Pest Risk Analysis (PRA) for Grain and Seed of Beans, *Phaseolus vulgaris* 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

According to Kilimo trust, 2012, the leading producers of beans in Africa are, Tanzania, Uganda and Kenya whose production volumes in 2010 were estimated at 950,000MT, 455,000MT and 390,598MT respectively. The volumes traded across borders in the East African region stand at 309,000MT annually according to the East African cross border trade bulletin of 2018. This poses potential pest risks to the bean value chain and requires analysis to provide scientific justification for Phytosanitary conditions in beans. This Pest Risk Analysis (PRA) documents outlines risks associated with the movement of grain and seeds of beans, *Phaseolus vulgalis* L. within East African member countries namely: Kenya, Burundi, Rwanda, Tanzania and Uganda.

The Beans 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 beans, with a view to developing phytosanitary import conditions that will be applied within the East African. The objectives of the Regional Pest Risk Analysis were to: review national pest lists for beans; develop a harmonized regional pest list for beans; develop a draft regional PRA; develop National Quarantine Pest Lists; and develop Phytosanitary import conditions for beans to be applied within the East African region.

This risk analysis was conducted by PRA specialists from five member countries of East African region namely, Tanzania, Burundi, Rwanda, Uganda and Kenya. South Sudan did not participate because at that time, it was not yet a member of EAC. The process involved comparing and harmonizing pest lists associated with beans from the five countries. The following draft documents were developed; harmonized regional potential quarantine lists for beans, regional PRA for Beans (Grain and seed,) and harmonized Phytosanitary import conditions for beans to be applied in the East African Region.

A list of pests associated with beans in East Africa was developed based on the Pest Risk Analysis (PRA) information from the East Africa NPPOs as well as from the search of both print and electronic sources of information, in accordance with ISPM No. 11 and 21. Based on the analysis, a total of 184 pest (63 insect, 5 mite, 67 fungi, 20 nematode, 17 bacteria and 12 virus) were found to be associated with seed and grain of beans. Out of this 9 pests comprising of one (1) insect (*Callosobruchus analis* (Fabricius) (bean weevil), one (1) nematode (*Ditylenchus dipsaci* (Kühn,) Filip'ev stem, and bulb nematode), five (5) fungi (*Sclerotinia sclerotiorum* (Lib) de Bary Cottony soft rot, *Fusarium oxysporium* fsp *phaseoli*, *Fusarium solani* fsp *phaseoli*, *Choanephora cucurbitarum* (Choanephora rot) and *Elsinoe phaseoli* (Bean scab), one (1) bacteria (*Pseudomonas syringae pv. syringae* van Hall 1902 Bacterial brown spot (beans) and one (1) virus (Cucumber Mosaic Virus), were classified as quarantine pests requiring phytosanitary measures/actions for bean seed. However, all of these pests were found to have negligible overall risk in bean grain except for *Callosobruchus analis* (bean weevil) which was found to have high risk.

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CABI, COPE, ICIPE, CIAT, EAC,

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Definition of Terms

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

Bean seeds - bean 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

According to Kilimo Trust, 2012, the leading producers of beans in Africa are Tanzania, Uganda and Kenya whose production volumes in 2010 were estimated at 950,000MT, 455,000MT and 390,598MT respectively. The volumes traded across borders in the East African region stand at 309,000MT annually according to the East African cross border trade bulletin of 2018. This poses potential pest risks to the bean value chain and requires analysis to provide scientific justification for Phytosanitary conditions in beans.

This risk assessment has been conducted by the East African Community (EAC) member countries, to examine pest risks associated with importation of beans, *Phaseolus vulgaris* within the EAC region. The risk assessment is "pathway-initiated" in that it is based on the potential pest risks associated with trade with the commodity within the region. This is a qualitative pest risk analysis that expresses risks in terms of High, Medium, or Low. To reduce Phytosanitary trade barriers existing in the East 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.

The scope of this analysis is risks associated with the movement of grain and seeds of beans, *Phaseolus vulgalis* L. within the East African member countries namely: Kenya, Burundi, Rwanda, Tanzania and Uganda.

The national pest lists evaluated by the team developed a consolidated pest list for beans for the region. In order to come up with regional quarantine pest list, all pests associated with the commodity were taken through the pest risk analysis (PRA) process. The process involved categorization of the pests associated with beans (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 beans within the region i.e. bean seed and grain. All pests of beans found to be of concern to the region (likely to follow the pathway) were identified for further analysis.

2.0. Risk Assessment - Pest Risk Analysis of pests associated with Bean

Quarantine pests that are likely to follow the pathway on commercial shipment of bean grain and seed 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 United Nations Food and Agriculture Organization (FAO), provide guidance for conducting pest risk analyses. 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 Initiating Event: Proposed Action

The EAC has made several milestones towards regional integration. The EAC-Sanitary and Phytosanitary (SPS) protocol has been signed and only needs to be ratified by respective EAC member country parliaments before adoption. Even as this progress is being made, harmonized import regulations for the commonly traded commodities have been lacking. Regional harmonization meetings were undertaken which led to the development of a regional PRA for beans in the region.

2.2 Analysis of Weed Potential of bean seeds, *Phaseolus vulgaris*

Bean is already being cultivated in the entire region hence it is not likely to be a weed.

2.3 Previous Risk Analysis, Current Status, and Pest Interceptions

A previous PRA report developed by Kenya was used as a reference. However, there are no interception reports on imports of beans within the region.

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

Common pests associated with bean seeds, *Phaseolus vulgaris* that occur in Kenya, Burundi, Rwanda, Tanzania and Uganda were updated as listed in **Table 1**. This list includes information on the presence or absence of these pests in the region and their ability to follow the pathway.

Table 1. Pests in EAC Countries Associated with Bean, *Phaseolus vulgaris* seeds/ grain

Pests/ Diseases	Distribution	Part(s) affected	Quarantine status	Follow Pathway	References
ARTHROPODS					
INSECTS					
HEMIPTERA - HETEROPTERA					
Acrosternum pallidoconspersum	KE, UG, TZ	Leaves	Yes	No	CPC, 2004, 2007, 2015, 2007, 2015
Anoplocnemis curcipes L.	KE	Shoots	Yes	No	Seif et al., 2001
Clavigralla tomentosicollis Stål	KE, UG, TZ, BI, RW	Flowers, Pods, Seeds	No	Yes	Allen et al., 1996; CPC, 2004, 2007, 2015; Farrell et al., 1995; Mailu 1996; Seif et al., 2001
Nezara viridula (Linnaeus)	KE, UG, TZ, BI, RW	Flowers, Leaves, Pods,	No	Yes	Allen et al., 1996; Farrell et al., 1995; Le Pelley, 1959; Seif et al., 2001

		Seeds, Stems			
Riptortus dentipes (Fabricius)	KE, TZ	Pods, Seeds	Yes	Yes	Allen et al., 1996; CPC, 2004, 2007, 2015; Seif et al., 2001
HEMIPTERA - HOMOPTERA					
Acyrthosiphon pisum Harris, 1776	KE, UG, TZ, BI, RW	Leaves Shoots	No	No	CPC 2011, Le Pelley, 1959
Aphis craccivora Koch, 1854	KE, UG, TZ	Leaves, Stems	Yes	No	CPC 2011, Allen et al., 1996; CPC, 2004, 2007, 2015, 2007, 2015; Farrell et al., 1995; Mailu 1996; Millar 1994; Muruli et al., 1980; Seif et al., 2001
Aphis fabae Scopoli	KE, UG, TZ, BI	Flowers, Leaves	No	No	Allen et al., 1996 ; Ampofo 1994, CPC, 2004, 2007, 2015; Farrell et al., 1995; Mailu 1996; Millar 1994; Seif et al., 2001
Aphis gossypii Glover, 1877	KE, UG, TZ, BI, RW	Leaves, Stems, Shoots	No	No	CPC, 2004, 2007, 2015; Le Pelley, 1959; Millar, 1994
Aphis spiraecola Patch, 1914	KE, BI, RW	Leaves, Shoots	No	No	CPC, 2004, 2007, 2015; Millar, 1994
Bemisia tabaci (Gennadius, 1889)	KE, UG,TZ	Leaves	No	No	Allen et al., 1996; CPC, 2004, 2007, 2015; Mailu 1996; Seif et al., 2001
Empoasca spp.	KE	Leaves	Yes	No	Allen et al., 1996; Ampofo 1994; Farrell et al., 1995; Muruli et al., 1980
Maconellicoccus hirsutus (Green, 1908)	KE, TZ	Leaves, Stems	Yes	No	CPC, 2004, 2007, 2015; Le Pelley, 1959
Macrosiphum euphorbiae Thomas, 1878	KE, UG, TZ, BI, RW	Leaves	No	No	CPC, 2004, 2007, 2015; Le Pelley, 1959
Hilda patruelis (Stål)	TZ	Stem, Roots	Yes	No	CPC, 2007, 2015, 2015
Rhopalosiphum rufiabdominale (Sasaki, 1899)	KE, TZ	Leaves, Roots, Stems	Yes	No	CPC, 2004, 2007, 2015
Pinnaspis strachani (Cooley) 1899	KE, UG, TZ	Leaves, Pods, Stems	Yes	No	CPC, 2004, 2007, 2015

