for maize to be applied within the EAC. The PRA area is the EAC region, namely Kenya, Uganda, Tanzania, Burundi and Rwanda.

2.2. Assessment of Weed Potential of maize, *Zea mays* L.

This step examined the potential of the commodity to become a weed after it enters the region (Table 1). However, the assessment did not indicate significant weed potential.

Table 1: Assessment of Weed Potential of maize grains/seeds, *Zea mays L.*

Commodity: Maize grains/seeds, *Zea mays L.*	
Phase 1: Many varieties of Maize, Zea mays L. are widely cultivated in the region.	
Phase 2: Is the species listed in:	
1) *Geographical Atlas of World Weeds* (Holm *et al*., 1979)	**No**
2) *World Weeds: Natural Histories and Distributions* (Holm *et al*., 1997)	**No**
3) Report of the Technical Committee to Evaluate Noxious Weeds; Exotic Weeds for Federal Noxious Weed Act (Gunn and Ritchie, 1982)	**No**
4) Crop Protection Compendium Database, CAB International (CPC, 2007).	**No**
5) Noxious Weed Act Cap. 325	**No**
6) Is there any literature reference indicating weediness, *e.g.*, AGRICOLA, CABI, Biological Abstracts, AGRIS; search on "species name" combined with "weed," such a search returns a prohibitive number of references, a sample of which do not indicate weediness, but that there are weeds associated with cultivation of Maize, *Zea mays L.*.	**No**
Phase 3: The assessment indicates that Maize, *Zea mays L.***.**is not likely to become a weed in the region. It is an important commodity and no weediness has been reported	

2.3. Previous Risk Assessments, Current Status, and Pest Interceptions

There are no previous PRA reports or interception reports on imports of maize within the region.

2.4. Pest Categorization–Identification of Quarantine Pests and Quarantine Pests Likely to follow the Pathway

Common pests associated with maize, *Zea mays* L., that occur in Kenya, Burundi, Rwanda, Tanzania and Uganda are listed in **Table 2.** This list includes information on the presence or absence of these pests in the countries, the affected plant part(s), the potential quarantine status of the pest with respect to the region, whether the pest is likely to follow the trade pathway within the region and pertinent references. Analysis takes into consideration that the commodity will be shipped as mature dry grains/seeds and that pests associated with other life stages are not likely to follow the pathway.

Table 2: Categorized pest list for pests associated with Maize (*Zea mays* L.) within the EAC region (Burundi, Rwanda, Tanzania, Kenya and Uganda)

Pest	Distribution	Parts affected	Quarantine Status	Likely to Follow Pathway	Reference
INSECTS					
COLEOPTERA					
Acanthoscelides obtectus (bean bruchid)	Kenya, Rwanda, Tanzania, Uganda, Burundi,	Seeds	No	Yes	Capinera, 2001; CPC, 2007
Ahasverus advena (foreign grain beetle)	Uganda	Seed/grains	Yes	Yes	CPC, 2011
Araecerus fasciculatus (cocoa weevil)	Kenya, Tanzania, Uganda, Burundi	Seed, Stem	No	Yes	CPC, 2007; Le Pelley, 1959
Carpophilus spp (dried-fruit beetles)	Kenya, Rwanda, Zambia, Tanzania, Uganda, Burundi	Cobs, seeds	No	Yes	CPC, 2007
Carpophilus dimidiatus (corn-sap beetle)	Kenya, Tanzania	Cobs, seeds	Yes	Yes	CPC, 2007
Carpophilus hemipterus (dried fruit beetle)	Kenya	cobs, seeds	Yes	Yes	CPC, 2007
Carpophilus humeralis (pineapple sap beetle)	Kenya, Tanzania	Stem	Yes	No	CPC, 2007; Le Pelley, 1959

Cryptolestes ferrugineus (rusty grain beetle)	Kenya	Seed	Yes	Yes	CPC,2007
Cryptolestes pusillus (flat grain beetle)	Kenya, Rwanda, Uganda, Tanzania, Burundi,	Kernel, Seeds	No	Yes	CPC, 2007
Cylas puncticollis (sweet potato weevil)	Kenya, Rwanda, Tanzania, Uganda, Burundi	Leaves, Roots, Stems	No	No	CPC, 2007
Epilachna similis (maize ladybird beetle)	Kenya, Uganda, Tanzania	Cobs, inflorescence , leaves	Yes	No	CPC, 2007
Heteronychus arator (African black beetle)	Kenya ,Tanzania,	Stems, leaves ,roots	Yes	No	CPC, 2007; Bosque-Pérez, 1995
Heteronychus licas (black sugarcane beetle)	Kenya, Tanzania, Uganda,	Stems, leaves, roots	Yes	No	CPC, 2007
Metmasius hemipterus (West Indian cane weevil)	Kenya	Leaves, stem	Yes	No	CPC,2010
*Prostephanus truncatus (*larger grain borer)	Kenya, Rwanda, Tanzania, Uganda, Burundi	Seed/Grains, cob	No	Yes	CPC, 2007; Bosque-Pérez, 1995, Rwegasira et al, 2003.
Sitophilus oryzae (lesser grain weevil)	Tanzania, Kenya	Seeds/Grain	Yes	Yes	CPC, 2010; Bosque-Pérez, 1995
Sitophilus zeamais (greater grain weevil)	Kenya, Uganda, Tanzania, Rwanda	Seeds/Grains	No	Yes	CPC, 2007; Bosque-Pérez, 1995
Tribolium castaneum (red flour beetle)	Kenya, Rwanda, Tanzania, Uganda, Burundi	Seeds, Fruits/pods, vegetative organs.	No	Yes	CPC 2007
Trogoderma granarium	Tanzania	Seeds/ Grains	Yes	Yes	CPC, 2010

Tribolium confusum (Confusedflour beetle)	Uganda	Seeds/Grains, Processed cereals	Yes	Yes	CPC 2007
*Rhyzopertha dominica(*lesser grain borer)	Rwanda, Tanzania,	Grains/seeds	Yes	Yes	CPC,2007
Pelopidas mathias(rice skipper)	Rwanda, Burundi	Leaves, young stem	Yes	No	CPC,2007; Buckyx,1962
Oryzaephilus surinamensis (saw toothed grain beetle)	Kenya	seeds	Yes	Yes	CPC, 2007;Giles, 1969
DIPTERA					
Atherigona orientalis (pepper fruit fly)	Kenya, Rwanda, Tanzania, Uganda, Burundi	Fruits/Pods, growing points, leaves, stems, roots, vegetative organs	No	No	CPC 2007
Atherigona soccata (sorghum stem fly)	Kenya, Uganda, Tanzania	Growing points, stems	Yes	No	CPC 2007
Dacus frontalis	Kenya, Tanzania	Cob	Yes	No	CPC 2007, www.gbif.org /species/Dacu s
Delia platura (bean seed fly)	Kenya, Rwanda, Uganda, Tanzania	Leaves, roots, seeds	No	Yes	CPC 2007
Liriomyza sativae (vegetable leaf miner)	Kenya	leaves	Yes	No	CPC 2007, Gitonga *et al*., 2010
HEMIPTERA					
Acyrthosiphon pisum (pea aphid)	Kenya, Rwanda	, inflorescence, leaves and whole plant.	Yes	No	CPC 2007
Aphis fabae (black bean aphid)	Kenya, Uganda, Tanzania, Burundi	Growing points, inflorescence, leaves and whole plant.	No	No	CPC 2007
Aphis gossypii (cotton aphid)	Kenya, Rwanda, Tanzania, Burundi, Rwanda	Growing points, inflorescence, leaves, stems and whole plant.	No	No	CPC 2007

Aphis spiraecola (Spirea aphid)	Kenya , Rwanda	Fruits/pods, growing points, inflorescence, leaves, stems and whole plant.	Yes	No	CPC 2007
Bagrada hilaris (painted, bug)	Kenya,Rwanda , Tanzania,Uganda, Burundi	Leaves	No	No	www.innonet-biovision.org/ pests...(2010)
Cicadulina mbila (maize leafhopper)	Kenya, Tanzania, Uganda	Leaves and whole plant	Yes	No	CPC 2010
Dysmicoccus brevipes (pineapple mealybug)	Kenya,Rwanda , Tanzania,Uganda, Burundi	Fruits/pods, growing points, leaves, roots, stems	No	No	CPC 2007
Ferrisia virgata (striped mealybug)	Kenya, Tanzania, Uganda	Fruits/pods, growing points, leaves and stems.	Yes	No	CPC 2007
Icerya aegyptiaca (breadfruit mealybug)	Kenya, Tanzania	Leaves, stems and whole plant.	Yes	No	CPC, 2007
Maconellicoccus hirsutus (pink hibiscus mealybug)	Kenya, Tanzania	Fruits/pods, growing points, inflorescence, leaves and stems.	Yes	No	CPC 2007
Macrosiphum euphorbiae (potato aphid)	Kenya, Tanzania, Uganda, Burundi, Rwanda	Flowering stage, fruiting stage, seedling stage and vegetative growing stage.	No	No	CPC 2007
Melanaphis sacchari (yellow sugarcane aphid)	Kenya, Zambia, Tanzania, Uganda, Burundi	Leaves	No	No	CPC 2007
Metopolophium dirhodum (rose-grass aphid)	Kenya, Burundi, Rwanda	Leaves and whole plant	Yes	No	CPC 2007
Metopolophium festucae (fescue aphid)	Kenya	Growing points, inflorescence, leaves, stems and whole plant	Yes	No	CPC 2007
Myzus persicae (green peach aphid)	Kenya,Rwanda , Tanzania,Uganda, Burundi	Growing points, inflorescence, leaves, stems and whole plant.	No	No	CPC 2007

Nezara viridula (green stink bug)	Kenya,Rwanda , Tanzania,Uganda, Burundi	Fruits/pods, growing points, inflorescence, leaves, seeds and stems.	No	Yes	CPC 2007
Oxycarenus hyalinipennis (cotton, seed bug)	Kenya, Tanzania, Uganda, Burundi	Seeds,Grains,fruits	No	Yes	CPC 2007; Halbert *et al* 2010
Peregrinus maidis (corn planthopper)	Kenya, Zambia, Tanzania, Uganda	Leaves, roots, stems and whole plant	No	No	CPC 2007
Rhopalosiphum insertum (apple-grass aphid)	Kenya	Leaves.	No	No	CPC 2007
Rhopalosiphum maidis (green corn aphid)	Kenya, Tanzania, Uganda, Burundi, Rwanda	Leaves ,tassels	No	No	CPC 2007 ; Bosque-Pérez, 1995
Rhopalosiphum padi (grain aphid)	Kenya	Growing points, inflorescence, leaves and whole plant.	Yes	No	CPC 2007
Schizaphis graminum (spring green aphid)	Kenya, Tanzania	Leaves, tassels	Yes	No	CPC 2007 ; Bosque-Pérez, 1995
Sitobion avenae (wheat aphid)	Kenya, Burundi	Inflorescence and leaves.	Yes	No	CPC 2007
LEPIDOPTERA					
Agrotis ipsilon (Hufnagel) (black cutworm)	Kenya,	Cobs, leaves, stems	Yes	No	CPC 2007
Agrotis segetum (Denis & Schiffermüller)(turnip moth)	Kenya, Tanzania, Uganda,	Leaves, roots, stems	Yes	No	CPC 2007
Busseola fusca Fuller (African maize stalk borer)	Kenya, Tanzania, Uganda, Burundi, Rwanda	Inflorescence, leaves, roots, seeds, stems	No	No	CPC, 2007

Cadra cautella Walker(dried currant moth)	Kenya,	Cobs, seeds	Yes	Yes	CPC, 2010
Chilo orichalcociliellus (Strand) (coastal stalk borer)	Kenya, Tanzania	Stems	Yes	No	CPC, 2010; Ofomata *et al*., 2000
Chilo partellus (Swinhoe) (spotted stem borer)	KenyaTanzania, Uganda, Burundi, Rwanda	Cobs, leaves, stems	No	No	CPC 2010; Bosque-Pérez, 1995
Chrysodeixis chalcites (Esper) (golden twin-spot moth)	Kenya, Zambia, Uganda	Cobs, leaves	Yes	No	CPC 2010
Corcyra cephalonica Stainton (rice meal moth)	Tanzania	Seeds/grains	Yes	Yes	CPC 2007
Cryptophlebia leucotreta Meyrick False codling moth	Kenya, Rwanda, Tanzania, Uganda, Burundi	Cobs, leaves, flowers,fruits	No	No	CPC 2007
Earias insulana Boisduval (Egyptian stem borer)	Kenya, Rwanda, Tanzania, Uganda, Burundi	Cobs, inflorescence, leaves, stems	No	Yes	CPC 2007
Eldana saccharina Walker (African sugarcane borer)	Kenya, Rwanda, Tanzania, Uganda, Burundi	Stems, cobs	No	No	CPC,2007; Bosque-Pérez, 1995
Helicoverpa armigera (Hübner) (cotton bollworm)	Kenya,Rwanda, Tanzania,Uganda, Burundi	Cobs, inflorescence, leaves	No	No	CPC, 2007
Helicoverpa assulta (Guenée) (cape gooseberry budworm)	Kenya, Tanzania, Uganda	Cobs, inflorescence, leaves	Yes	No	CPC, 2007
Hippotion celerio L.(taro hawkmoth)	Kenya, Rwanda, Tanzania, Uganda, Burundi	Leaves, stems	No	No	CPC, 2007