Trialeurodes ricini (Misra)	KE, UG	Leaves	Yes	No	CPC, 2007, 2015
Trialeurodes vaporariorum Westwood 1856	KE	Leaves	Yes	No	CPC, 2004, 2007, 2015; Seif et al., 2001
THYSANOPTERA					
Frankliniella occidentalis (Pergande)	KE	Leaves	Yes	No	CPC, 2004, 2007, 2015
Frankliniella schultzei (Trybom, 1910)	KE, UG, TZ	Leaves	Yes	No	CPC, 2004, 2007, 2015; Seif et al., 2001
Megalurothrips sjostedti (Trybom)	KE, UG, TZ	Leaves	Yes	No	Allen, et al., 1996; Ampofo, 1994; CPC, 2004, 2007, 2015; Farrell, et al., 1995; Le Pelly, 1959; Mailu, 1996
Sericothrips spp	KE	Leaves, Stems	Yes	No	HCDA, MOA & JICA, 2003
Hydatothrips adolfifriderici Karny, 1913	KE, UG, TZ, RW	Leaves, stems, flower, Pod	No	No	Moritz et al., 2013
Caliothrips phaseoli (Hood, 1912)	KE, TZ	Leaves, stems, flower, Pod	Yes	No	Moritz et al., 2013
Caliothrips impurus (Priesner, 1927)	KE	Leaves, stems, flower, Pod	Yes	No	Moritz et al., 2013
Caliothrips fasciatus (Pergande, 1895)	KE, UG	Leaves, stems, flower, Pod	Yes	No	Moritz et al., 2013
Caliothrips sudanensis (Bagnall 1938; Cameron, 1932)	KE	Leaves, stems, flower, Pod	Yes	No	Moritz et al., 2013
COLEOPTERA					
Acanthoscelides obtectus Say	KE, UG, TZ, BI, RW	Seeds	No	Yes	Allen et al., 1996; CPC, 2004, 2007, 2015, 2007, 2015; Mailu 1996
Alcidodes dentipes (Olivier, 1790)	KE, UG, TZ	Leaves, Stems	Yes	No	EPPO 2009; CPC 2011
Alcidodes leucogrammus (Erichson)	KE, TZ	Leaves, Stems	Yes	No	Allen, et al., 1996; Farrell et al., 1995; Mailu 1996; Seif et al., 2001
Bruchidius atrolineatus (Pic)	KE	Seeds	Yes	Yes	CPC, 2004, 2007, 2015; Warui, 1984
Callosobruchus analis (Fabricius)	KE, TZ	Seeds	Yes	Yes	CPC, 2004, 2007, 2015; Warui 1984
Callosobruchus chinensis (Linnaeus, 1758)	KE, UG, TZ	Seeds	Yes	Yes	CPC, 2004, 2007, 2015; Mailu, 1996

Callosobruchus phaseoli (Gyllenhal)	KE, UG	Seeds	Yes	Yes	CPC, 2004, 2007, 2015; Warui, 1984
Callosobruchus rhodesianus (Pic)	KE	Seeds	Yes	Yes	CPC, 2004, 2007, 2015; Warui, 1984
Carpophilus hemipterus (Linnaeus)	KE	Seeds	Yes	Yes	CPC, 2004, 2007, 2015, Noyes, 1982
Coryna spp	KE	Flowers	Yes	No	Seif et al., 2001
Monolepta sp	KE	Leaves	Yes	No	Seif et al. 2001
Mylabris spp	KE	Flowers	Yes	No	Seif et al. 2001
Ootheca bennigseni Weise	KE, UG, TZ, BI, RW	Roots, Leaves	No	No	CPC, 2004, 2007, 2015; Muruli et al,. 1980 ; Karel & Autrique 1989
Ootheca spp	KE, TZ, RW	Leaves	No	No	Seif et al., 2001
Sitona lineatus Linnaeus	UG, BI, RW	Leaves, Roots	No	No	CPC, 2007, 2015, 2015
Sitophilus zeamais Motschulsky	KE, UG, TZ, RW	Seeds	No	Yes	CPC, 2004, 2007, 2015
Tribolium castaneum (Herbst)	KE, UG, TZ, BI, RW	Seeds	No	Yes	CPC, 2004, 2007, 2015; Mailu 1996
Zabrotes subfasciatus (Boheman)	KE, UG, TZ	Seeds	Yes	No	Allen et al., 1996; CPC, 2004, 2007, 2015
DIPTERA					
Bactrocera cucurbitae Coquillett	KE, UG, TZ	Pods	No	No	CPC, 2004, 2007, 2015; EPPO 2009
Delia platura (Meigen)	KE, UG, TZ, BI, RW	Leaves, Roots, Seeds	No	Yes	CPC, 2004, 2007, 2015, Seif, et al., 2001
Liriomyza huidobrensis (Blanchard)	KE	Leaves	Yes	No	CPC, 2004, 2007, 2015, EPPO, 2005
Liriomyza sativae (Blanchard)	KE	Leaves	Yes	No	Varela, et al., 2003;
Liriomyza trifolii Burgess in Comstock, 1880	KE, TZ	Leaves	Yes	No	CPC, 2004, 2007, 2015; Mailu, 1996
Ophiomyia centrosematis (de Meijere)	KE, UG, TZ	Leaves, Roots, Stem	No	No	Allen et al., 1996; CPC, 2004, 2007, 2015; Seif et al., 2001
Ophiomyia phaseoli Tryon, 1888	KE, UG, TZ, BI, RW	Roots, Stem	No	No	Allen et al., 1996; Ampofo 1994; CPC, 2004, 2007, 2015; Farrell et al., 1995; HCDA, MOA & JICA 2003; Mailu, 1996; Seif et al., 2001
Ophiomyia spencerella	KE, UG, TZ	Roots, Stems	No	No	Allen et al., 1996; CPC, 2004, 2007, 2015; Farrell et al., 1995; Mailu 1996; Seif et al., 2001

LEPIDOPTERA					
Agrotis ipsilon (Hufnagel, 1766)	KE	Stem	Yes	No	CPC 2011, Allen et al., 1996; CPC, 2004, 2007, 2015, 2007, 2015 ; HCDA, MOA & JICA, 2003; Le Pelley, 1959; Mailu, 1996; Muruli et al ,. 1980
Agrotis segetum (Dennis and Schiffermuller)	KE, UG, TZ	Stem	Yes	No	Seif, et al., 2001
Alpenus investigatorum (Karsch)	KE	Leaves	Yes	No	Seif et al., 2001
Chrysodeixis chalcites (Esper)	KE, UG	Leaves, Pods	Yes	Yes	CPC, 2004, 2007, 2015;, USA Pest Alert, 2005
Etiella zinckenella (Treitschke)	KE, UG, TZ	Pods	Yes	No	CPC, 2004, 2007, 2015
Helicoverpa armigera (Hübner, 1809*)*	KE, UG, TZ, BI, RW	Flowers, Leaves	No	No	Allen, et al., 1996; Ampofo, 1994; CPC, 2004, 2007, 2015; Farrell, et al., 1995; HCDA, MOA & JICA, 2003, Mailu, 1996; Le Pelley, 1959; Seif, et al., 2001
Lampides boeticus Linnaeus (1767)	KE, UG, TZ	Flowers, Pods, Seeds	No	Yes	CPC, 2004, 2007, 2015; NHM, 2005
Maruca vitrata Fabricius	KE, UG, TZ, BI, RW	Flowers, Leaves, Pods	No	No	Allen, et al., 1996; Ampofo, 1994; CPC, 2004, 2007, 2015; Farell, et al., 1995; Mailu, 1996; NHM, 2005
Spilosoma jacksoni (Rothschild)	KE	Leaves	Yes	No	Seif et al., 2001
Spodoptera exigua (Hübner)	KE, TZ, BI, RW	Leaves	No	No	Allen, et al., 1996; CPC, 2004, 2007, 2015; Le Pelley, 1959
Spodoptera littoralis (Boisduval)	KE, UG, TZ, BI, RW	Leaves, Pods	No	No	Allen, et al., 1996; CPC, 2004, 2007, 2015; Le Pelley, 1959; NHM, 2005
Thysanoplusia orichalcea (Fabricius, 1775)	KE, UG, TZ	Leaves, Pod	Yes	No	CPC, 2004, 2007, 2015, Khaemba & Mutinga, 1982
Trichoplusia ni (Hübner)	KE, TZ	Leaves	Yes	No	CPC, 2004, 2007, 2015
MITES					
Brevipalpus obovatus Donnadieu	KE, UG, TZ, BI, RW	Leaves, Stems	No	No	CPC, 2004, 2007, 2015; Le Pelley, 1959

Brevipalpus californicus (Banks)	KE	Leaves, Pods, Stems	Yes	No	CABI & EPPO, 2005; CPC, 2004, 2007, 2015; Laycock & Templer, 1973
Mononychellus tanajoa Bondar	KE, UG, TZ, BI, RW	Leaves	No	No	CPC 2004, 2007, 2015, 2007, 2015; Farrell et al., 1995; Mailu 1996
Tetranychus cinnabarinus (Boisduval)	KE, UG	Leaves	Yes	No	Anyango, 2001; HCDA, MOA & JICA, 2003; Le Pelley, 1959
Tetranychus urticae Koch	KE, UG, TZ	Leaves	No	No	Allen et al., 1996; Anyango 2001; CPC 2004, 2007, 2015, 2007, 2015; Le Pelley 1959; Seif et al., 2001;
NEMATODES					
Ditylenchus dipsaci (Kühn,) Filip'ev stem, bulb nematode	KE	Leaves, seeds, stems,	**Yes**	**Yes**	CPC, 2007, 2015; CPC 2015
Helicotylenchus dihystera (Cobb, 1893) Sher, 1961	KE	Roots	Yes	No	CPC 2007 ; Kimenju *et al*., 2004a & b
Helicotylenchus multicinctus (Cobb, 1893) Golden, 1956	KE, UG, TZ	Roots	No	No	CPC 2007
Helicotylenchus pseudorobustus (Steiner, 1914) Golden, 1956	KE, UG, TZ	Roots	No	No	CPC 2007; Desaeger & Rao, 2001
Meloidogyne acronea (Coetzee)	KE	Leaves, Roots	Yes	No	Allen et al. 1996 ; CPC, 2004, 2007, 2015; Mailu 1996
Meloidogyne africana (Neal, 1889) Chitwood, 1949	KE	Leaves, Roots	Yes	No	Mailu, 1996
Meloidogyne arenaria (Neal, 1889) Chitwood	KE, UG, TZ	Leaves, Roots	No	No	CPC, 2004, 2007, 2015
Meloidogyne incognita (Kofoid & White) Chitwood,	KE, UG, TZ	Roots	No	No	Allen et al., 1996; CPC, 2004, 2007, 2015; HCDA, MOA & JICA, 2003; Kedera, 1996; Kimenju et al., 2004a & b; Mailu, 1996
Meloidogyne ethiopica Whitehead	KE, TZ	Roots	Yes	No	Carneiro et al., 2005; CABI/EPPO, 2013; EPPO, 2014
Meloidogyne hapla (Chitwood)	KE, UG, TZ	Root	No	No	Allen et al., 1996 ; CPC, 2004, 2007, 2015; Kedera, 1996; Kimenju et al., 1999 & 2004a;
Meloidogyne javanica (Treub) Chitwood	KE, UG, TZ, BI, RW	Root	No	No	Allen et al., 1996 ; CPC, 2004, 2007,

					2015; Desaeger & Rao, 2001; Kedera, 1996; Kimenju et al., 1999 & 2004a; Mailu, 1996
Meloidogyne kikuyuensis (de Grisses)	KE	Roots	Yes	No	Mailu, 1996
Pratylenchus brachyurus (Godfrey) Filipjev & Schuurmans Stekhoven	KE, UG	Roots	Yes	No	Allen et al., 1996 ; CPC, 2004, 2007, 2015; Kimenju et al., 1998; Kimenju et al., 2004a
Pratylenchus goodeyi Sher & Allen, 1953	KE, UG, TZ, BI, RW	Roots	No	No	CPC, 2004, 2007, 2015
Pratylenchus penetrans (Cobb, 1917) Filipjev & Schuurmans Stekhoven, 1941	KE, TZ	Root	Yes	No	Allen et al., 1996 ; CPC, 2004, 2007, 2015 ; Hollis 1962 ; Kimenju et al., 2004a
Pratylenchus thornei (Sher & Allen)	KE	Roots	Yes	No	CPC, 2004, 2007, 2015; Desaeger & Rao 2001
Pratylenchus vulnus Allen & Jensen, 1951	KE	Leaves, Roots	Yes	No	CPC, 2004, 2007, 2015
Radopholus similis (Cobb) Thorne	KE, UG, TZ, BI	Leaves, Roots	No	No	Mailu, 1996; Ngundo & Taylor, 1973
Rotylenchulus parvus (Williams, 1960) Sher, 1961	KE, UG, TZ	Leaves, Root, Stem	No	No	CPC, 2007, 2015
Rotylenchulus reniformis Linford & Oliveira, 1940	KE, UG, TZ, BI	Leaves, Root, Stem	No	No	CPC, 2007, 2015; Hollis, 1962
Trichodorus spp	KE, TZ, BI	Leaves, Roots	Yes	No	Kimenju et al., 1999 & 2004a
FUNGI/OOMYCETES					
Acremonium strictum (W. Gams)	KE, UG	Leaves, Stems	Yes	No	CPC, 2004, 2007, 2015; Farr et al 2003; Farrell, et al, 1995; Kedera, 1996; Kung'u & Boa, 1997; Macdonald & Chapman, 1997
Alternaria alternata	KE, UG	Leaves	Yes	No	Careta, 1999 ; CPC, 2004, 2007, 2015; Farr et al 2003;
Alternaria brassicicola	UG, TZ	Fruits, pods, leaves, seeds, stems	Yes	Yes	CPC 2007, EPPO 2006

Alternaria cucumerina (Ell. & Ev.) Elliott	KE	Leaves Pods	Yes	No	Farr et al 2003 ; Kung'u & Boa, 1997
Ascochyta boltshauseri (Sacc.)	KE, UG	Leaves, Stem, Pods	Yes	No	Farrell, et al., 1995; Schwartz, 2003
Aspergillus flavipes	KE	Leaves, Pods, Roots	Yes	No	Farr et al 2003 ; Kung'u & Boa, 1997
Aspergillus flavus (Link)	KE, UG	Seeds	Yes	No	CPC, 2004, 2007, 2015; Farr et al 2003; Ismail, 2001; Muriuki & Siboe, 1995
Aspergillus niger Tiegh	KE, UG	Leaves, Pods Roots	Yes	No	CPC, 2004, 2007, 2015; Farr et al 2003; Kedera, 1996; Kung'u & Boa, 1997
Aspergillus ochraceus (K.Wilhelm)	KE	Seeds	Yes	Yes	CPC, 2004, 2007, 2015; Farr et al 2003
Aspergillus tamarii (Kita)	KE	Leaves, Seeds, Stems	Yes	Yes	CPC, 2004, 2007, 2015; Farr et al., 2003; Natrass, 1961
Botryodiplodia theobromae (Pat.) Griffiths & Maubl. [anamorph]	KE, UG, TZ	Pods, leaves, roots, seeds, stems	Yes	Yes	CPC, 2007, 2015
Botryotinia fuckeliana (de Bary) Whetzel	KE	Leaves Stems	Yes	No	CPC, 2004, 2007, 2015; Kung'u & Boa, 1997
Cercospora spp.	KE, UG	Leaves	Yes	No	Kedera, 1996; Schwartz, 2003
Chalara elegans (Nag Raj & W.B. Kendr)	KE, UG	Leaves, Pods, Roots	Yes	No	CPC, 2004, 2007, 2015; Farrell, et al., 1995
Choanephora cucurbitarum	TZ	Leaves, Pods, Seeds Stems	Yes	Yes	CPC, 2007, 2015
Chaetomium spirale	KE, UG	Seeds	Yes	Yes	Kung'u & Boa, 1997
Cladosporium spp	KE, UG	Roots	No	No	Kedera, 1996
Cochliobolus sativus (root and foot rot)	KE, UG, TZ	Flowers, Leaves, Roots, Stems, Seeds	Yes	Yes	CPC, 2004, 2007, 2015
Colletotrichum dematium (Pers.) Grove	KE, TZ	Leaves	Yes	No	Farr et al 2003; Kedera, 1996
Colletotrichum gloeosporioides	KE, UG, TZ	Pods, leaves, stems	No	No	CPC, 2007, 2015
Colletotrichum lindemuthianum (Sacc. & Magnus) Briosi & Cavara	KE, UG, TZ, BI, RW	Leaves, Pods, Seeds	No	Yes	Allen, et al., 1996; CPC, 2004, 2007, 2015; Farrell, et al., 1995; HCDA, MOA & JICA, 2003;