Mussidia nigrivenella (cob borer)	Tanzania, Kenya	Ear, grain, Seeds	Yes	Yes	CPC 2007; Muli et al., 2008
Plodia interpunctella Hubner (Indian meal moth)	Kenya, Uganda, Tanzania, Rwanda, Burundi	Cobs, seeds	No	Yes	CPC 2010 Hill, 2008
Mythimna loreyi (Duponchel) (maize caterpillar)	Kenya, Tanzania, Uganda	Leaves	Yes	No	CPC, 2007
Sesamia calamistis Hampson (African pink stem borer)	Kenya, Rwanda, Tanzania, Uganda, Burundi	Inflorescence, Roots, Seeds, Stems	No	No	CPC 2007; Bosque-Pérez, 1995
Sesamia cretica Lederer Greater sugarcane borer	Kenya	Leaves , Stems	Yes	No	CPC 2007
Sesamia Nonagrioides (Lefebvre) (Mediterranean corn stalk borer)	Kenya, Rwanda, Tanzania, Uganda, Burundi,	Cobs, Inflorescence, Roots, Seeds, Stems	No	Yes	CPC 2007
Sitotroga cerealella (Olivier)(grain moth)	Kenya, Tanzania,	Seeds/grains	Yes	Yes	CPC 2007
Spodoptera exempta Walker (black armyworm)	Kenya, Rwanda, Tanzania, Uganda, Burundi	Leaves, stems	No	No	CPC 2007; Bosque-Pérez, 1995
Spodoptera exigua (Hübner) (beet armyworm)	Kenya, Rwanda, Tanzania, Burundi,	Cobs, inflorescence, leaves	No	No	CPC 2007
Spodoptera frugiperda J.E. Smith (Fall armyworm)	Kenya, Rwanda, Tanzania, Uganda, Burundi	Cobs, inflorescence, leaves, roots. stem	No	No	CPC 2019
Spodoptera mauritia Boisduval (paddy swarming caterpillar)	Tanzania, Uganda,	Leaves, stems	Yes	No	CPC 2007
Spodoptera littoralis (Boisduval) (cotton leafworm)	Kenya, Tanzania, Uganda,	Cobs, Leaves	No	No	CPC 2007

	Rwanda, Burundi				
Spoladea recurvalis (Fabricius) (Hawaiian beet webworm)	Kenya, Tanzania, Uganda,	Cobs, inflorescence, leaves, roots.	Yes	No	CPC 2007
Thaumatotibia leucotreta Meyrick (false codling moth)	Kenya, Tanzania, Uganda, Burundi	Cobs, leaves, seeds	No	Yes	EPPO, 2006, CPC 2007 CPC, 2011
Trichoplusia ni (Hübner) (cabbage looper)	Kenya, Tanzania	Leaves	Yes	Yes	CPC, 2011
ORTHOPTERA					
Locusta migratoria (migratory locust)	Kenya, Rwanda, Tanzania, Uganda, Burundi	Cobs, inflorescence, leaves, stems	No	No	CPC, 2011
Nomadacris septemfasciata (red locust)	Kenya, Rwanda, Tanzania, Uganda, Burundi	Cobs, inflorescence, leaves, stems	No	No	CPC, 2011
Oedaleus senegalensis (Senegalese grasshopper)	Tanzania	leaves, seeds	Yes	No	CPC, 2011
MITES AND SPIDERS					
Tenuipalpidae					
Brevipalpus phoenicis (false spider mite)	Kenya, Rwanda, Tanzania, Uganda, Burundi,	Leaves, stems and whole plant.	No	No	CPC 2007
Tetranychidae					
*Tetranychus evansi (*red spider mite)	Kenya, Tanzania, Uganda,	Leaves	Yes	No	CPC 2007
Tetranychus pacificus (Pacific spider mite)	Kenya	Leaves, Kernel	Yes	No	CPC 2007
Tetranychus urticae (two-spotted spider mite)	Kenya, Tanzania,	Leaves.	No	No	CPC 2007

Frankliniella occidentalis (Pergande, 1895)	KE, TZ	Leaves, Tassel, Cob	Yes	No	Mortiz et al., 2013
Thrips pusillus Bagnall, 1926	KE	Leaves, Tassel, Cob	No	No	Mortiz et al., 2013
Thrips tabaci Lindeman, 1889	KE, UG, TZ	Leaves, Tassel, Cob	No	No	Mortiz et al., 2013
Haplothrips gowdeyi (Franklin, 1908)	KE, UG, TZ	Leaves, Tassel, Cob	No	No	Mortiz et al., 2013; cabi 2019

	Uganda, Burundi				
Tyrophagus putrescentiae (cereal mite)	Kenya	Seeds/grains	Yes	Yes	CPC 2007
Tetranychus cinnabarinus (Carmine Spider Mite)	Uganda	Leaves.	Yes	No	CPC 2007
THYSANOPTERA					
Frankliniella williamsi Hood, 1915	KE, UG	Leaves, Tassel, Cob	Yes	No	Nyasani et al., 2012; Mortiz et al., 2013
Frankliniella schultzei (Trybom, 1910)	KE, UG, TZ	Leaves, Tassel, Cob	No	No	Nyasani et al., 2012; Mortiz et al., 2013
Frankliniella occidentalis (Pergande, 1895)	KE, TZ	Leaves, Tassel, Cob	Yes	No	Mortiz et al., 2013
FUNGI					
ANAMORPHIC FUNGI					
Acremonium ochraceum Gams(Syn.Sagrahamala ochracea)	Kenya	Leaves	Yes	No	CPC, 2007; Farrell et al., 2005 ; Kung'u & Boa, 1997
Acremonium strictum (syn. *Cephalosporium acremonium*) (acremonium wilt)	Kenya, Uganda	Leaves, Stems, kernels	Yes	Yes	CPC, 2007; CIMMYT, 2004; Farrell et al., 1995;

					Kung'u & Boa, 1997
Alternaria brassicae(dark spot of crucifers)	Kenya, Tanzania, Rwanda	Leaves, Stems	Yes	No	CPC, 2007; Kung'u & Boa, 1997
Aspergillus flavus (Aspergillus ear rot)	Kenya, Uganda	Kernel, cob	Yes	Yes	CPC, 2007; Kung'u & Boa, 1997; CIMMYT, 2004
Aspergillus niger (Collar rot) (Tiegh.)	Kenya, Uganda	Leaves, Roots, Kernel	Yes	Yes	CPC, 2007; Kung'u & Boa, 1997
Bipolaris sacchari (E. J. Butler) Shoemaker	Kenya, Uganda,	Leaves, Roots, Kernel	Yes	Yes	CPC, 2007
Cercospora sorghi (Ellis & Everh.) (Cercosporiosis)	Kenya. Rwanda, Tanzania, Uganda, Burundi	Leaves Stems	No	No	CPC, 2007; Kung'u & Boa, 1997
Cercospora zeae-maydis ((Tehon & .Y.Daniels) Grey leaf spot)	Kenya, Uganda, Tanzania	Leaves, Stems, Seeds, Kernel	Yes	Yes	CPC, 2007; Kung'u & Boa, 1997
Lasiodiplodia theobromae (diplodia pod rot of cocoa)	Kenya, Tanzania, Uganda	Fruits, cobs, leaves, Inflorescence, seeds, stems	Yes	Yes	CPC, 2007
Gloeocercospora sorghi (Bain & Edgerton ex Deighton) (zonate leaf spot)	Kenya, Tanzania, Uganda	Leaves, Seeds	Yes	Yes	CPC, 2007; Kung'u & Boa, 1997; CIMMYT, 2004
Sarocladium oryzae (Sawada) W. Gams & D. Hawksw.	Kenya, Tanzania, Burundi,	Leaves, Seeds, Inflorescence	Yes	Yes	CPC, 2007; Kung'u & Boa, 1997
Botryodiplodia theobromae (Pat.) Griffiths & Maubl. (Syn. *Lasiodiploidia theobromae*) syn. *Diploidia maydis*	Kenya, Tanzania, Uganda	Leaves, Stems, ears	Yes	Yes	CPC 2007 ; CIMMYT, 2004
Stenocarpella maydis (Berk.) B. Sutton	Kenya, Tanzania, Uganda	Leaves, Stems, Roots, cob, Seeds	Yes	Yes	Kabeere & Wulf., 2008;CPC, 2007;

					Kung'u & Boa, 1997; CIMMYT, 2004
Ustilaginoidea virens (Cke.) Tak (False smut)	Kenya, Tanzania,	Kernel, Seed, Inflorescence	Yes	Yes	CPC, 2007; HCDA and JICA, 2003; CIMMYT, 2004
Macrophomina phaseolina (Tassi) (charcoal rot of bean/tobacco)	Kenya, Tanzania, Uganda	Roots, Stems, kernels	Yes	No	CPC, 2007; Farrel *et al.*, 1995 ; CIMMYT, 2004
Paecilomyces ochraceus	Kenya	Leaves,	Yes	No	Kung'u & Boa, 1997
ASCOMYCETES					
Ceratocystis paradoxa (black rot of pineapple)	Kenya, Tanzania, Uganda	Leaves, Stems, Roots, , Seeds	Yes	Yes	CPC, 2007; Kung'u & Boa, 1997
Pyrenophora teres (net blotch)	Kenya,	Inflorescence, leaves, seeds	Yes	Yes	CPC, 2007
Rosellinia necatrix Prill. (dematophora root rot)	Kenya	Leaves, Roots, Stems	Yes	Yes	CPC, 2007; Kung'u & Boa, 1997;
Penicillium aurantiogriseum (Dierckx)	Kenya	Leaves, Stems	Yes	No	CPC, 2007; Farrell et al., 1995; Kedera, 1996; Kung'u & Boa, 1997
Penicillium digitatum (green mould)	Kenya, Tanzania,	Leaves, flowers, fruits, stems	Yes	No	CPC, 2010
Choanephora cucurbitarum (Choanephora fruit rot) (Maize leaf spot)	Kenya, Tanzania	Cob, inflorescence, seeds, stem	Yes	Yes	CPC, 2007;
Cochliobolus carbonum (maize leaf spot)	Kenya, Tanzania	Cobs, leaves, roots, whole plant	Yes	No	CPC, 2007; Farrel *et al.*, 1995; Kedera, 1996
Cochliobolus heterostrophus (southern leaf spot)	Kenya, Tanzania, Uganda	Leaves, Stems, Inflorescence, Seeds	Yes	Yes	CPC, 2007; Kung'u & Boa, 1997

Cochliobolus sativus (root and foot rot)	Kenya, Tanzania, Uganda	Stems, Seedlings, Leaves, Inflorescence, Roots, Seeds	Yes	Yes	CPC, 2007; Kung'u & Boa, 1997
Corticium rolfsii (sclerotium rot)	Kenya, Tanzania, Burundi,	Roots	Yes	No	CPC, 2007; Kung'u & Boa, 1997
Curvularia (black kernel)	Kenya, Tanzania, Burundi, Uganda	Stems, Leaves, Seeds, Inflorescence	No	Yes	Kabeere & Wulf., 2008;CPC, 2007; Kung'u & Boa, 1997
Fusarium oxysporum (Schlechtendahl) (basal rot)	Kenya, Tanzania, Burundi, Uganda	Leaves, Stems	No	No	CPC, 2007; Kung'u & Boa, 1997
Fusarium pallidoroseum	Kenya, Uganda	Leaves, Stems	Yes	No	Kung'u & Boa, 1997; Kabeere & Wulf., 2008
Fusarium sporotrichioides	Kenya, Tanzania	Flowers, Seeds, cones, calyx	Yes	Yes	CPC, 2010
Gibberella fujikuroi Syn. *Fusarium verticillioides* (Sacc.) (fig endosepsis)	Kenya, Tanzania, Uganda	Leaves, Stems, Seeds, cobs	Yes	Yes	CPC, 2007; Farrel *et al*., 1995; Kedera 1996; Kung'u and Boa, 1997
Gibberella zeae) : syn. *Fusarium graminearum* (Schwabe) (headblight of maize)	Kenya, Tanzania, Uganda	Leaves, Stem, seed	Yes	Yes	CPC, 2007; Kedera 1996; CIMMYT, 2004
Glomerella graminicola Politis (red stalk rot of cereals)	Kenya, Tanzania, Uganda, Rwanda, Burundi	Leaves, Stems, Seed, Inflorescence	No	Yes	CPC, 2007
Khuskia oryzae Huds. (Syn. *Nigrospora sphaerica* (Sacc. (cob rot of maize)	Kenya, Tanzania, Uganda	Leaves, Stems	Yes	No	Kung'u & Boa, 1997;CPC, 2010
Setosphaeria turcica (Luttr.) K. J. Leonard & Suggs (Syns. *Exserohilum*	Kenya, Tanzania, Burundi,	Leaves, roots and whole plant.,seeds/Grains	No	Yes	CPC 2007; Farrel et al., 1995; Kedera,