					Kedera, 1996; Kung'u & Boa, 1997
Colletotrichum truncatum (Schwein.) Andrus & W.D. Moore	KE, UG, TZ	Flowers, Leaves, pods, Stems	No	No	CPC, 2004, 2007, 2015; Farr et al 2003; Schwartz, 2003
Corticium rolfsii Curzi	KE, UG, TZ, BI, RW	Roots, Stem	No	No	Allen et al., 1996; CPC, 2004, 2007, 2015; Farrell et al., 1995; Kedera, 1996; Kung'u & Boa, 1997
Diaporthe phaseolorum var. sojae (Cooke & Ell.) Sacc. Synomym: *Phomopsis phaseoli*	TZ, UG	Pods, leaves, roots, seeds, stems	Yes	Yes	CPC, 2007, 2015
Elsinoe phaseoli (Jenk. in Bruner & Jenk.)	KE	Leaves, Pods, Stems	Yes	No	Allen, et al., 1996; Farrell, et al., 1995; Kedera, 1996; Kung'u & Boa, 1997
Erysiphe pisi DC. var. pisi (Vanha) Weltzien	KE, UG, TZ, BI, RW	Leaves, Pods, Stems	No	No	Allen, et al., 1996, CPC, 2004, 2007, 2015; HCDA, MOA & JICA; 2003; Farrell, et al., 1995; Schwartz, 2003
Erysiphe polygoni	UG, KE	Leaves, pods,	No	No	Buruchara etal., 2010
Fusarium cuneirostrum	UG	Roots, stems	yes	No???	Mukankusi et al., 2010
Fusarium culmorum (W.G. Sm.) Sacc.	KE, TZ	Stems, Roots	Yes	No	CPC, 2007, 2015
Fusarium equisetin (Corda) Sacc	KE, UG	Roots	Yes	No	Farr et al 2003; Kedera, 1996
Fusarium graminearum (Schwein.) Petch	KE, UG	Leaves, Roots, Seeds Stems	Yes	Yes	CPC, 2007, 2015
Fusarium moniliforme (Sawada) S. Ito	KE, UG, TZ	Pods, Leaves, Roots Seeds, Stems	Yes	Yes	CPC, 2007, 2015
Fusarium pallidoroseum	KE	Seeds	Yes	Yes	Farr et al 2003; Kedera, 1996; Kung'u & Boa, 1997
Fusarium oxysporum Schlechtendahl	KE, TZ, RW	Root	No	No	CPC, 2004, 2007, 2015; Kimenju et al, 2004
Fusarium oxysporum f.sp. phaseoli J.B. Kendr. & W.C. Snyder	KE, RW, BI, UG	Fruits/pods, inflorescence, leaves,	Yes	Yes	CPC, 2007, 2015, Allen, et al., 1996,

		roots, seeds , stems			
Fusarium oxysporum f.sp. tracheiphilum (E.F.Sm.) Snyder & H.N.	TZ	Leaves, Roots	Yes	No	CPC, 2007, 2015
Fusarium pallidoroseum	KE, UG	Seed	Yes	Yes	Farr *et al* 2003; Kedera, 1996; Kung'u & Boa, 1997
Fusarium redolens	UG	Roots, stems, seeds	Yes	No**	Namasaka et al , 2017
Fusarium solani (Wollenw.) Gerlach	UG	Fruits/pod, inflorescence, leaves, roots, seeds, stems	Yes	Yes	CPC, 2007, 2015
Fusarium subglutinans	UG	Pods, Leaves, Roots Stems	Yes	No	CPC, 2007, 2015
*Gibberella avenacea (*R.J. Cook)	KE	Roots, Seeds, Stems	Yes	Yes	CPC, 2007, 2015
Gibberella fujikuroi (Sawada) S. Ito	KE, UG, TZ	Leaves, Pods, Roots Stems, Seeds	Yes	Yes	Kedera, 1996; Macdonald & Chapman, 1997
Gibberella zeae (headblight of maize)	KE	Flowers Roots, Seeds Stems	Yes	Yes	CPC ,2004; Farr et al 2003
Glomerella cingulata (Stonem.) Spauld. & Schrenk	KE, UG, TZ	Leaves	No	No	CPC, 2004, 2007, 2015
Lasiodiplodia theobromae (Pat.) Griffiths & Maubl.	KE, UG, TZ	Flowers Leaves, Shoots, Stems, Pods Seeds	Yes	Yes	Farr et al 2003; Kedera, 1996
Leveillula taurica (Lév.) G. Arnaud	KE, UG, TZ	Leaves Stems	No	No	CPC, 2004, 2007, 2015; Farr et al 2003; Kedera, 1996
Macrophomina phaseoli (Tassi) Goid	KE, UG, TZ	Roots, Stems	No	No	CPC, 2004, 2007, 2015 ; Farr et al 2003; Schwartz, 2003
Macrophomina phaseolina (Tassi) Goid	KE, UG, TZ	Roots, Pod, Stems Seeds	Yes	Yes	Allen, et al., 1996; CPC, 2004, 2007, 2015; Farrell et al., 1995; Kedera, 1996;

					Kung'u & Boa, 1997; Schwartz, 2003
Myrothecium roridum Tode	KE, UG, TZ	Seeds	Yes	Yes	CPC, 2004, 2007, 2015; Farr et al 2003
Mycovellosiella phaseoli (Drummond) Deighton	KE	Leaves, Seeds	Yes	Yes	Allen et al., 1996; Kung'u & Boa, 1997
Nematospora coryli (Peglion)	xxx	Leaves	Yes	No	CPC, 2004, 2007, 2015; Schwartz, 2003
Peronospora spp.	KE	Leaves, Pods, Stem	Yes	No	HCDA, MOA & JICA, 2003
Penicillium aurantiogriseum (Dierckx)	KE, UG, TZ, BI, RW	Roots, Seeds	No	Yes	Kedera, 1996 ; Kung'u & Boa 1997; Seif et al., 2001
Phoma spp.	KE, UG, TZ, BI, RW	Roots	No	No	CPC, 2007, 2015
Pestalotia spp.	UG	Leaves	Yes	No	CPC, 2007, 2015
Phoma exigua var. exigua (Desm.)	KE	Leaves, Roots	Yes	No	Farr et al 2003; Farrell, 1995; Kung'u & Boa 1997
Phoma exigua var. Dispersispora (Boerema et al.)	KE, UG, TZ	Leaves, Roots, Pods	Yes	No	Allen et al., 1996; Kedera, 1996; Kung'u & Boa, 1997; Schwartz, 2003
Phaeoisariopsis griseola (Sacc.) Ferraris	KE, UG, TZ, BI, RW	Pods, leaves, seeds, stems	No	Yes	Allen et al., 1996 ; CPC, 2004, 2007, 2015; Farrell et al., 1995; Kedera, 1996; Kung'u & Boa, 1997; Wagara et al,. 2004
Phakopsora pachyrhizi Syd. & P. Syd.	KE, UG, TZ	Leaves, Pods, Stems	No	Yes	Caldwell, & Laing, 2002; CPC, 2004, 2007, 2015; Hall, 1991;
Pythium ultimum	UG, TZ, KE, RW	Roots	NO	No	Buruchara etal., 2001; Binagwa et al., 2015
Pythium aphanidermatum (Edson) Fitzp.	KE, TZ	Roots	No	No	CPC, 2007, 2015
Rhizoctonia solani (Frank) Donk [teleomorph]	KE, UG, TZ, BI, RW	Flower, Leaves, Roots Pods, Stems, Seeds	No	Yes	CPC, 2007, 2015
Rhizopus spp.	KE, UG	Leaves, Stems	No	No	CPC, 2004, 2007, 2015; Kedera, 1996; Kung'u & Boa, 1997
Sclerotinia sclerotiorum (Lib.) de Bary	KE, TZ, UG	Flower, Leaves, Roots	Yes	Yes	Allen et al., 1996 ; CPC, 2004, 2007, 2015; Farrell, et al., 1995; Kung'u & Boa, 1997

		Pods, Stems, Seeds			
Sclerotium rolfsii Curzi	KE, UG, TZ, BI, RW	Pods, leaves, roots, seeds, stems	No	Yes	CPC, 2007, 2015
Thanatephorus cucumeris (Frank)	KE, UG, TZ, BI, RW	Flowers, Leaves, Pods, Roots, Seeds, Stems	No	Yes	Allen, et al., 1996; Farrell, et al 1995; Kedera, 1996; Kung'u & Boa, 1997; Otsyula et al,. 1998
Trichoderma harzianum	KE, UG	Roots	Yes	No	CPC, 2004, 2007, 2015; Otieno et al., 2003
Uromyces appendiculatus (Pers.) Unger (1816)	KE, UG, TZ	Leaves, Pods	Yes	Yes	CPC, 2004, 2007, 2015; HCDA, MOA & JICA, 2003; Kung'u & Boa, 1997; Schwartz, 2003
Uromyces viciae-fabae (Pers.) J. Schröt.	KE, UG, TZ	Leaves	Yes	No	CPC, 2004, 2007, 2015; HCDA, MOA & JICA, 2003; Kung'u & Boa, 1997; Schwartz, 2003
Verticilium dhaliae (Kleb)	KE, UG	Leaves, Stems	Yes	No	CPC, 2007, 2015
BACTERIA					
Bacillus cereus (Frankland & Frankland)	KE	Roots	Yes	No	CPC, 2004, 2007, 2015
Bacillus subtilis (Ehrenberg) Cohn	KE	Roots	Yes	No	CPC, 2004, 2007, 2015
Pseudomonas aeruginosa (Schroeter) Migula	KE	Roots	Yes	No	CPC, 2004, 2007, 2015; Kaaya and Darji, 1989
Pseudomonas cichorii (bacterial blight of endive)	TZ, BI	Leaves, Stems	Yes	No	CPC, 2007, 2015
Pseudomonas marginalis pv. marginalis (lettuce marginal leaf blight)	KE, UG, TZ	Leaves, Roots, seeds	No	No*	CPC, 2004, 2007, 2015
Pseudomonas savastanoi pv. phaseolicola (halo blight (of beans))	KE, UG, TZ, BI, RW	Leaves, Pods, Roots	No	No	Allen et al., 1996; CPC 2004, 2007, 2015, 2007, 2015; Farrell et al., 1995; Kedera, 1996; Kung'u & Boa,

					1997; Seif et.al., 2001; Schwartz, 2003
Pseudomonas syringae (Van Hall)	KE, BI	Leaves	Yes	No	CPC, 2004, 2007, 2015,
Pseudomonas syringae pv. garcae (Amaral et al) Young et al. (bacterial blight of coffee)	KE	Leaves, Stems, Shoots	Yes	No	CPC, 2004, 2007, 2015; Kung'u & Boa, 1997
Pseudomonas syringae pv. syringae (bacterial canker or blast (stone and pom)	KE, UG, TZ	Flowers, Leaves	Yes	No	CPC, 2004, 2007, 2015; Kung'u & Boa, 1997; Schwartz, 2003
Pseudomonas syringae pv. tabaci (wildfire)	KE, UG, TZ	Leaves	Yes	No	CPC, 2004, 2007, 2015; Kung'u & Boa, 1997
Pseudomonas viridiflava (bacterial leaf blight of tomato (USA))	KE, UG, TZ	Leaves, Pods, Stems	Yes	No	CPC, 2004, 2007, 2015
Rhizobium radiobacter (crown gall)	KE, UG, TZ	Roots	Yes	No	CPC, 2004, 2007, 2015
Serratia marcescens (Bizio)	KE	Roots	Yes	No	CPC, 2004, 2007, 2015; Kaaya et al., 1993
Xanthomonas axonopodis pv. glycines (soyabean bacterial pustule)	KE, UG, TZ	Leaves, Pods	No	No	CPC, 2004, 2007, 2015; Schwartz, 2003
Xanthomonas axonopodis pv. vignicola (bacterial: cowpea blight)	KE	Leaves, Pods, Stem	Yes	No	Kedera, 1996
Xanthomonas axonopodis pv. phaseoli (bean blight)	KE, UG, TZ, BI, RW	Leaves, Pods	No	No	Allen et al., 1996 ; CPC, 2004, 2007, 2015; Farrell et al 1995; Kedera, 1996
Xanthomonas campestris pv. campestris (Pammel) Dowson	KE, UG, TZ	Leaves, Pods, Seeds Stems	No	Yes	CPC, 2004, 2007, 2015
VIRUSES					
Alfalfa mosaic virus (alfalfa yellow spot)	KE, TZ	Leaves, Stems, Roots	No	No	CPC, 2004, 2007, 2015;
Bean common mosaic necrosis virus	KE, UG, TZ, BI, RW	Leaves, Roots, Seeds	No	Yes	CPC, 2004, 2007, 2015; Guzmán et al., 1997; Spence & Walkey, 1995
Bean common mosaic virus (common mosaic of beans)	KE, UG, TZ, BI, RW	Leaves, Pods, Stem	No	No	Allen et al., 1996; CPC, 2004, 2007, 2015; Farrell et al., 1995;

					Kedera, 1996; Seif et al., 2001
Bean yellow mosaic virus (bean yellow mosaic)	KE, TZ	Leaves	Yes	No	Bock et al. 1974; CPC, 2004, 2007, 2015
Broad bean wilt virus (lamium mild mosaic)	TZ	Pods, Leaves, Seeds, Stems	Yes	Yes	CPC, 2007, 2015
Cowpea mild mottle virus (angular mosaic of beans)	KE, UG, TZ	Stem, Leaves	No	No	CPC, 2004, 2007, 2015
Cucumber mosaic virus (cucumber mosaic)	KE, TZ	Leaves	Yes	No	CPC, 2004, 2007, 2015;
Peanut mottle virus (peanut mottle)	KE, UG, TZ	Leaves, Pods, Stem	No	No	Bock et al. 1974; CPC, 2004, 2007, 2015
Tobacco Mosaic Virus	KE	Leaves	Yes	No	CPC, 2004, 2007, 2015; Hollings et al,. 1981
Tobacco rattle virus	KE	Leaves, Stems	Yes	No	CPC, 2004, 2007, 2015; Khurana &Garg, 2003
Tomato spotted wilt virus (tomato spotted wilt)	KE, UG, TZ	Leaves, Pods	No	No	CPC, 2004, 2007, 2015
Tomato yellow leaf curl virus (leaf curl)	TZ	Leaves, Stems	Yes	No	CPC, 2007, 2015

Table 2. Harmonized regional pest list for Beans

	Pest name	Distribution	Pathway	References	Remarks
1	*Pseudomonas marginalis* pv *marginalis* (Brown) Stevens Lettuce marginal leaf blight	KE, TZ, UG	Fruits/pods, inflorescence, leaves, roots, seed	CPC, 2015	The pest is not known to be associated with seeds in trade, hence removed from the list.
2	*Pseudomonas syringae* pv. *syringae* van Hall 1902. Bacterial brown spot (beans)	KE, TZ, UG, BR	Leaves, pods, seed	CPC, 2004, 2007, 2015, Schwartz et al., 2005; KEPHIS 2012	Addition of TZ, UG and BI to the list
3	*Pseudomonas syringae* pv. *tabaci* wildfire	KE TZ, UG	Leaves, pods, seed	CPC, 2007, 2015 ; Kung'u & Boa, 1997 ; Schwartz et al., 2005	
4	*Xanthomonas axonopodis* pv *glycines* (Nakano) Vauterin et al	KE, UG, TZ	Leaves, pods, seeds	CPC, 2007, 2015; Schwartz et al., 2005	Even though beans have been listed as host, there are no reported losses on