turcicum, *Helminthosporium turcicum*) (maize leaf blight)	Uganda, Rwanda				1996; Kung'u & Boa, 1997; CIMMYT, 2004
Papularia sphaerosperma (Pers.) Hohn(Syn. *Athrinium phaeospermum*)	Kenya, Tanzania,	Roots, stems, fruiting bodies, Seeds-	Yes	Yes	Farr et al., 2005; Kung'u & Boa, 1997;Ellis 1965
Phaeosphaeria maydis (P. Hennings)	Kenya	Roots, Leaves	Yes	No	CPC, 2007; Farr et al., 2005;
BASIDIOMYCETES					
Thanatephorus cucumeris (Frank)	Kenya, Tanzania, Uganda	Leaves, Root, Seeds/Grain	Yes	Yes	CPC, 2007; Kung'u & Boa, 1997
Sphacelotheca reiliana (J. G. Kühn) Clinton (Head smut of maize)	Kenya, Tanzania, Uganda, Rwanda, Burundi	Leaves, Stems, Inflorescence, Seeds	No	Yes	CPC, 2007; Farrel *et al*., 1995; Kedera, 1996
OOMYCETES					
Pythium aphanidermatum (damping-off)	Kenya,Tanzania,	Roots, seeds	Yes	Yes	CPC, 2007; Kung'u & Boa, 1997; CIMMYT, 2004
Pythium debaryanum (damping-off)	Tanzania, Uganda	Inflorescence,leaves ,roots,stems	Yes	No	CPC, 2007
Pythium splendens (blast of oil palm)	Tanzania	Roots, stems, leaves, Growing medium	Yes	No	CPC, 2007
Peronosclerospora sorghi (sorghum downy mildew)	Kenya, Rwanda, Burundi	Leaves, stems, seedlings, inflorescence	Yes	No	CPC, 2011
Sclerophthora macrospora (downy mildew) Syn. *Sclerospora graminicola*	Kenya, Uganda, Tanzania,	Inflorescence, leaves, roots, seeds, stems and whole plant	Yes	Yes	CPC, 2011; Thakur et al., 2010
Mycosphaerella holci (glume blight)	Tanzania	Leaves, Stems, Seed,	Yes	Yes	CPC, 2011

CHYTRIDIOMYCETES					
Physoderma maydis (syn. *Physoderma zea* (Miyabe) (brown spot of corn)	Kenya, Uganda, Tanzania	Leaves, Stems, Inflorescence	Yes	No	CPC, 2007; Kung'u & Boa, 1997
UREDINIOMYCETES					
Puccinia polysora Underw) (American corn rust)	Kenya, Uganda, Tanzania,	Leaves, Stems	Yes	No	CPC, 2007; Kedera, 1996; Kung'u & Boa, 1997 ; CIMMYT, 2004
Puccinia purpurea (Cooke) (Rust of grasses)	Kenya, Uganda, Tanzania, Burundi	Leaves, Seeds	No	Yes	CPC, 2007; Kung'u & Boa, 1997
Puccinia sorghi Schwein. (common rust of maize)	Kenya, Uganda, Tanzania	Leaves, Seeds, Inflorescence	Yes	Yes	CPC 2007; Farrell *et al*., 1995; Kedera, 1997; Kung'u & Boa, 1997 ; CIMMYT, 2004
USTILAGOMYCETES					
Ustilago maydis syn. *Ustilago zeae* (Schwein.) Unger (Ustilaginales : Ustilaginaceae)(Common smut of maize)	Kenya, Uganda, Tanzania,	Ears, Leaves, Stems, seeds, tassels	Yes	Yes	CPC, 2007; Kedera, 1996; Kung'u & Boa 1997; CIMMYT, 2004
ZYGOMYCOTA					
Rhizopus spp.	Kenya,Uganda	Leaves, Stems, Seeds	Yes	Yes	CPC, 2007; Kedera, 1996; Kung'u and Boa, 1997; Kabeere & Wulf., 2008
Stenocarpella macrospora, syn. *Diplodia macrospore* (Macrospora leaf stripe)	Tanzania, Uganda	Seed, foliage	Yes	Yes	CIMMYT, 2004;CPC,2007

NEMATODES					
Aphelenchoididae					
Aphelenchoides besseyi (Rice leaf nematode)	Kenya, Burundi, Tanzania, Uganda,	Leaves, Stems, Inflorescence Seeds	No	No	CPC, 2007; Kimenju *et al*., 1999
Criconemella(Ring nematode)	Kenya,	Stem, Roots	Yes	No	CPC, 2007; Kimenju *et al*., 1999, 2004a
Ditylenchus dipsaci (Stem and bulb nematodes)	Kenya	Leaves, Stems, Roots, Seeds	Yes	Yes	CPC, 2007
Hoplolaimidae					
Helicotylenchus dihystera (Common spiral nematode)	Kenya	Roots,	Yes	No	CPC, 2007; Kimenju *et al*, 1999, 2004a
Helicotylenchus multicinctus (banana spiral nematode)	Kenya, Burundi, Tanzania, Uganda,	Roots, whole plant	No	No	CPC, 2007
Helicotylenchus pseudorobustus (spiral nematode)	Kenya, Tanzania, Uganda	Roots	Yes	No	CPC, 2011
Rotylenchulus parvus (Reniform nematode)	Kenya, Tanzania, Uganda	Roots	Yes	No	CPC, 2007
Rotylenchulus reniformis (Reniform nematode)	Kenya, Tanzania, Uganda, Burundi	Roots	No	No	CPC, 2007, Kimenju *et al*., 2004a
Scutellonema brachyurus	Kenya, Tanzania, Uganda	Root,	Yes	No	CPC, 2007
Scutellonema clathiricaudatum	Kenya, Uganda, Tanzania	Roots, seedlings	Yes	No	CPC, 2011
Rotylenchulus variabilis(Reniform nematode)	Kenya	Roots--	Yes	No	CPC, 2007;Sutherland & Kibata, 1993
Longidoridae					

Longidorus (Longidorids)	Kenya	Roots	Yes	No	CPC, 2007, Kimenju *et al*. 2004a
Meloidogynidae					
Meloidogyne arenaria (Peanut root knot nematodes)	Kenya, Uganda, Tanzania,	Roots	Yes	No	CPC 2007
Trichodoridae					
Paratrichodorus	Kenya, Burundi, Tanzania	Roots, whole plant	Yes	No	CPC, 2007
Paratrichodorus minor (Stubby root nematode)	Kenya	Root, Leaves	Yes	No	CPC, 2007; Kimenju *et al*., 1999; Wolff, 1968
Trichodorus	Kenya, Burundi, Tanzania,	Root	Yes	No	CPC, 2010
Pratylenchidae					
Pratylenchus brachyurus (Root lesion nematode)	Kenya, Tanzania, Uganda	Root, Stem, Seed , Leaves	Yes	Yes	CPC, 2007; Kimenju *et al*., 1998, 1999, 2004a
Pratylenchus coffeae (Banana root nematode)	Kenya, Tanzania, Uganda	Roots	Yes	No	CPC, 2007; Kimenju *et al*., 1998, 1999; 2004a
Pratylenchus goodeyi (Banana lesion nematode)	Kenya, Tanzania, Uganda, , Burundi,	Roots	No	No	CPC, 2007; Kimenju *et al*., 1998, 1999, 2004a
Pratylenchus penetrans (Northern root lesion)	Kenya, Tanzania	Roots	Yes	No	CPC, 2007; Kimenju *et al*., 1998, 1999, 2004a
Pratylenchus vulnus (Walnut root lesión nematode)	Kenya	Leaves, Roots	Yes	No	CPC, 2007; Kimenju *et al*., 1998, 1999
Pratylenchus zeae (Root lesión nematode)	Kenya, Uganda, Tanzania	Roots	Yes	No	CPC, 2007; Sutherland and Kibata, 1993

Radopholus similis (burrowing nematode)	Kenya, Uganda, Tanzania, Burundi, Rwanda	Leaves, roots, whole plant, vegetative organs	No	No	CPC 2007
Xiphinematidae					
Xiphinema spp	Kenya	Roots	Yes	NO	CPC 2019
VIRUSES					
Barley yellow dwarf viruses (barley yellow dwarf)	Kenya, Tanzania, Rwanda	Leaves, whole plant	Yes	No	CPC, 2007
Mononegavirales					
Cucumber mosaic virus (cucumber mosaic)	Kenya,Tanzania	Seeds, leaves, fruits/pods, inflorescence	Yes	Yes	CPC, 2007
Maize mottle virus	Kenya	Leaves	Yes	No	Kedera 1996
Maize chlorotic mottle virus	Kenya, Uganda, Tanzania, Rwanda	Leaves, roots, whole plant, vegetative organs	Yes	Yes	CPC 2019
Maize dwarf mosaic virus (dwarf mosaic of maize)	Kenya,	leaves	Yes	No	CPC, 2007
Maize mosaic virus (corn mosaic virus)	Kenya, Rwanda, Tanzania	leaves	Yes	No	CPC, 2007
Maize streak virus (streak disease of maize)	Kenya, Burundi, Uganda, Rwanda,	Leaves, whole plant	No	No	Kedera 1996, CPC 2007
Maize stripe virus (stripe disease of maize)	Kenya, Rwanda, Tanzania	Leaves, inflorescence	Yes	No	CPC, 2007
Maize line virus	Kenya	leaves	Yes	No	Kedera 1996,
Sugarcane mosaic virus (mosaic of abaca)	Kenya, Uganda, Tanzania	Leaves, stems, whole plant	Yes	No	CPC, 2007
BACTERIA					
Burkholderiales					
Burkholderia andropogonis(bacterial leaf stripe of sorghum and cor)	Kenya, Uganda	Inflorescence, leaves, seeds, stems	Yes	Yes	CPC, 2007

Acidovorax avenae subsp. *avenae* (bacterial leaf blight)	Kenya, Tanzania, Rwanda, Uganda	Leaves, seeds	No	Yes	CPC, 2007
Enterobacteriales					
Erwinia chrysanthemi pv. zeae (bacterial wilt of dahlia)	Kenya	Leaves, roots, stems	Yes	No	CPC, 2007
Erwinia carotovora subsp. Atroceptica(Potato Black leg disease)	Tanzania	Stems,	Yes	No	CPC,2011
Pseudomonadales					
Pseudomonas syringae	Kenya, Burundi,	Leaves, inflorescence, fruits, stems	Yes	No	CPC, 2007
Pseudomonas syringae pv. coronafaciens (halo blight)	Kenya	Leaves, sheaths or glumes	Yes	No	CPC, 2007
Pseudomonas syringae pv. syringae (bacterial canker or blast (stone and pom)	Kenya, Burundi, Tanzania, Uganda	Fruits/pods, inflorescence, leaves, roots, seeds, stems	No	Yes	CPC, 2007
Pseudomonadales					
Pseudomonas viridiflava (bacterial leaf blight of tomato (USA))	Kenya, Uganda, Tanzania	Leaves, stems, true seeds, seedlings, fruits, flowers, Bark	Yes	Yes	CPC, 2007
Pseudomonas fuscovaginae	Rwanda, Tanzania, Burundi	Seedling, leaves, flowers, stems,seeds/Grain	Yes	Yes	CPC, 2011
Herbaspirillum rubrisubalbicans (mottled stripe of sugarcane) *(Syn. Pseudomonas rubrisubalbicans*	Tanzania	Leaves	Yes	No	CPC, 2011
Xanthomonadales					
Xanthomonas albilineans (leaf scald of sugarcane)	Kenya, Uganda, Tanzania, Rwanda	Leaves,Stems	No	No	CPC, 2007

Below is a summarized list of quarantine pests that are likely to follow the pathway on commercial shipment of Maize grain/seeds within the five countries in the region (**Table 3**). These pests are further analysed in this PRA. Quarantine pests not included in Table 3 have the potential to be detrimental to agriculture or ecosystems within the region. However, they were not subjected to further analysis because they are mainly associated with plant parts other than the parts of the commodity being shipped, or they are unlikely to be associated with the commodity during transport or processing because of their size, biology, or inherent mobility.

Table 3: Pests associated with maize seed/grain of concern to the region identified for further assessment

	Pest	**Life form**	**Distribution**
1	*Alternaria brassicae* (dark spot of crucifers)	Fungi	Kenya, Tanzania, Rwanda
2	*Araecerus fasciculatus* (cocoa weevil)	Insect	Kenya, Tanzania, Uganda, Burundi
3	*Choanephora cucurbitarum (Choanephora fruit rot)* (Maize leaf spot)	Fungi	Kenya, Tanzania
4	*Cochliobolus sativus*	Fungi	Kenya, Tanzania, Uganda
5	*Cochliobolus heterostrophus*	Fungi	Kenya, Tanzania, Uganda
6	*Cochliobolus carbonum*	Fungi	Kenya, Tanzania
7	Cucumber Mosaic Virus (CMV)	Virus	Kenya,Tanzania
8	*Curvularia lunata*	Fungi	Kenya, Tanzania, Burundi, Uganda
9	*Ditylenchus dipsaci* (Stem and bulb nematode)	Nematode	Kenya
10	Maize Dwarf Mosaic Virus	Virus	Kenya
11	Maize Chlorotic Mottle Virus	Virus	Kenya, Uganda, Tanzania, Rwanda
12	*Prostephanus truncatus* (Larger Grain borer)	Insect	Kenya, Rwanda, Tanzania, Uganda, Burundi
13	*Sitotroga cerealella* (Olivier)(grain moth)	Insect	Kenya, Tanzania
14	Sugarcane Mosaic Virus (mosaic of abaca)	Virus	Kenya, Uganda, Tanzania
15	*Tribolium confusum* (confused flour beetle)	Insect	Uganda

16	*Pyricularia setariae* (blast of millet)	Fungi	Tanzania, Uganda
17	*Stenocarpella macrospora* (Earle) B.Sutton (dry rot of maize)	Insect	Tanzania, Uganda
18	*Ahasverus advena* (foreign grain beetle)	Insect	Uganda

3.0: Risk Assessment and pests requiring Phytosanitary Measures

The consolidated potential quarantine list for maize for the region composed of 18 pests (4 insects, 1 nematode, 8 fungi, and 5 viruses), were then assessed further. Quarantine pests that reasonably can be expected to follow the pathway, i.e., be included in shipments of grain and seed maize traded within the EAC countries, are included on the pest list (Table 4-Table 20). However, those pests, which may be potentially detrimental to agriculture but were not chosen for further analysis is because they are either well established or widespread in the region or associated mainly with plant parts other than the traded commodity. If they were associated with the commodity, it was not considered reasonable to expect them to remain with the commodity during post harvest and processing. In addition for the pests that were common in the region and not identified for further assessment, it was agreed that the plant import permit should state clearly indicate the conditions of any intended importation of maize into the region and the commodity should be accompanied by a phytosanitary certificate from the exporting country indicating that the import conditions of the importing country have been met.

Consequences of Introduction—Economic/Environmental Importance

Potential consequences of introduction are rated using five risk elements:

1. Climate-Host Interaction
2. Host Range
3. Dispersal Potential
4. Economic Impact
5. Environmental Impact

These elements reflect the biology, host ranges and climatic/geographic distributions of the pests.

Risk Element 1- Climate-Host Interactions

If a species encounters suitable climate and hosts in the area where it is introduced, the organism may survive and achieve pest status in the new environment. This risk element is evaluated on the minimum number of ecological zones in which the species might achieve pest status. Risk ratings are based on the following criteria:

Low (1): the species is only likely to become established in one zone

Medium (2): the species is likely to become established in two or three zones

High (3): the species is likely to become established in four or more zones

Risk Element 2- Host Range

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

Low (1): pest attacks a single species or multiple species within a single genus

Medium (2): pest attacks multiple species within a single plant family

High (3): pest attacks multiple species among multiple plant families

Risk Element 3-Dispersal Potential

A pest may disperse after arriving in a new area. The following items are considered in regard to dispersal potential: reproductive patterns of the pest (e.g., voltinism, biotic potential); inherent powers of movement; factors facilitating dispersal, wind, water, presence of vectors, humans, etc.

Low (1): pest has neither high reproductive potential nor rapid dispersal capability

Medium (2): pest has either high reproductive potential OR the species is capable of rapid dispersal

High (3): Pest has high biotic potential, e.g., many generations per year, many offspring per reproduction ("r-selected" species), AND evidence exists that the pest is capable of rapid dispersal, e.g., over 10km/year under its own power; via natural forces, wind, water, vectors, etc., or human-assistance.

Risk Element 4-Economic Impact

Introduced pests can cause a variety of direct and indirect economic impacts. These impacts are divided into three primary categories (other types of impacts may occur): lower yield of the host crop, e.g., by causing plant mortality, or by acting as a disease vector; lower value of the commodity, e.g., by increasing costs of production, lowering market price, or a combination; and loss of foreign or domestic markets due to the presence of a new quarantine pest.

Low (1): pest causes any one or none of the above impacts

Medium (2): pest causes any two of the above impacts

High (3): pest causes all three of the above impacts

Risk Element 5 - Environmental Impact

A pest may cause significant, direct consequences to the environment, e.g., cause an ecological disaster or reduce biodiversity. Significance is qualitative and encompasses the likelihood and severity of an environmental impact. A pest is considered to have an environmental impact if: pest is expected to have direct impacts on species by infesting/infecting a listed plant; pest is expected to have indirect impacts on species by disrupting sensitive, critical habitat; introduction of the pest would stimulate chemical or biological control programs."

Low (1): none of the above would occur

Medium (2): one of the above would occur

High (3): two or more of the above would occur.

3.1. Assessment of likelihood of entry, establishment, spread and economic impacts

Table 4. Technical evaluation of risk factors *Alternaria brassicae* (dark spot of crucifers)

Pest	Type of pest	Pathway	Risk factors	Risk rating	Description
Alternaria brassicae (dark spot of crucifers)	**Fungus**	**Seeds (inc. Grain)**	**Likelihood of Entry**	Medium	There is a likelihood that *Alternaria brassicae* may spread within the East African Region. This is especially due to a lot of trade of maize as seed or as grain. The pest is seedborne and can be transport on the outside of seeds or borne internally (Humpherson-Jones, 1992). The fungus however, behaves like a saprophyte, survives on infected seeds and debris of cultivated and weed hosts (Vaartnou and Tewari, 1972; Maude and Humpherson-Jones, 1980. It is possible to treat seeds/ grains using fungicides like Iprodione and fenpropimorph. These fungicides are reported to be effective in commercial treatment of Brassica seed (Maude et al., 1984; Humpherson-Jones, 1992). The orgamisn is wind dispersed.
			Likelihood of Establishment	Medium	*A. brassicae* has a wide host range, which extends to many cruciferous and non-cruciferous plants (Anon., 1960; Mukerji and Bhasin, 1966; Conners, 1967; Ginns, 1986; Strandberg, 1992; Yu, 1992; Tewari and Conn, 1993; Verma and Saharan, 1994; Farr et al., 1995). Most of these host crops are found

					within the EAC regions and can support establishment of the pest. Optimum conditions for sporulation; relative humidity greater than 91.5% RH and a temperature range of 18-24°C (Humpherson-Jones and Phelps, 1989) are also present in the PRA area. Many fungicides are active against *A. brassicae* (Tewari and Skoropad, 1979; Humpherson-Jones, 1992; Verma and Saharan, 1994; Seidle et al., 1995); pest control or management is therefore possible.
			Likelihood of Spread	High	Once introduced into new regions, this pest is highly likely to spread. Seed infections of up to 90% have been reported (Humpherson-Jones, 1992; Verma and Saharan, 1994). There are reports on a high proportion of infected seeds developing into infected seedlings (Humpherson-Jones, 1992). Transmission rates of up 35% may occur under field conditions (Humpherson-Jones, 1992). Field experiments conducted in 1991 and 1992 showed that a seed-borne inoculum of the fungus produced lesions on the cotyledonary leaves and then in the first true leaves. Otherwise, Many fungicides are active against *A. brassicae* (Tewari and Skoropad, 1979; Humpherson-Jones, 1992; Verma and Saharan, 1994; Seidle et al., 1995); pest

					control or management is therefore possible.
			Economic impact	Low	*A. brassicae* inflicts high economic losses in some parts of the world (Humpherson-Jones, 1991, 1992). It is reported to cause yield losses of 25-40% in faba bean at elevations of <1600 m in the Garhwal Mountains in India (Bisht et al., 1997). Yield losses of up to 71.5%, in India (Kolte, 1985; Singh and Bhowmik, 1985; Kolte et al., 1987). This pest can cause head rot of cauliflower in Colombia resulting in 30% losses (Tamayo et al., 2001). It can also lead to production of poor quality of oil thus loss of market and employment. The overall economic impact is low, since there are no reported yield losses in maize due to this pest. The pest is also known to survive on infected seeds and debris of cultivated and weed hosts (Vaartnou and Tewari, 1972; Maude and Humpherson-Jones, 1980. Even though maize seeds have been listed as host, there are no reported losses on maize.
			Overall Risk	Medium	It is a regulated non-quarantine pest and risk management is required.
			Category (QP, RNQP, NRP)		**RNQP**
			Requires Risk Management (yes / no)		Yes

Table 5. Technical evaluation of risk factors *Araecerus fasciculatus* (cocoa weevil)

Pest	**Type of pest**	**Pathway**	**Risk factors**	**Risk rating**	**Description**
Araecerus fasciculatus (cocoa weevil)	Insect	Seeds (inc. Grain)	**Likelihood of Entry**	High	The overall likelihood that *Araecerus fasciculatus* survives in the East African Region is high. This is especially because the pest is highly polyphagous and primarily is a pest of stored products. It has been reported to occur in Kenya, Tanzania, Uganda (Mphuru, 1974) and Burundi (Pierrard, 1962). The larval and pupal stages of this pest are borne internally in the product (Mphuru (1974). It is therefore, difficult to see it with the naked eye thus a high risk of transporting infested commodity especially at early stages of infestation. The adult weevil can survive on commodities for up to 17 weeks and larvae between 29 to 56 days (Mphuru,1974) and Li and Li (2009). Under favourable conditions and by transporting infested seed it is possible to introduce the pest to new regions like Rwanda.
			Likelihood of Establishment	High	The PRA area has suitable hosts and environmental conditions. There is no known vector for the pest that have been reported in the EAC region. The pest is an important pest of many plants or plant products, including coffee, cocoa, nutmegs, corn, peanuts, spices, grains, dried fruit, yam, cassava, ginger,

					turmeric, garlic bulbs, several seeds and grains (Mphuru, 1974; Abraham, 1975; Parker & Booth, 1979; Childers & Woodruff, 1980; Nagano, 1981; Joseph et al., 2001). It can also live to a certain extent on flour, thrives on biscuits and even on ordinary bread, preferring the crumb to the crust (El Sayed, 1940). Its ability to attack a broad spectrum of commodities is enhanced by high moisture content of the food or high relative humidity of the environment; because it is very moisture dependent, (Bitran et al., 1978). There is a high likelihood of the pest to survive on the alternative hosts which are all grown in EAC regions.
			Likelihood of Spread	High	The pest can survive and spread well within the tropical and subtropical regions, whenever the commodity is not properly stored and /or has a high moisture content or relative humidity above 70-80% (Abrahas and Bitran, 1973; Parker and Booth, 1979). Adults can be easily seen since they feed externally on commodities producing some powder and may live up to 17 weeks at optimal humidity (80%+ RH) . Otherwise, the Larval and pupal stages are difficulty to see with the naked eye thus may easily escape undetected during early stages of infestation (Mphuru, 1974). It is possible to transport the pest with the commodities especially at the

					early stages of infestation but use of effective pesticides to dress maize seed can help eliminate / kill the pest. Natural enemies like *A. fasciculatus, Anisopteromalus calandrae, Cephalonomia gallicola, and Pyemotes tritici* (Silva P, 1974) have been reported to effective for control of the pest although they are not available in the EAC regions.
			Economic impact	Medium	*A. fasciculatus* has an economic impact as a contaminant. It can also cause severe damage on stored commodities such as cassava (Abrahas and Bitran, 1973; Parker and Booth, 1979). The pest is polyphagous. It is an important pest of many plants or plant products, including coffee, cocoa, nutmegs, corn, peanuts, spices, grains, dried fruit, yam, cassava, ginger, turmeric, garlic bulbs, several seeds and grains (Mphuru, 1974; Abraham, 1975; Parker & Booth, 1979; Childers & Woodruff, 1980; Nagano, 1981; Joseph et al., 2001). It can also live to a certain extent on flour, thrives on biscuits and even on ordinary bread, preferring the crumb to the crust (El Sayed, 1940). Even though maize seeds have been listed as host, there are no reported losses on maize.
			Overall Risk	Medium	It is a regulated non-quarantine pest and risk management is required

			Category (QP, RNQP, NRP)		RNQP
			Requires Risk Management (yes / no)		Yes

Table 6. Technical evaluation of risk factors for *Choanephora cucurbitarum* (Choanephora fruit rot) (Maize leaf spot)

Pest	**Type of pest**	**Pathway**	**Risk factors**	**Risk rating**	**Description**
Choanephora cucurbitarum (Choanephora fruit rot) (Maize leaf spot)	Fungus	Seeds (inc. Grain)	**Likelihood of Entry**	Low	*Choanephora cucurbitarum* can be controlled with fungicide such as zineb, mancozeb, ziram and thiram as pre-inoculation treatments, but zineb and thiram performed best when sprayed 24 h after inoculation with 80% control (Chahal and Grover, 1974). *C. cucurbitarum* is seedborne on okra in Malaysia (Tai Luang Huan and Musa Bin Jamil, 1975). Seed transmission of *C. cucurbitarum* was 0.5% in grain amaranth (Roy and Deka, 1989). There are no reports on seedborne aspect in maize and therefore the overall risk of entry of this pest negligible. **PRA therefore stops.**
			Likelihood of Establishment		-
			Likelihood of Spread		-
			Economic impact		-

			Overall Risk		
			Category (QP, RNQP, NRP)		NRP
			Requires Risk Management (yes / no)		NO

Table 7: Technical evaluation of risk factors *for Cochliobolus sativus*

Pest	Type of pest	Pathway	Risk factors	Risk rating	Description
Cochliobolus sativus	Fungus	Seed and grain	**Likelihood of Entry**	High	The pest occurs in three of the countries in PRA area where a lot of trade (formal and informal) in maize occurs between countries sometimes without strict phytosanitary checks. The pest is associated with the pathway (seed borne or can be transmitted by seed) and the destination (PRA area) has favourable environmental conditions (temperature, humidity) for the pest making it an important pest. Optimum temperature for the fungus growth is 27.28.C. Light accelerates conidia formation. Optimum humidity ratio of a substratum for the fungus development is 60 - 80%. *C. sativus* overwinters as mycelium and conidia on plant debris and on grain. .