	Soyabean bacterial pustule				beans hence pest removed from list
5	*Cochliobolus sativus* (root and foot rot)	UG, KE, RW, TZ	Growing points: Inflorescence: Leaves: Roots: rot; Seeds: Stems: Whole plant	EPPO, 2003; CMI, 1986, CABI /CPC 2005, 2007, 2011, 2015	
6	*Elsinoe phaseoli* (Bean scab)	UG, KE TZ	Fruits/pods, leaves, shoots and branches	CABI/CPC 2005, 2007, 2011	The disease has been reported in West and East Africa (IITA)
7	*Sclerotinia sclerotiorum* (Lib) de Bary Cottony soft rot	KE, TZ, RW, BR	Fruits/pods, inflorescence, leaves, roots, seeds, stems	CPC 2007, CPC 2015	
8	*Lasiodiplodia theobromae* (Pat) Griffiths & Maubl Syn *Botryodiplodia theobromae* Pat Diplodia pod rot of cocoa	KE, UG, TZ	Fruits/pods, inflorescence, leaves, roots, seeds, stems	CPC 2007; Farr et al 2003; Kedera, 1996	
9	*Verticillium dahliae* (Kleb) Verticillium wilt	KE	Roots	CPC 2007; Farr et al 2003; Kedera, 1996; Klingemanp,2005	Bean not a host hence deleted from the list
10	*Fusarium solani* f.sp. *phaseoli* (Burkholder) Snyder & Hansen	KE, TZ, UG, RW	Fruits/pods, inflorescence, leaves, roots, seeds, stems	KEPHIS, 2012, PHS, 2008, Allen et al, 1996	Locally and seasonally damaging.
11	*Fusarium oxysporum* fsp *phaseoli* (JB Kendr & WC Snyder) Yellows of beans	KE, TZ, RW, BI	Fruits/pods, inflorescence, leaves, roots, seeds, stems	Allen et al, 1996; CPC, 2007, 2015; CPC, 2015, Kedera, 1996	Systemic pathogen favoured by high temperatures in drought prone areas.
12	*Cochliobolus lunatus* RR Nelson & Haasis [teleomorph] head mould of grasses, rice , sorghum	KE, TZ, UG	Inflorescence, leaves, seeds	CABI, 2011, CPC, 2015	The pest is found in Kenya, Tanzania and Uganda. Its economic impact is negligible and therefore requires no risk management
13	*Choanephora cucurbitarum* (Berk & Ravenel) Thaxt Choanephora fruit rot	KE, TZ	Fruits/pods, growing points, inflorescence, leaves, seeds, stems	CPC, 2007, 2015, CPC, 2015	
16	*Alternaria brassicicola*	TZ, UG, KE	Fruits/pods, inflorescence, leaves, seeds, stems and whole plant.	EPPO, 2006; Rop et al, 2009	Also, a major pest for cabbages

17	*Clavigralla elongata* (African podbug)	UG, KE, TZ, BI, RW	Fruits/pods: grains	Allen et al., 1996, CPC 2007,2011	Deleted because it has been reported in all the countries present
18	*Clavigralla tomentosicollis* (African pod bug)	UG	Pods, flowers and grain/seeds, Flowers: True Seeds (inc. Grain)	CPC 2007/2011	Deleted because it has been reported in all the countries present
19	*Alcidodes leucogrammus* (Erichson) Stripped bean weevil	KE, TZ		CPC, 2007, 2015; Allen et al., 1996; Farrell et al., 1995 ; Mailu 1996 ; Seif et al., 2001; CPC 2015	Mainly a pest of cowpeas but minor pest on beans and attacks stems
20	*Bruchidius atrolineatus* (Pic) Bruchidae	KE (Unconfirmed)	Seeds	CPC, 2007, 2015; Warui, 1984; CPC 2015	
21	*Callosobruchus analis* (Fabricius) Bean weevil	KE, TZ (restricted)	Fruits/pods and seeds.	CPC, 2007, 2015; Warui 1984; CPC 2015	High cost of risk management and economic impact is high although spread is medium
22	*Callosobruchus chinensis* (Linnaeus) Chinese bruchid	KE, TZ, UG	Seeds	CPC, 2007, 2015; Mailu, 1996; CPC 2015	Likelihood of moving in trade is minimal
23	*Callosobruchus maculatus* (Fabricius, 1775) Cowpea weevil	KE, UG, TZ, RW	Seeds	CPC, 2007, 2015; Warui, 1984; CPC 2015	
24	*Callosobruchus phaseoli* (Gyllenhal) Bruchidae	KE, UG	Seeds	CPC, 2007, 2015; Warui, 1984; CPC 2015	
25	*Tribolium castaneum* Red flour beetle	KE, UG, TZ, BI, RW	Fruits/pods, seed and vegetative	CPC, 2007, 2015; Mailu 1996	Deleted because it has been reported in all the countries present
26	*Zabrotes subfasciatus* (Boheman) Mexican bean weevil	KE, UG, TZ, BI, RW	Seeds	Allen et al., 1996; CPC, 2007, 2015	Deleted because it has been reported in all the countries present
27	*Ditylenchus dipsaci* (Kühn,) Filip'ev stem, bulb nematode	KE (Occasional)	Leaves, seeds, stems,	CPC, 2007, 2015; CPC 2015	
28	Bean common mosaic necrosis virus	UG, KE, TZ, BI, RW	Leaves, Roots Seeds,	Spence & Walkey, 1995, Kabere 2008, CABI/CPC 2005, 2007, 2011. Uganda, 2003	Deleted because it has been reported in all the countries present
29	Bean common mosaic virus (common mosaic of beans)	UG, KE, TZ, BI, RW	Pods, Roots, Seeds, Stems,	CABI/CPC 2005, 2007, 2011. Kabere and Wulff, 2008	Deleted because it has been reported in all the countries present

				Uganda, 2003; CPC 2015	
30	Alfalfa mosaic virus (Alfalfa yellow spot)	Localized in KE & TZ	Leaves, Stems, Roots, seed	CPC, 2007, 2015; CPC 2015	
31	Bean Yellow mosaic virus	TZ, KE	Leaves	EPPO, 2006; CPC 2015	
32	Cucumber Mosaic Virus	KE, UG, TZ	Leaves	Brunt, 1996	RNQP in Kenya

3. Table with all quarantine pest to be analyzed

	Pest
1.	*Cochliobolus lunatus* (glume mould of rice)
2.	*Cochliobolus sativus* (root and foot rot)
3.	*Sclerotinia sclerotiorum* (Lib) de Bary Cottony soft rot
4.	*Lasiodiplodia theobromae* (Pat) Griffiths & Maubl Syn (diplodia pod rot of cocoa)
5.	*Fusarium oxysporium* fsp *phaseoli*
6.	*Fusarium solani* fsp *phaseoli*
7.	*Choanephora cucurbitarum* (Choanephora rot)
8.	*Alternaria brassicicola* (dark leaf spot of cabbage)
9.	*Elsinoe phaseoli* (Bean scab)
10.	*Alcidodes leucogrammus* (Erichson) (Stripped bean weevil)
11.	*Bruchidius atrolineatus* Pic
12.	*Callosobruchus analis* (Fabricius) (bean weevil)
13.	*Callosobruchus chinensis* (Linnaeus, 1758) Chinese bruchid
14.	*Callosobruchus maculatus* (Fabricius,1775) (cowpea weevil)
15.	*Callosobruchus phaseoli* (Gyllenhal 1833)
16.	*Pseudomonas marginalis pv marginalis*
17.	*Pseudomonas syringae pv. tabaci* wildfire (beans)
18.	*Pseudomonas syringae pv. syringae* van Hall 1902. Bacterial brown spot (beans)
19.	Alfalfa mosaic virus (Alfalfa yellow spot)
20.	Bean Yellow Mosaic Virus
21.	Cucumber Mosaic Virus
22.	*Ditylenchus dipsaci* (Kühn,) Filip'ev stem, bulb nematode

3.0 Pest Risk Analysis based on introduction potential and Consequences

Estimate of risks are expressed in the qualitative terms of high, medium, low or negligible.