					The pest is not detectable by inspection with unaided eye thus can escape detection at entry points. Control measures are available and when employed timely, they are removed from the grain. This is however not practical for seedborne infections (seed) as there is need for adequate monitoring during active growth, testing of the seed to confirm freedom from the pest. If seed is infected, then it is not possible to rid it of the pest.
			Likelihood of Establishment	High	The establishment of this pest within the PRA area is possible due to the presence of a wide range of hosts and suitable environmental conditions such as temperature and humidity. In conditions of a droughty climate *C. sativus* conidia are kept in ground to 5 years (Agro Atlas 2015). There are possible control methods for the pest that can be applied to ensure the grain or seed is free from the pest. This includes; chemical control, cultural control and sanitation, inspectorate regulatory

					activities basing on laboratory analysis reports and field inspection reports indicating pest freedom. This is very practical for the grain, with few challenges incase the farmers convert grain into seed.
			Likelihood of Spread	High	The natural environment in the PRA area is suitable for spread of the pest. Hosts are available easily, both wild and cultivated. The natural enemies are not known to be effective in controlling the pest. The farmer practices in the area causing fast transfer of the material around the PRA area therefore causing quick dissemination incases the pest is identified. Commonly farmers convert grain into seed thus introducing them to the farms, which when grown, disperse the mycelia by wind and water to uninfected fields The grain is taken to the milling facilities for processing thus reducing risk of exposure of escaped pest to the farms. Maize spillage may occur when poorly handled transportation

					mechanisms causing them to grow in the areas where the seed has spilled.
			Economic impact	Medium	The pest has a high potential of causing moderate economic losses and social economic disturbances within the PRA area. There is not much information on yield losses on maize due to the pest. Yield losses ranging from 16 to 33% have been reported for susceptible barley cultivars (Clark, 1979) A more recent study using soil fumigation techniques demonstrated grain yield losses of 16-29% in seed from common root rot (Bailey *et al.*, 1997). In Brazil, losses of 19% were estimated in field trials comparing infected with healthy plants. The reduction in yield was attributed to fewer heads per plant and seeds per head, and lower seed weight (Diehl et al., 1983). Annual losses of 3-5% from common root rot are typical in the High Plains region (Bugwood Wiki,2015)

			Overall Risk	Medium	
			Category (QP, RNQP, NRP)		RNQP
			Requires Risk Management (yes / no)		Yes

Table 8: Technical evaluation of risk factors *Cochliobolus heterostrophus*

Pest	**Type of pest**	**Pathway**	**Risk factors**	**Risk rating**	**Description**
Cochliobolus heterostrophus	Fungi	Seed and grain	**Likelihood of Entry**	High	The pest occurs in two of the countries in PRA area where a lot of trade (formal and informal) in maize occurs between countries. The pest is associated with the pathway (seed borne or can be transmitted by seed) and the destination (PRA area) has favourable environmental conditions (temperature, humidity) for the pest. Disease development is promoted by prolonged wetness on foliage, extended dew, Relative humidity (97-100%) and relatively warm temperatures (24-35 ºC) Different responses to environmental factors such as temperature, light and humidity have been identified between races and within populations of individual races (Garraway et al., 1989; Jenns and Leonard, 1985; Warren,

					1975). This means that the races can survive varied temperature ranges during transport. Similar agricultural practices which make it easier for the pest to survive. The cultural control, field sanitation and chemical control measures are known to manage the pest (CPC, 2015). The host plant resistance and biological control are showing promising results for possible future use (CPC, 2015). Use of storage pesticides / dusting protects the grains against attack by storage pests including insects and fungi. In Kenya, a survey indicated that <50% of the farmers practice dusting their produce and some use un-recommended compounds. Despite there being possibility of managing the pest, the adoption levels remain low. Grain can adequately be controlled by fumigants. For seed, there is need for proper inspection for freedom from pest when the plants are in the field for them to be certified as disease free.
			Likelihood of Establishment	High	The pest survives on a relatively broader range of

					host plants all of which are grown as important crops in the PRA area. The pest survives on seed (Boothroyd, 1971; Kulik, 1971) and maize crop residues (Wang and Wu, 1987; Sumner and Littrell, 1974). Under ideal conditions, the fungus is able to complete its life cycle in only 60 to 72 hours thus can undergo many generations in a maize growing season. The establishment of this pest within the PRA are is possible due to the presence of a wide range of hosts and suitable environmental conditions such as temperature and humidity. However available pest control measures such as cultural control, field sanitation and chemical control can manage the pest within the PRA area for grains when adequately and timely applied. However, for the seed, there is need for adequate monitoring during active growth to ensure freedom from the pest. If seed is infected, then it is not possible to rid it of the pest.
			Likelihood of Spread	High	The natural environment (wild) has hosts where the pest can survive. The pest can be found in many tropical and sub-tropical

					areas of the world due to favorable environmental conditions. Host plants are cultivated by the farmers across the PRA area. The pest is capable of surviving on crop residues such as maize stover during the harsh season and is easily spread by wind and water. The natural enemies are not known to be effective in controlling the pest. The farmer practices in the area causing fast transfer of the material around the PRA area therefore causing quick dissemination in case the pest is identified. This also applies when farmers share their own `seed` from previous crops.
			Economic impact	High	The pest constitutes a major threat to maize production throughout the world (White.DG, 1999; Kump *et al.*, 2011 The monetary value of the lost corn crop in an epidemic in USA caused by the disease is estimated at 1 Billion USD (Agrios George Nicholas, 2005). In the present day, the disease can still be an issue in tropical climates causing devastating yield losses of up to 70% (Garraway *et al.*,

					1998; Wang *et al.,* 2001; Ali *et al.*, 2011a). Under experimental conditions, yield losses as high as 46% have been observed in maize inoculated with the pest (Fisher *et al.,1976; Byrnes et al,. 1989)* However, yield losses of this magnitude in commercial production are rare because hybrids which have some level of quantitative **resistance** (e.g. U.S and Southern Europe) thus greatly reducing yield losses. The pest has a high potential of causing economic losses and social economic disturbances within the PRA area. The losses in terms of monetary value are high and unacceptable.
			Overall Risk	High	
			Category (QP, RNQP, NRP)		QP
			Requires Risk Management (yes / no)		Yes

Table 9: Technical evaluation of risk factors for *Cochliobolus carbonum*

Pest	Type of pest	Pathway	Risk factors	Risk rating	Description
Cochliobolus carbonum	Fungus	Seed and grain	**Likelihood of Entry**	Low	The trading of maize grain within the PRA area poses a risk to those countries

					(Uganda, Rwanda and Burundi) where the pest has not been reported. The volume of consignments traded among the PRA area countries is high. The pest is not seed transmitted but can be transmitted on the surface of grains. Other sources of information indicate that the pest is commonly seed borne, although levels of infection have not been reported (Koehler, 1959) Since there is not much supporting information that seed can disseminate the pest, the maize grain, remains the most likely pathway for the pest. The environmental conditions, such as temperature and humidity, prevailing within the PRA area are favourable for the growth and multiplication of the pest. This environment coupled with the presence of host plants within the area synergistically influences the survival of the pest. There are various general recommendations that have been highlighted in the control of C. carbonum and other maize diseases including the destruction of plants, crop rotation,

					spraying with fungicides or nitrogen and potassium fertilization (Aleksandrov and Primakovskaya, 1980; Smiljakovic, 1975). However, no specific control measures have been developed for this disease. Since there is no information of the pest being seed borne, and there is information of the pest being carried on the surface; available pest control measures can adequately handle the pest on the grain **PRA STOPS**
			Likelihood of Establishment		-
			Likelihood of Spread		-
			Economic impact		-
			Overall Risk		-
			Category (QP, RNQP, NRP)		NRP
			Requires Risk Management (yes / no)		No

Table 10: Technical evaluation of risk factors for Cucumber Mosaic Virus (CMV)

Pest	Type of pest	Pathway	Risk factors	Risk rating	Description
Cucumber Mosaic	Virus	Seed and grain	**Likelihood of Entry**	High	CMV is seed borne. Palukaitis et al. (1992) list 22 plant species in

Virus (CMV)					which CMV is seed borne. CMV can be found in cotyledons, embryo and the seed testa (Wylie et al., 1993; Yang et al., 1997). The pathogen can survive in seed or grain while in transportation (CPC 2015). High volumes of seed and grain shall be traded within EAC region posing high likelihood of CMV entry. Control measures for CMV are also difficult to apply due to the wide host range. It also attacks weeds and ornamental plants which act as virus reservoirs and infect crops in adjacent fields. Seedlings derived from infected seeds are also primary sources of inoculum. CMV is transmitted by over 80 aphid species; the diverse behaviour of various aphid vectors can greatly reduce the impact of insecticide sprays, which are more effective when the insects are a direct 'pest' rather than a 'vector'. Therefore, there is likelihood of the pest surviving or evading existing pest management practices. The likelihood of entry of the pathogen through grain is low unlike in seed consignments.
			Likelihood of Establishment	High	CMV has a wide host range of more than 800 species of both monocotyledonous and dicotyledonous plants from over 85 families (Kaper and Waterworth, 1981; Palukaitis et al., 1992). The hosts include members of the Cucurbitaceae, Solanaceae and Araceae families among others. *Capsicum annuum*, *Cucumis sativus*, *Dioscorea* and *Solanum*

					lycopersicum are also primary hosts. The host range is widely distributed in the EAC region. CMV is transmitted by over 80 aphid species (CPC 2015), which are widely distributed within the EAC region. The virus is also stylet-borne and all instars of aphids act as efficient vectors (CPC 2015) Since the disease pathogen is vector transmitted, its prevalence is highly dependent on the population of aphid vectors present. Aphid reproduction is highly influenced by favourable temperatures and suitable hosts. During the dry season, suitable hosts especially legumes, and various types of trees, are colonized by *A. gosypii. A. gosypii* populations are known to survive the dry season, thus forming numerous reservoirs scattered among plants and in very varied habitats (Deguine et. al. 1999).
			Likelihood of Spread	High	Availability of a wide host range (Kaper and Waterworth, 1981; Palukaitis et al., 1992), presence of suitable natural and managed environmental conditions (CPC 2015) and the ability of the aphid vectors to spread within the EAC region favour the spread of CMV. In addition, the possibility of the pathogen to be transported with consignments escalates the risk of spread to areas of higher economic potential.
			Economic impact	High	There is no specific information currently available on yield-loss

					estimates in maize affected by CMV. CMV is a causal agent of several epidemics in crops such as tomatoes in Spain, Italy, Iran and Japan, bananas in Morocco and Central America (Palukaitis et al., 1992), lupins and capsicums in Australia. The virus has devastated high-value vegetable crops in China (Tien and Wu, 1991). Due to the wide host range and inadequate management measures (CPC 2015), the likelihood of economic loss will be high. CMV also infects non-agricultural plants hence affecting aesthetic value and landscapes. Chemical control approach on vectors if not properly applied, they can contaminate the food chain and waterways.
			Overall Risk	**High**	
			Category (QP, RNQP, NRP)		**QP**
			Requires Risk Management (yes / no)		**Yes**

Table 11: Technical evaluation of risk factors *Curvularia lunata*

Pest	**Type of pest**	**Pathway**	**Risk factors**	**Risk rating**	**Description**
Curvularia lunata ***Synonyms:*** *Cochliobolus lunatus* R.R.	Fungus	Seed and grain	**Likelihood of Entry**	High	*Curvularia lunata* is known to be spread through seed or grains. Infection levels of

Nelson & Haasis [teleomorph] R.R. Nelson & Haasis *Acrothecium lunatum* Wakker [anamorph] Wakker *Pseudocochliobolus lunatus* (R.R. Nelson & Haasis) Tsuda et al. [teleomorph] (R.R. Nelson & Haasis) Tsuda et al.					up to 31% can be detected on maize seeds (Yap and Kulshrestha, 1975; Aulakh et al., 1976; Gulya et al., 1979; Handoo and Aulakh, 1979, 1982). Large volumes of grain or seed in trade provide a high risk of entry and spread for the pathogen. The pathogen is associated with the pathway from origin since it attacks seed both internally and externally (Deshmukh and Raut, 1993). On transit, temperatures of up to 20^{o}C favours thriving of the pathogen. Management practices such as crop rotation and soil fumigation are not effective when applied in the field. Unlike seed, grain intended for milling pose negligible risk in facilitating entry for the pest.
			Likelihood of Establishment	Medium	*C. lunata* is pathogenic to numerous hosts. The main host range includes Maize, millet, rice, sorghum and

					various grasses. Other hosts include, common bean, Cowpea, Ginger, Wheat, Barley, Eucalyptus and Okra. *C. lunata* has no known vectors (CPC 2015). The pathogen can survive on crop residues and in the soil (Komoto and Hori, 1983; Hossain et al., 1991). Spores can also be detected in storage facilities (Manju-Singh et al., 1989). High humidity and tropical temperature favour the growth of *C. lunata*. Various spray treatments options such as Thiram + Carnebazin & Mancozeb are effective when used against the pathogen.
			Likelihood of Spread	Medium	*C. lunata* has natural enemies such as *Trichoderma, Gibberella fujikuroi* and *G. indica* which are present some area of EAC (CPC, 2015) and no known natural vectors (CPC 2015). *C. lunata* is seed borne and the

					commodity of trade is grain and seed therefore likely to spread through transportation. The risk of spread is high for seed and low for grain.
			Economic impact	High	*C. lunata* can cause serious losses in tropical regions with up to 60% loss recorded in inoculated plots (Fajemisin and Okuyemi, 1976; Grewal and Payak, 1976; Mabadeje, 1969; Mandokhot and Basu Chaudhary, 1972). Without proper management of the pathogen, the disease can translate to economic loses in EAC region. Besides, the chemicals that may be applied for management are an environmental risk if not properly utilized.
			Overall Risk	Medium	
			Category (QP, RNQP, NRP)		**RNQP**
			Requires Risk Management (yes / no)		**Yes**

Table 12: Technical evaluation of risk factors for *Ditylenchus dipsaci* (Stem and bulb nematode)

Pest	Type of pest	Pathway	Risk factors	Risk rating	Description
***Ditylenchus dipsaci* (Stem and bulb nematode)**	Nematode	Seed and grain	**Likelihood of Entry**	High	Few occurrences are reported in Kenya and absence in the rest of EAC region (CABI 2015; CPC 2007). Kenya exports an important quantity of maize seed in the region. The pest is seed transmitted though seed born incidence is low. *Ditylenchus dipsaci* is liable to be carried on dry seeds and in planting material of host plants. Grain imports contaminated with soil from where this nematode occurs pose a likelihood of entry of this pathogen (Anselme 1975; CPC 2015). The likelihood of entry of the pathogen through grain is low. However for seed consignments or grain utilized as seed, there is likelihood of entry especially with consignments originating from higher altitudes with cooler temperatures. *Ditylenchus dipsaci* can survive in a desiccated state. The nematode in its desiccated state can survive in infected seed (Palmisano *et al.*, 1971). The presence of the

					infective fourth stage juveniles in seed and dry plant material is also important in the passive dissemination of the nematode over long distances. (Palmisano *et al.*, 1971).
			Likelihood of Establishment	Medium	*D. dipsaci* is seed-borne especially on principal hosts such as beans and bulbs like garlic, onions and leeks. there are low chances of it being seed-borne. Maize is a primary host of the nematode, although chances of the nematode establishment in a tropical environment of the greater the EAC are low except at high altitudes with cooler temperatures like in some parts of Kenya. *D. dipsaci* attacks more than 1 200 species of wild and cultivated plants. Many weeds and grasses are hosts for the nematode and may play an important role in its survival in the absence of cultivated plants. *D. dipsaci* is polyphagous on cereals, most grains, rye, corn, and oats. Other hosts include onion, garlic, carrots, peas, potatoes, strawberry, sugarbeets, apples and peaches in nurseries and weeds (Ferris, 2014).

					There are no natural vectors for *D. dipsaci*, however human foot wear, mechanical and farm tool implements with soil, floods and conveyances may facilitate dispersion. During cold storage of bulbs and tubers, *D. dipsaci* may continue to develop. In onion plants at 15°C, the lifecycle takes approximately 20 days. The duration of the life cycle depends on the temperature and differs among isolates of different origins. Maximum activity and invasive ability is generally between 10 and 20°C. Therefore there are few areas within the EAC that have suitable environment No known control measures of other pests have been known to control *D, dipsaci*. Only cultural methods such as crop rotation for at least 3-4 years, sanitation by freedom from soil, hot water treatment and systemic nematicides can control *D. dipsaci* (CPC 2015). In international trade *D. dipsaci* is liable to be carried on dry seeds and planting material of host plants. Females lay 200-500 eggs each. Fourth-

					stage juveniles tend to aggregate on or just below the surface of heavily infested tissue to form clumps of 'eelworm wool' and can survive in dry conditions for several years; they may also become attached to the seeds of host plants such as onions, *lucerne, Trifolium pratense, faba* beans and *Phlox drummondii*. In clay soils, *D. dipsaci* may persist for many years. Cool, moist conditions favour invasion of young plant tissue by this nematode (CPC 2015).
			Likelihood of Spread	High	The pest is seed borne transmitted and physical vectors are available. There are areas with suitable temperature and other climatic conditions that can enhance survival of *D. dipsaci* within the EAC region. The maximum activity and invasive ability for *D. dipsaci* is generally between 10°C and 20°C of temperatures. Contaminated farm tools and machinery are also sources of inoculum dissemination. *D. dipsaci* may be vectored by humans on clothes, foot wear and possessions; containers and packaging (wood), in soil, sand and gravel

					among others (CPC 2015). *D. dipsaci* is a migratory endoparasite that feeds upon parenchymatous tissue in stems and bulbs. Therefore *D. dipsaci* can be transported within the seed grain or maize seeds, and dry plant material. Mechanical equipment and conveyances have been known to vector the pathogen within adhered soil particles (CPC 2015). Seed commodities present high level of risk compared to negligible risk presented by grain.
			Economic impact	High	*D. dipsaci* is one of the most devastating plant-parasitic nematodes, especially in temperate regions. Without control, it can cause complete failure of host crops such as onions, garlic, cereals, legumes, strawberries and ornamental plants, especially flower bulbs (CPC 2015). Due to the wide host range and complicated management measures *D. dipsaci* can result to huge economic losses.
			Overall Risk	**High**	

			Category (QP, RNQP, NRP)		**QP**
			Requires Risk Management (yes / no)		**Yes**

Table 13: Technical evaluation of risk factors for Maize Dwarf Mosaic Virus

Pest	Type of pest	Pathway	Risk factors	Risk rating	Description
Maize Dwarf Mosaic Virus	*Virus*	Seed/Grain	**Likelihood of Entry**	High	There are huge volumes of Maize seed traded in the EAC Region either as seed for planting and grain for consumption. MDMV has been found in infected plants and, to a lesser extent, infected seed, (less than 0.01%) (Sutic and Tosic, 1966; Tosic and Simova, 1967; Onazi and Wilde, 1974). MDMV has been detected at levels of about 0.5% in maize seeds (Shepherd and Holdeman, 1965; Williams et al., 1968; Boothroyd, 1977; Hill et al., 1974; Mikel et al., 1984b). The virus is borne internally in true seed, thus there is a possibility of the pest to survive during transport. There are no Phytosanitary measures on seed treatment against MDMV and no interception recorded. If used for planting, the seed has a high risk of pathogen introduction into the PRA areas.
			Likelihood of Establishment	Medium	MDMV has major, minor and many wild hosts in PRA areas. Many aphid species are

					involved in MDMV transmission. The PRA area has an environment, which is conducive for MDMV. Control of vectors by use of insecticides and the use of resistance varieties can reduce the impact of MDMV. MDMV reaches higher concentrations at 15° than at 25° or at 35°C (Jensen *et al*., 1985) which therefore, would survive in the PRA area. Mixed infection s with other viruses affects plant growth and development (Ivanovic *et al*., 1992).
			Likelihood of Spread	High	The PRA area has an environment, which is conducive for MDMV. Persistence of MDMV in aphid vectors for a few hours can allow long distance transmission (Zeyen *et al*., 1987). MDMV is seed borne and therefore can be transported in maize seed and grain commodities. MDMV has a likelihood of spreading into areas of higher economic importance because the pest has mixed infections with Sugarcane mosaic virus, Maize chlorotic dwarf virus, Barley yellow dwarf virus and Cucumber mosaic virus (Panjan, 1966;) that affects plant growth and development (Ivanovic *et al*., 1992). Use of the commodity as seed for planting may spread the pathogen to the wide host range. There are no natural enemies that can control the pathogen.

			Economic impact	High	No information on economic impacts of MDMV have been reported. The total yield of maize can be very much affected by MDMV infection. Yield reduction per fertile field maize plant infected with MDMV can be up to 42% (Tosic and Misovic, 1967), with maize inbred lines or with sweetcorn, especially after later sowing, the yield can be reduced by 75% or more (Forster *et al*., 1980).
			Overall Risk	High	There are huge volumes of Maize seed/Grain traded in the EAC Region either as seed for planting and grain for consumption. The virus is borne internally in true seed, thus there is a possibility of the pest to survive during transport. There are no Phytosanitary measures on seed treatment against MDMV. MDMV reaches higher concentrations at 15° than at 25° or at 35°C (Jensen *et al*., 1985) which therefore, would survive in the PRA area (Ivanovic *et al*., 1992). The total yield of maize can be very much affected by MDMV infection. Yield reduction per fertile field maize plant infected with MDMV can be up to 42% (Tosic and Misovic, 1967), with maize inbred lines or with sweetcorn, especially after later sowing, the yield can be reduced by 75% or more (Forster *et al*., 1980).

			Category (QP, RNQP, NRP)		**QP**
			Requires Risk Management (yes / no)		**Yes**

Table 14: Technical evaluation of risk factors Maize Chlorotic Mottle Virus

Pest	**Type of pest**	**Pathway**	**Risk factors**	**Risk rating**	**Description**
Maize Chlorotic Mottle Virus	Virus	Seed/Grain	**Likelihood of Entry**	High	The intended consignment is seed for planting and grain for consumption; therefore, there is high probability of use in many PRA areas. There are huge volumes of Maize seed traded in the EAC Region. If used for planting, the seed has a high risk of introducing the pathogen into the PRA areas. The virus can survive in corn residue (Nyvall 1999).
			Likelihood of Establishment	Medium	Maize is the only known host of MCMV (Brockelman et al., 1982). MCMV is vectored by thrips (*Frankliniella williamsii*). The PRA area has a conducive environment for MCMV so can be established. MCMV is widely available in tropical corn seed stocks hence the most effective management of maize chlorotic mottle is through the integration of cultural practices with insecticides and host resistance (Scot Nelson *et al*, 2011) which the PRA area use, can reduce the incidences. MCMV infections re-occur in the same locations within maize fields year after year and

					maintained in the soil from season to season (Uyemoto, 1983). The virus has been shown to survive in ploughed corn stubble, therefore if there is no good control measures the virus can stay and increase the risk of establishment.
			Likelihood of Spread	High	MCMV is seed borne that confirmed in Hawaii-produced maize seed (Jiang et al., 1992) and in sweetcorn seed by (Delgadillo-Sanchez et al., 1994), therefore the possibility of pest to be transported in the commodity is great. The pest has been observed to occur in combinations with other potyviruses causing even greater disease complexes. The intended use of seeds/grains for planting and consumption respectively may spread the pathogen to the wide host range and destinations considered in PRA area. There are no known natural enemies that can control the pathogen. MCMV infections re-occur in the same locations within maize fields year after year and maintained in the soil from season to season (Uyemoto, 1983) thus spreading into areas of higher economic importance is great.
			Economic impact	High	MCMV can cause economic losses in maize if the pathogen is severe. In Peru, losses in floury and sweet maize varieties due to MCMV have been reported to average between 10 and 15% (Castillo, 1976). There would

					be unemployment due to reduced cultivation and food insecurity.
			Overall Risk	High	The intended use of seeds/grains for planting and consumption respectively may spread the pathogen to the wide host range and destinations considered in PRA area. If used for planting, the seed has a high risk of introducing the pathogen into the PRA areas (Nyvall 1999). MCMV is vectored by thrips (*Frankliniella williamsii*) (Scot Nelson et al, 2011). The PRA area has a conducive environment for MCMV so can be established. MCMV is seed borne that confirmed in Hawaii-produced maize seed (Jiang *et al*., 1992) and in sweetcorn seed by (Delgadillo-Sanchez *et al*., 1994), therefore the possibility of pest to be transported in the commodity is great. MCMV can cause economic losses in maize if the pathogen is severe. In Peru, losses in floury and sweet maize varieties due to MCMV have been reported to average between 10 and 15% (Castillo, 1976). There would be unemployment due to reduced cultivation and food insecurity.
			Category (QP, RNQP, NRP)		**QP**
			Requires Risk Management (yes / no)		**YES**

Table 15: Technical evaluation of risk factors *Prostephanus truncatus* (Larger Grain borer)