Table 4: Technical evaluation of risk factors for *Cochliobolus lunatus*

Pest	*Cochliobolus lunatus* (glume mould of rice)	
Type	Fungus	
Pathway	Seed/ grain	
Factors	Overall Risk rating	

Likelihood of Entry	High	Even though the risk could be low as there are no interception reports in the PRA area on the pest so far, high risk could be due to: • Large volumes for both grain and seed likely to be imported • Pathogen is seed borne and seed transmitted • Transit temperatures (inside trucks which are the mode of transport) of up to 20 ^{0}c favour thriving of the pathogen • Recommended control measures at country of origin such as crop rotation, soil fumigation are not practical, hence unlikely to be implemented • Wide /countrywide distribution both for grain and seed as there are no designated zones for bean production and commodity also consumed country wide.
Likelihood of Establishment	Medium	The pest risk was rated as low because various effective treatments options such as Thiram + Carbendazim & Mancozeb are available. However, the risk could be high because: • The pest has a wide host range that includes various grasses like Sudan, Johnson, Ford, Barley and Lucerne. It is also a host for important crops such as Cowpea, Ginger, Wheat, Barley, Maize, Rice, Eucalyptus and Okra. • The pathogen can also survive on crop residues and in soil. • Furthermore, high humidity and tropical temperature favour pest growth.
Likelihood of Spread	Medium	The risk was rated as low due to regionally available natural enemies such as *Trichoderma, Gibberella fujikuroi* and *G. indica*. Also, there are no known vectors. However, the risk was as rated high due to: • The likelihood of the pest being spread through both seed and grain • The likelihood for the pest movement to a region of higher economic importance due to widespread demand for both bean seed and grain. • The pathogen is both soil and air borne. • Within the PRA area, grain is sometimes used as seed • Most grasses are hosts, hence pest likely to spread across the grass lands
Economic impact	NEGLIGIBLE	High economic losses reported in grasses, but not in beans; Risk rated as –NEGLIGIBLE RISK and the PRA STOPS

Overall Risk rating	NEGLIGIBLE	Rated as –NEGLIGIBLE RISK for grain Rated as NEGLIGIBLE RISK for seed
Category (QP, RNQP, NRP)	NRP	
Requires Risk Management (yes / no)	NO	

Table 5: Technical evaluation of risk factors for *Sclerotinia sclerotiorum*

Pest	*Sclerotinia sclerotiorum* (Lib) de Bary Cottony soft rot	
Type	Fungus	
Pathway	Seed/ Grain	
Factors	Overall Risk Rating	
Likelihood of Entry	Medium	The Following factors present high likelihood for the pathogen to enter into PRA area: • Huge number of grain and seed consignments likely to be imported • Pathogen is seed borne internally and can be transmitted through seed • Light is not essential for pathogen survival; the pathogen can survive above 10^0C which is the common temperature in trucks which form the major transportation means • Managing the pest through solarization is expensive and the recommended crop rotation may not be a viable option. On the other hand, the risk could be low due to the following reasons; • Effective seed treatment at country of origin is possible using thiram. Use of common fungicides such benomyl and fludioxonil has also been reported to be effective • Use of cultural methods such as spacing and good tillage are both effective and practical.
Likelihood of Establishment	Medium	Considering that suitable environmental conditions for establishment of the pathogen are available such as temperature ranges of at least 10^0 C to 20^0 C, availability of alternative hosts such as: tomato, carrots, aubergines, cabbage, sweet potato and peas (there is a wide host range from the following families ,Asteraceae , Fabaceae, Brassicaceae, Solanaceae, Apiaceae and Ranunculaceae) as well as the ability for the pathogen to rapidly multiply using mycelia, there

		is high rating for the pathogen to be established in the PRA area. However, the risk could be low since effective broad-based spectrum fungicides are available for effective control measure at country of origin. Studies have also shown that high temperatures and high moisture content available in PRA area encourages degradation of the pathogen near the soil surface. Furthermore, there are no known vectors for the pathogen
Likelihood of Spread	Low	The pathogen can be spread through grain or seed (seed borne). Ascospores can be spread by wind, water, animals, honeybees, farm equipment and conveyances. The likelihood for the pest movement to a region of higher economic importance due to widespread demand for both bean seed and grain is high. Moreover, within the PRA area, grain is sometimes used as seed The risk was rated as low due to regionally available natural enemies such as *Trichoderma* spp, *Penicillium* spp, and *Aspergillus niger* and Bacillus *subtilis.* Also, there are no known vectors.
Economic impact	Medium	In bean growing areas of northeastern Tanzania, the pest has caused severe losses in recent years. Low economic loss due to effective control measures like spraying appropriate fungicides and IPM.
Overall Risk rating	Medium	Rated as NEGLIGIBLE RISK for grain Rated as MEDIUM for Seed
Category (QP, RNQP, NRP)	QP	
Requires Risk Management (yes / no)	Yes	

Table 6: Technical evaluation of risk factors for *Lasiodiplodia theobromae*

Pest	*Lasiodiplodia theobromae* (Pat) Griffiths & Maubl Syn (diplodia pod rot of cocoa)	
Type	Fungus	
Pathway	Seed/ Grain	
Factors	Overall Risk Rating	
Likelihood of Entry	Medium	Risk for introduction through entry is high because: • Many consignments are anticipated for both consumption and seed for propagation- • The pathogen is seed borne internally and can be externally transmitted on the seed coat.

		• Light is not essential for survival; the pathogen can survive at 20 ^{0}C which is the common temperature in trucks which form the major transportation means However, Seed treatment is effective using mancozeb and carbendazium and there are no interception reports so far
Likelihood of Establishment	Medium	The risks could be higher as the pest has a wide host range that includes: Alternative hosts are: Cocoa, Ground nuts, Bananas, Cotton, Sweet potato, Cassava, Tea, Sugarcane, Tobacco and Avocado. Also, the pathogen is hosted by some wild plants. Pathogen may be found on living and dead stems of sorghum and passiflora. Furthermore, optimal temperature for development is 30 ^{0}C, which is common in the EAC member states. However, the rating could be low since broad- spectrum fungicides available are able to effectively control the pest.
Likelihood of Spread	Medium	The natural environment is suitable for spread because; • The likelihood of the pest being spread through both seed and grain • The likelihood for the pest movement to a region of higher economic importance due to widespread demand for both bean seed and grain. • The pathogen is both soil and air borne, and insect transmitted. Similarly, commodities or conveyances that have soil attached can transmit the soil pathogen. According to research, it sporulates quickly on host tissue upon incubation. • Within the PRA area, grain is sometimes used as seed. However; There are known vectors and natural enemies available within the EAC, such as *Bacillus subtilis* and *Xanthomonas oryzae* pv *oryzae*. Also, there are no known vectors.
Economic impact	NEGLIGIBLE	Reports show that the level of economic loss is relatively high in maize, cocoa and passion fruits, recorded as up to 57% in maize; in cocoa and passion fruit however, there are no records available on economic loss in beans.
Overall Risk rating	NEGLIGIBLE	Rated as –NEGLIGIBLE RISK for grain Rated as NEGLIGIBLE RISK for seed
Category (QP, RNQP, NRP)	NRP	
Requires Risk Management (yes / no)	No	

Table 7: Technical evaluation of risk factors for *Fusarium oxysporium* fsp *phaseoli*

Pest	*Fusarium oxysporium* fsp *phaseoli*	
Type	Fungus	
Pathway	Seed/ Grain	
Factors	Overall Risk Rating	
Likelihood of Entry	High	Risk for introduction through entry is high because: • Many consignments are anticipated for both consumption and seed for propagation- • The pathogen is seedborne internally and can be externally transmitted on the seed coat. • Light is not essential for survival; the pathogen can survive at 20 ^{0}C which is the common temperature in trucks which form the major transportation means However, Reported seed treatment using copper-based fungicides suppressed symptoms, however no details provided in the reference. Resistant germplasm reported as effective means of control. • No interception reports so far
Likelihood of Establishment	Medium	• The pathogen has a narrow host range including: *Phaseolus vulgaris, P. coccineus, Lupinus luteus, L. albus*; There are no records on vector transmission; No information given about invasiveness hence risk rated as low • However, the pathogen could pose high risk due to: - -Optimal temperatures for development are 20 ^{0}C which is common in the EAC member states. -Little information available in Management however reports shown that Trichoderma can suppress the pest (Otado et al., 2011) Low F. *oxysporum* chlamydospores can survive in the soil and infect plant debris.
Likelihood of Spread	High	The risk could be low due to: No wild hosts reported hence unlikely to cause environmental degradation. No reports on vectors likely to transmit the pathogen. However, the risk rating could be high due to: Commodities or conveyances that have soil attached to it can transmit the soil pathogen. The likelihood for the pest to move to a region of higher economic importance is high, through seed. The pathogen is also soil, seed and air borne. Within the PRA area, grain is sometimes used as seed; No information on natural enemies