Pest	Type of pest	Pathway	Risk factors	Risk rating	Description
Prostephanus truncatus (Larger Grain borer)	Insect	Seed/Grain	**Likelihood of Entry**	High	There are huge volumes of Maize seed traded in the EAC Region either as seed for planting and grain for consumption. *P. truncatus* behaves as a typical primary pest of farm-stored maize; whole grains are attacked, on the cob, both before and after harvest. Adult females lay eggs in chambers bored at right angles to the main tunnels. This therefore, increases its likelihood of being present in traded maize seed/grain. *P. truncatus* is spread over longer distances almost entirely through the import and export of infested grain as eggs, larvae, pupae, adults. The most effective method of controlling *P. truncatus* in maize is to use dust insecticide combinations. However, recent laboratory and field studies have shown that unless inert dusts are applied at very high rates, they are not particularly effective

					against *P. truncatus.* This shows that the pest can evade existing control measures. No records of interception are available. If used for planting, the seed has a high risk of pest introduction into the PRA areas.
			Likelihood of Establishment	Medium	*P.truncatus* is a major pest of stored grain. Its major hosts are Manihot esculenta (cassava) stored products (dried stored products) Zea mays (maize) and minor hosts: Arachis hypogaea (groundnut), Dioscorea (yam), Phaseolus vulgaris (common bean), Sorghum bicolor (sorghum), Triticale and Triticum aestivum (wheat). The pest has no vector. Fumigation with phosphine is very effective in large-scale stores for the control of *P.truncatus.* Good cultural practices e.g. store hygiene, removal of infested residues and the selection of only sound material for storage can play an important role in limiting infestation. The success of this pest may be partly due to its ability to develop in grain at low moisture, which is found in a

					PRA area where the pest can be established.
			Likelihood of Spread	High	*P.truncatus* is a sporadic, but serious pest of maize and cassava in tropics (Birkinshaw LA *et al.*, 2002). The pest not vectored. *P. truncatus* spreads rapidly in trade moving in infested consignments of maize and dried cassava. Trade flows have a profound effect on its speed of movement. Nevertheless, it can fly and does use this as a means of dispersal (CPC 2007, CPC 2015). Use of infested seed for planting may affect yield. Harvested and stored products may be lost when infested by the pest. *Teretrius* (formerly Teretriosoma) *nigrescens*, has been associated with P. Truncates in Central America as a predator. However, once the predator has landed it is no longer attracted by the pheromone but by material in the frass of *P. truncatus* (Stewart-Jones *et al.*, 2004, 2006). The natural enemy, *Beuvaria bassianna* has been used in Tanzania to control the pest and has brought good results.

			Economic impact	High	Infestations in maize may start on the mature crop in the field, i.e. when moisture content is at or below 18%. Weight losses of up to 40% have been recorded in Nicaragua from maize cobs stored on the farm for 6 months (Giles and Leon, 1975). In Tanzania, up to 34% losses have been observed after 3 months storage on the farm, with an average loss of 8.7% (Hodges et al., 1983). *P. truncatus* infests the granaries of subsistence farmers and in sub-Saharan Africa, the losses that result can be twice that caused by other storage pests. Subsistence farmers typically rely on their stored maize as food until the next maize harvest. The depredation of *P. truncatus* results in farmers having to purchase maize, or those farmers with more extensive stock will have no maize to sell. The pest is thus a threat to food security and to the livelihoods of poor people. The pest has negative impact on trade and international relations.

			Overall Risk	High	*P. truncatus* remains a quarantine threat to maize-growing regions in the world. There are huge volumes of Maize seed traded in the EAC Region either as seed for planting and grain for consumption. *P. truncatus* is spread over longer distances almost entirely through the import and export of infested grain as eggs, larvae, pupae, adults. The pest has ability to develop in grain at low moisture, which is found in a PRA area where the pest can be established. *P. truncatus* infests maize and cassava in storage and in sub-Saharan Africa, the losses that result can be twice that caused by other storage pests. *P. truncatus* spreads rapidly in trade moving in infested consignments of maize and dried cassava. Trade flows have a profound effect on its speed of movement. Nevertheless, it can fly and does use this as a means of dispersal (CPC 2007, CPC 2015). The pest is thus a threat to food security and to the livelihoods of poor

					people. The pest has negative impact on trade and international relations.
			Category (QP, RNQP, NRP)		**QP**
			Requires Risk Management (yes / no)		**Yes**

Table 16: Technical evaluation of risk factors for *Sitotroga cerealella* (Olivier)(grain moth)

Pest	**Type of pest**	**Pathway**	**Risk factors**	**Risk rating**	**Description**
Sitotroga cerealella (Olivier)(grain moth)	Insect	Grain and seed	**Likelihood of Entry**	High	Maize is the most traded food crop in the EAC region, the exportable surplus elsewhere in the EAC is between 200,000 and 300,000 tonnes (two-thirds of this in Uganda and one-third in Tanzania) (USDA-EAC corn report', June 2012). Tanzania is the second largest exporter of maize within the EAC region after Uganda. *S. cerealella* is one of the most important pest and is widely distributed in Tanzania. The larvae complete their development inside a single grain; damage is therefore not visible externally until the late stages of the infestation when translucent windows appear in the grain as the larva carves out a chamber beneath the surface of the grain.

					Standard insecticide and fumigation treatments are usually effective against *S. cerealella*, however most of the commodity is informally traded by small scale traders through the porous borders and in most cases they do not treat their consignments. Therefore, this makes the likelihood of the pest to enter into the importing country to be high.
			Likelihood of Establishment	High	*S. cerealella* is a pest of stored products (grains) especially Rice, Sorghum, Maize, Parl Millet. The pest has also been found to infest stored spices, bell pepper (Capsicum annuum), coriander (Coriandrum sativum), black pepper (Piper nigrum), ginger (Zingiber officinale), turmeric (Curcuma longa) (Padwal-Desai et al., 1987) which are available in the region. The climatic conditions are favourable for the development of the pest in the PRA area. In warmer climates such as the EAC, *S. cerealella* is continuously brooded with up to 12 generations per year. The rate of development is dependent on temperature. Mondragon and Almeida (1988) found that development was favoured at 25°C, and that at this temperature, with 70±2% RH and a diet of maize, the mean period of

					development for the larval stage was 29.4 days. Although the pest can be easily controlled by fumigation and application of insecticides such as methacrifos and deltamethrin, the likelihood of the pest not being detected during inspection is high due to the fact that larvae complete their development inside a single grain; damage is therefore not visible externally until the late stages of the infestation.
			Likelihood of Spread	High	The prevailing climatic conditions in the region are favourable for the development of the pest. 16°C and 30% RH are cited as the minimum conditions for population increases (Evans, 1987) and the upper temperature limit is 35°C. These climatic conditions are within the range in PRA area. Larvae bore into the grain after hatching. Adults are strong fliers and cross-infestation occurs easily. The risk of infested maize grains spreading to area of higher economic importance such maize farms and milling stations and warehouses is high due to the fact that maize distribution chain from the whole sellers is far-reaching to the household level. Although, the pest is

					affected by a variety of parasites, parasitoids and preditors that affect it at all stages, their occurrence, distribution and effectiveness is not well established in the PRA
			Economic impact	Medium	*S. cerealella* is a major pest of stored grains, causing weight loss to grains by hollowing them out. Its impact is greater in the tropics and subtropics where it attacks grain in the field as well as in storage. *S. cerealella* is often found alongside other pests, in Tanzania, a complex of pests was responsible for dry weight loss of 31.8% for maize cobs and 7.85% for grains after 9 months of storage (Henckes, 1992). Prior infestation for 6 month by *S. cerealella* makes maize the suitable medium for reproduction for *Tribolium casteneum* and *Oryzaephilus surinamensis* (Weston P. A and Rattlingound P.L 2000). Damage and losses in untreated and pesticide-treated maize stored on-farm were estimated by Giga et al. (1991). After 8 months, damage to untreated grain and grain treated with malathion, pirimiphos-methyl and methacrifos was 76, 36, 17 and 10%, respectively, and the weight losses estimated were

					approximately 13, 6, 4 and 2%.
			Overall Risk	Medium	
			Category (QP, RNQP, NRP)		RNQP
			Requires Risk Management (yes / no)		YES

Table 17: Technical evaluation of risk factors for Sugarcane Mosaic Virus (mosaic of abaca)

Pest	**Type of pest**	**Pathway**	**Risk factors**	**Risk rating**	**Description**
Sugarcane Mosaic Virus (mosaic of abaca)	Virus	Grain and true Seed	**Likelihood of Entry**	High	Maize is the most traded food crop in the EAC region, the exportable surplus elsewhere in the EAC is between 200,000 and 300,000 tonnes (two-thirds of this in Uganda and one-third in Tanzania) (USDA-EAC corn report', June 2012), and Kenya being the major exporter of maize seed in the region. Although the seed borne incidence for SCMV is low, the pest can be easily seed transmitted and there is no known treatment to control the pest. The common method to control viral diseases by rouging the infected plants was found ineffective to control SCMV. Huge quantities of maize seeds are imported from Kenya where the virus has been found in 20 districts and only in the western plateaus, Central Highlands, and Rift Valley. Therefore, the likelihood of the virus being present in the seeds

					consignments is high and it can easily end up in maize fields of the importing country.
			Likelihood of Establishment	High	Cross-inoculation tests show that SCMV usually infects only various members of the Poaceae, although the Sabi strain can cause a latent infection of Phaseolus vulgaris (Teakle and Grylls, 1973). SCMV is transmitted by aphid vectors in the non-persistent manner. Aphid species involved in natural spread may be Rhopalosiphum maidis, Aphis gossypii and Myzus persicae (Noone et al., 1994) which are present in the PRA. Often perennial grass hosts of SCMV maintain the virus over periods of cold or drought area. The rate of mosaic spread in a field depends on many factors including: the strain of the virus present; the number and distribution of infection foci; numbers, kinds and activity of aphid vectors present; and weather and other environmental conditions influencing the susceptibility of the plants or activity of the aphid vectors. The main vectors that transmit SCMV are well established in the region. Although no effective control measure has been established against SCMV, tolerant hybrids, such as H614C, H611(R)C5, H612C, H5020, or EAH6302, are recommended in areas of East Africa where SCMV is prevalent.
			Likelihood of Spread	High	The natural environment is suitable for the pest due to the presence of the vectors

					responsible for the transmission of SCMV such *Myzus persicae, Aphis gossypii* and *Ropalosiphum maidis* which are well established in the PRA area (CPC 2007). Maize as one of the major host of the virus is the main crop in the region. Other perennial plants such as finger millet, sugarcane, Johnson grass can host and maintain SCMV over periods of cold or drought area. For the imports intended for consumption the risk is low as long as farmers do not use the grain for planting. Imports intended for planting the risk high if infected seeds are imported for planting.
			Economic impact	High	Losses caused by SCMV are mainly (1) a reduced yield of the crop, (2) the need to include mosaic resistance when breeding new cultivars, and (3) the slowing of the interchange of cultivars between countries because of quarantine concerns over the introduction of new strains of SCMV In East Africa, 10 susceptible maize hybrids had yield losses of 18-46% when inoculated with SCMV in the seedling stage (Louie and Darrah, 1980). SCMV and related potyviruses may occur in disease complexes with other plant pathogens; either additive or synergistic effects may occur. In East Africa is has been found to synergize with MCMV and cause a more devastating disease- MLND. Infection rates and damage can be very high, seriously affecting yields and sometimes causing

					complete loss of the crop especially when the virus combine with MCMV (Wangai et al. 2012)
			Overall Risk	High	
			Category (QP, RNQP, NRP)		QP
			Requires Risk Management (yes / no)		YES

Table 18: Technical evaluation of risk factors *Tribolium confusum* (confused flour beetle)

Pest	**Type of pest**	**Pathway**	**Risk factors**	**Risk rating**	**Description**
Tribolium confusum (confused flour beetle)	Insect	Grain and true Seed	**Likelihood of Entry**	High	Maize is the most traded food crop in the EAC region, the exportable surplus elsewhere in the EAC is between 200,000 and 300,000 tonnes two-thirds of this in Uganda (USDA-EAC corn report, June 2012). T confusum can lay eggs between 4-500 eggs over a period of a few months. Under favourable conditions, eggs hatch in 3-5 days. In whole grain, the presence of grain dust and debris provides a suitable environment for the development of early instars. In such an environment, larvae can develop at moisture contents as low as 8%. Larvae molt 5-11 times, depending on the food source and environment. T. confusum is more successful

					than T. castaneum on undamaged cereal grains. Although fumigation with phosphine is effective (Sauer, 1992), the potential for entry of the pest is still high due to informal maize trade in the region where treatments are not administered. For example, informal maize trade constituted an estimated 83 percent of Ugandan maize exports to Kenya from 2004 to 2006, and anecdotal evidence suggests that informal maize volumes are increasing (Lesser and Moise-Leeman 2009). The total maize flow from Uganda to Kenya was estimated to exceed 250,000 metric tons in 2008 (Karugia et al. 2009)
			Likelihood of Establishment	High	*T. confusum* is an important pest of many commodities, especially cereals and cereal products, but also dried fruits, nuts, spices (Sauer, 1992) and even Cannabis sativa (Smith and Olson, 1982). The optimum temperature for development of the pest is between (32.5°C) minimum and (37.5°C) maximum is suitable for the development of the pest. These conditions are ideal in the PRA area and may favour the establishment of the pest. Synergised pyrethrins have been observed to have a repellent effect on T. confusum (LaHue, 1966). Chlorpyrifos-methyl and pirimiphos-methyl are

					effective control agents, and in some experiments have been shown to be more effective than malathion (Sauer, 1992). Resistance to deltamethrin has been demonstrated (Korunic and Hamel-Koren, 1985). Fumigation with phosphine is effective (Sauer, 1992). Frequent monitoring of the pest in storage is emphasised since the population can build up very quickly. The maximum rate of increase is about a 60-fold increase in population size per lunar month. Adults normally live for about 1 year, but have been known to live for up to 5 years (Sauer, 1992)
			Likelihood of Spread	High	There is an elaborate distribution of maize within the importing country from the whole sellers to the consumers. Therefore there is high risk of infested maize grains spreading to area of higher economic importance such maize farms and milling stations and warehouses. Most of the traders import maize and store them in anticipation of high prices. This allows the pest to develop and increase in population thus aggravating the risk of spread. However, in cases where the maize is milled immediately the risk is even higher.
			Economic impact	Low	It is less important in tropical countries (except in produce stored in locally cooler regions, such as high altitude

					areas, or on produce recently imported from cooler areas), and is more important in temperate climates, where it is an important secondary pest of flour and cereal products. T. confusum does not seem to be as common as T. castaneum in tropical climates (see Hill, 1987; Mills & White, 1994).
			Overall Risk	Medium	
			Category (QP, RNQP, NRP)		RNQP
			Requires Risk Management (yes / no)		Yes

Table 19: Technical evaluation of risk factors for *Pyricularia setariae* (blast of millet)

Pest	**Type of pest**	**Pathway**	**Risk factors**	**Risk rating**	**Description**
Pyricularia setariae (blast of millet)	Fungus	Grain and Seed	**Likelihood of Entry**	Low	Even though, the pest has high economic importance, seed borne incidence is low and no seed transmission has been established on the pest. The overall risk of introduction of *Pyricularia setariae* is generally low. It was also found that Maize is minor host (CABI 2015) **Therefore PRA STOPS**
			Likelihood of Establishment		--
			Likelihood of Spread		--
			Economic impact		--

			Overall Risk		--
			Category (QP, RNQP, NRP)		NRP
			Requires Risk Management (yes / no)		NO

Table 20: Technical evaluation of risk factors for *Stenocarpella macrospora* (Earle) B.Sutton (dry rot of maize)

Pest	Type of pest	Pathway	Risk factors	Risk rating	Description
***Stenocarpella macrospora* (Earle) B.Sutton (dry rot of maize)** **Synonyms:** *Diplodia macrospora* Earle, *Macrodiplodia macrospora* (Earle) Höhnel, *Macrodiplodia zeae* var. *macrospora* (Earle) Petrak & Sydow, *Stenocarpella zeae* Sydow (Fungus)	Fungus	Seed, grain	**Likelihood of Entry**	High	There are frequent consignments of seed maize from nations under review. International spread of *S. macrospora* takes place through infected maize seed (CABI, 2015). *S. macrospora* survives as viable pycnidia and mycelium on maize debris in the soil, or on seed. The symptoms of *S. macrospora* are usually invisible to the naked eye at grain/seed stage (Post-harvest) and roots (Growth & establishment). The imported commodity will be used as seeds for planting or for consumption. Seeds used for planting exhibits high risk than those used for consumption. Seed Maize poses some risk and especially if it is not dressed with specific fungicides. Grain for milling has a lower risk.

			Likelihood of Establishment	High	Maize is the main host of *S. Macrospora* (CABI, 2015). It is not vectored (CABI, 2015) but disseminated by wind and rain. The pest is a problem in humid and warm zones. In no-tillage areas there is a higher incidence of maize plants and grain infected by *S. macrospora* (Flett & Wehner, 1991). The treatment of these diseases requires the use of crop rotation for a period of time required for the straw to be decomposed. As *S. macrospora* exclusively infect corn plants, crop rotation and seed treatment with fungicides in effective doses (House, 1998), can eliminate or reduce the primary inoculum. However, the benefit of crop rotation should be complemented with information related to the distance from transport conidia by wind and / or by rain splash (Ricardo et al, 2003) *S. macrospora* survives as viable pycnidia and mycelium on maize debris in the soil, or on seed. Under warm, moist conditions, spores are extruded from pycnidia in long cirrhi and disseminated by wind and rain and, probably, by insects. The development of the stalk rot phase is

					favoured by dry weather early in the growing season, followed by extended periods of rainfall shortly after silking.
			Likelihood of Spread	High	*S. macrospora* is not vectored. Under warm, moist conditions, spores are extruded from pycnidia in long cirrhi and disseminated by wind and rain and, probably, by insects (CABI, 2010). International spread by *S. macrospora* will most probably take place through infected maize seed. *S. macrospora* is present in the endosperm and embryo of maize seeds (Zad & Ale Agha, 1985). The infected material is mainly dispersed through movement. Seed maize has the possibility of being distributed over a wide area posing a high risk of spread.
			Economic impact	High	Losses due to stalk and grain rots vary from season to season and between regions, but may be greater than 50% (CABI, 2015). In the USA, 10-20% yield reductions are common (CABI, 2015). Losses arise directly from poor grain filling and indirectly from harvest losses because of lodging (EPPO, 2006). *S. macrospora* can affect yield of harvested grain if infection occurs early enough to trim kernel and

					ear size. Severely affected ears can have test weight losses as high as 35 percent. Feeding and milling qualities of the grain may also be affected (CIMMYT, 2004). Maize is an important silage and grain crop in the EAC region, and *S. macrospora* could have a considerable economic impact in warm, humid regions. Since the PRA area has similar ecological conditions as in areas where the pest occurs, the pest has potential to cause damage in the PRA area as portrayed in the areas where it exists.
			Overall Risk	**High**	
			Category (QP, RNQP, NRP)		**QP**
			Requires Risk Management (yes / no)		**Yes**

3.2 Overall Summary of Pest Risk Assessment results

The summary information on all pests assessed is in **Table 21**

Table 21. Risk assessment results for pests of concern to EAC region on bean grain/seed transited within EAC countries.

Pest	**Pest risk assessment**						
	Likelihood of entry	**Likelihood of establishment**	**Likelihood of spread**	**Potential economic impact**	**Overall Risk (High, Med or Low)**	**Category (QP, RNQP, NRP)**	**Risk Management required (Y/N)**

Alternaria brassicae (dark spot of crucifers)	Medium	Medium	High	Low	Medium	RNQP	Yes
Araecerus fasciculatus (cocoa weevil)	High	High	High	Medium	Medium	RNQP	Yes
Choanephora cucurbitarum (Choanephora fruit rot) (Maize leaf spot)	Low	**PRA therefore stops**					
Cochliobolus sativus	High	High	High	Medium	Medium	RNQP	Yes
Cochliobolus heterostrophus	High	High	High	High	High	QP	Yes
Cochliobolus carbonum	Low	**PRA therefore stops**					
Cucumber Mosaic Virus (CMV)	High	High	High	High	High	QP	Yes
Curvularia lunata	High	Medium	Medium	High	Medium	RNQP	Yes
Ditylenchus dipsaci (Stem and bulb nematode)	High	Medium	High	High	High	QP	Yes
Maize Dwarf Mosaic Virus	High	Medium	High	High	High	QP	Yes
Maize Chlorotic Mottle Virus	High	Medium	High	High	High	QP	Yes
Prostephanus truncatus (Larger Grain borer)	High	Medium	High	High	High	QP	Yes
Sitotroga cerealella (Olivier)(grain moth)	High	High	High	Medium	Medium	RNQP	Yes
Sugarcane Mosaic Virus (mosaic of abaca)	High	High	High	High	High	QP	Yes
Tribolium confusum (confused flour beetle)	High	High	High	Low	Medium	RNQP	Yes
Pyricularia setariae (blast of millet)	Low	**PRA therefore stops**				NRP	No
Stenocarpella macrospora (Earle) B.Sutton (dry rot of maize)	High	High	High	High	High	QP	Yes

4.0: **Pest Risk Management**

Pest to be regulated and their proposed pest risk management options are presented in Table 22.

Table 22: Management options for regulated pests on Maize seed (Zea mays L)

Based on the analysis, a total of 13 pest comprising of three (3) insects; and, one (1) nematode;, five (5) fungi; and four (4) viruses; were classified as quarantine pests requiring phytosanitary measures/actions for maize seed.

Proposed Phytosanitary measures for pest in maize seeds

Names of pests to be regulated	**Management Options**
Araecerus fasciculatus, Prostephanus truncutus, Sitotroga cerealella	The consignment inspected found free of *Araecerus fasciculatus, Prostephanus truncutus, Sitotroga cerealella* or the consignment was treated with an appropriate insecticide or fumigant before dispatch
Alternaria brassicae, ***Cochliobolus heterostrophus,*** *Cochliobolus sativus, Curvularia lunata, Stenocarpella macrospora*	Parent plants were inspected during active growth and found to be free from *Alternaria brassicae, Cochliobolus heterostrophus, Cochliobolus sativus, Curvularia lunata, Stenocarpella macrospora or* the seeds were tested and found free from *Alternaria brassicae, Cochliobolus heterostrophus, Cochliobolus sativus, Curvularia lunata, Stenocarpella macrospora* The seed was treated with an appropriate fungicides before dispatch
Maize Dwarf Mosaic Virus, Sugarcane Mosaic Virus (mosaic of abaca), *Cucumber mosaic virus*	The plants were inspected during active growth and found to be free from *Cucumber mosaic virus* (cucumber mosaic), *Maize Dwarf Mosaic Virus (MDMV), Sugarcane Mosaic Virus* OR the Consignment was tested and found free from *Cucumber mosaic virus, Maize Dwarf Mosaic Virus (MDMV), Sugarcane Mosaic Virus*
Ditylenchus dipsaci (Stem and bulb nematodes)	The plants were inspected during active growth and found to be free from *Ditylenchus dipsaci* (Stem and bulb nematodes) or seed was tested and found free from *Ditylenchus dipsaci* (Stem and bulb nematodes)
Maize chlorotic mottle virus (MCMV)	*Maize Chlorotic Mottle Virus* is not known to occur in the area of production or the plants were inspected during active growth and found to be free from *Maize Chlorotic Mottle Virus*. The Consignment sampled, tested and found free from Maize Chlorotic Mottle Virus

Proposed Phytosanitary measures for pest in maize grains

However, seven (7) pests were found to have phytosanitary risk in maize grain. These pests were, seven (7) insects in the table as below

Table 23: Proposed Phytosanitary measures for pest in Maize grains

Names of pests to be regulated	Management Options
Araecerus fasciculatus (cocoa weevil)	Grain were treated with appropriate chemical or fumigated with appropriate fumigant
Tribolium confusum	Grain were treated with appropriate chemical or fumigated with appropriate fumigant
Ahasversus advena (Waltl, 1832) (Foreign grain beetle)	Treatment with an admixture of insecticides or the grain stocks were fumigated with phosphine or methyl bromide
Rhyzopertha dominica (Fabricius) (lesser grain borer)	Treatment with an admixture of insecticides or fumigated with phosphine or methyl bromide
Corcyra cephalonica (Stainton, 1866)- (rice meal moth)	Treatment with an admixture of insecticides Or grain stocks were fumigated with phosphine or methyl bromide
Tribolium confusum Jacquelin du Val (confused flour beetle)	Grain stocks be fumigated with phosphine or methyl bromide or treated with appropriate insecticide
Trogoderma granarium Everts (Khapra beetle)	Grain were treated with appropriate chemical or fumigated with appropriate fumigant

5.0 Conclusion

The evaluation for introduction and the assessment of economic and environmental impacts is summarized in Table 24 where a total of fifteen (15) (5 insects, 1 nematode, 5 fungi, and 4 viruses) pests associated with maize were considered for risk assessment. *Araecerus fasciculatus* (cocoa weevil), *Prostephanus truncatus* (Larger Grain borer), *Sitotroga cerealella* (Olivier)(grain moth), *Tribolium confusum* (confused flour beetle), *Ahasversus advena* (Waltl, 1832) (Foreign grain beetle*)*, *Ditylenchus dipsaci* (Stem and bulb nematodes), *Cochliobolus heterostrophus* (southern leaf spot), *Cochliobolus sativus* (root and foot rot), *Alternaria brassicae* (dark spot of crucifers), *Curvularia lunata*, *Stenocarpella macrospora*, syn. *Diplodia macrospore* (Macrospora leaf stripe), *Cucumber mosaic virus* (cucumber mosaic), Sugarcane Mosaic Virus (mosaic of abaca), and Maize Dwarf Mosaic Virus were found to be of quarantine importance to the region. Maize Lethal Necrosis Disease is a combination of Sugarcane Mosaic Virus and Maize Chlorotic Mottle Virus. Based on the analysis, the import conditions for trade facilitation were developed for grain and seed maize to be applied within the region.

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