Economic impact	Low	Reports show, the level of economic loss is low whereby loses can go up to 6% in bean in Rwanda, which however would not be attributed to only the pathogen. It is also recorded seed treatment with copper-based fungicides suppressed the disease.
Overall Risk rating	Medium	Rated as NEGLIGIBLE for grain Rated as Medium for SEED
Category (QP, RNQP, NRP)	QP	
Requires Risk Management (yes / no)	Yes	

Table 8: Technical evaluation of risk factors for *Fusarium solani* fsp *phaseoli*

Pest	*Fusarium solani* fsp *phaseoli*	
Type	Fungus	
Pathway	Seed/Grain	
Factors	Overall Risk Rating	
Likelihood of Entry	High	Even though there are no interception reports on the pest so far, high risk is due to: • Large volumes for both grain and seed • Seed borne and seed transmitted pathway • Transit temperatures of up to 20 ^{0}C favour thriving of the pathogen • Recommended crop rotation using crops such as alfalfa (not a possibility for majority of farmers), minimizing soil compaction before planting; not cultivating when soil is wet (Bean compendium) = measures not practical. Soil fumigation with Methyl bromide effective but not cost effective and prohibited in most countries therefore not practical • There is countrywide distribution both for grain and seed.
Likelihood of Establishment	High	• Optimal temperature for development is 20 ^{0}C which is common in the EAC member states. • Crop rotation not practical; most management techniques aimed at prevention as opposed to control (Luginbuhi, 2010) • The host range includes bean, potato, pea, cucurbits which are very important crops. • Pathogen can survive in the soil for several years; clamydospores are used as survival structures in the

		absence of a host plant; it can spread by rain splash or carried by floods.
Likelihood of Spread	High	The risk for spread is rated high due to the following reasons: • The fungus can be vectored by the black twig borer (*Xylosandrus compactus*) present in KE, UG & TZ (Bosso et al., 2012). • Commodities or conveyances that have soil attached to it can transmit the soil pathogen • The pathogen is also airborne • The likelihood for the pest to move to a region of higher economic importance is high, through seed. • Within the PRA area, grain is sometimes used as seed. • No information on natural enemies However, low risk could be due to no wild hosts reported, hence no environmental degradation is likely.
Economic impact	Low	The pathogen causes root rot in snap and dry beans, but not quantifiable; percentage loss not document; Causes infections in humans such as vision impairment.
Overall Risk rating	Medium	Rated as NEGLIGIBLE for grain Rated as Medium for SEED
Category (QP, RNQP, NRP)	NRP	
Requires Risk Management (yes / no)	No	

Table 9: Technical evaluation of risk factors for *Choanephora cucurbitarum*

Pest	*Choanephora cucurbitarum* (Choanephora rot)	
Type	Fungus	
Pathway	Seed /Grain for consumption	
Factors	Overall Risk Rating	
Likelihood of Entry	Low	Despite the fact that big volumes of bean which are frequently traded in between Tanzania and Kenya, Rwanda and Burundi and the fact that the pest is a liable to be carried in true Seeds including grain, the fungus can be easily be controlled by fungicide that are effective by 80%. On the other hand, most of the consignments are transported in tracks where the spillage is minimal and are intended for consumption.
Likelihood of Establishment	Medium	Despite of the available control measures of *C. cucurbitarum* there are chances for the establishment of the pest due to

		favourable climatic conditions and the existence of the hosts in the PRA area
Likelihood of Spread	Medium	The absence of natural enemies for the fungus and the presence of ideal climatic conditions in the PRA area gives a likelihood of the pest to spread regardless of the fact that the grain bean are imported for consumption. Farmers may retain some of the grains and use for planting.
Economic impact	Medium	Crop losses are highly variable between seasons and years. Precise data are seldom given but losses are most serious when warm and moist conditions prevail. Crop losses varies with cultivar from moderate to total loss in the rainiest season in legumes (Turkensteen, 1979).
Overall Risk rating	Medium	Big volumes of bean frequently traded in between Tanzania and Kenya, Rwanda and Burundi give the entry potential of the pest in the PRA. Despite of the available control measures of *C. cucurbitarum* there are chances for the establishment and spread of the pest due to favourable climatic conditions and the existence of the hosts in the PRA area. Crop losses varies with cultivar from moderate to total loss in the rainiest season in legumes.
Category (QP, RNQP, NRP)	QP	
Requires Risk Management (yes / no)	YES	

Table 10: Technical evaluation of risk factors for *Alternaria brassicicola*

Pest	*Alternaria brassicicola* (dark leaf spot of cabbage)	
Type	Fungus	
Pathway	Seed /grain for consumption	
Factors	Overall Risk Rating	
Likelihood of Entry	High	The possibility of *A. brassicicola* to enter the PRA area can be high due to the following factors; Beans is one of the most traded crops in big volumes in the region. The pest is liable to be carried on true Seeds including grains and it can survive during transportation. The pest can evade the existing control measures by surviving in crop debris and weed hosts.
Likelihood of Establishment	High	The major hosts of the pest including cruciferous plants and non-cruciferous plants which are reported to be a host are present in the importing countries. The ideal germination temperature of conidia which takes place between 28 and 31°C is also available in importing countries, despite of the control measures available, the

		pest can be able to survive on seeds and debris of cultivated and weed hosts and hence chances of establishing of the pest are favourable
Likelihood of Spread	Medium	True Seeds (inc. Grain): Spores, Hyphae; borne internally; borne externally; invisible, likely to disperse the pest.
Economic impact	Negligible	*A. brassicicola* causes economic losses in several different ways (Verma and Saharan, 1994). Seed infection causes reduced germination and seedling vigour, in addition to pre- and post-emergence damping-off and affects the sale and use of infected/infested seed. The pest is mostly likely of minor importance in beans hence no serious economic losses can be expected in the PRA area.
Overall Risk rating	Negligible	Beans is one of the most traded crops in big volumes in the region. Infected seeds can be detected during Phytosanitary inspection by the presence of lesion and shriveled seeds. Since the beans are mainly imported to urban area where are mainly used for human consumption chances of spread is average. The pest is mostly likely of minor importance in beans hence no serious economic losses can be expected in the PRA area.
Category (QP, RNQP, NRP)	NRP	
Requires Risk Management (yes / no)	NO	

Table 11: Technical evaluation of risk factors for *Alcidodes leucogrammus*

Pest	*Alcidodes leucogrammus* (Erichson) (Stripped bean weevil)	
Type	Insect	
Pathway	Seed /grain for consumption	
Factors	Overall Risk Rating	
Likelihood of Entry	Negligible	Beans is one of the most traded crops in big volumes in the region. Adult stripped bean weevils are found feeding in bean leaves. Grubs of the weevils live in soil and feed on roots or may bore into the stem of the bean plant causing swelling. Therefore, the pest is not associated with the bean grains at any stage of its life cycle, hence no further PRA to be continued.
Overall Risk rating	Negligible	

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

Table 12: Technical evaluation of risk factors for *Bruchidius atrolineatus*

Pest	*Bruchidius atrolineatus* Pic	
Type	Insect	
Pathway	Seed/grain for consumption	
Factors	Overall Rating	
Likelihood of Entry	Negligible	The beetle *B. atrolineatus* (Pic) commonly infests and damages seeds of cowpea, *Vigna unguiculata* (L.) Walp. in tropical Africa. Its ability to infest and damage other tropical legumes including two cultivars of *P. vulgaris* was determined. The beetle could not successfully complete its life cycle in seeds of *P. vulgaris*, but the others supported development to adult emergence (Ofuya & Credland, 1996). The pest cannot follow the pathway of the imported commodity therefore the PRA terminated.
Overall Risk rating	Negligible	
Category (QP, RNQP, NRP)	NRP	
Requires Risk Management (yes / no)	No	

Table 13: Technical evaluation of risk factors for *Callosobruchus analis*

Pest	*Callosobruchus analis* (Fabricius) (bean weevil)	
Type	Insect	
Pathway	Seed/ grain for consumption	
Factors	Overall Risk Rating	
Likelihood of Entry	High	Beans are produced as a staple food by around 87% and consumed by over 41% of the population of EAC. *C. analis* is liable to be carried on bean grain where females lay many eggs up to 200. The eggs are firmly glued to the surface of the host seed. Chances of the beetle to be introduced in the PRA area are high due to the fact that beetle can survive during transport. Although the

		commodity is imported for consumption its distribution across the region is extensive hence poses the risk of the pest to be further disseminated.
Likelihood of Establishment	High	The major hosts of the pest including stored legumes species such as cowpeas, black grams, mung beans, ground nuts are present in the importing countries. The PRA are is conducive for optimum development conditions for *C. analis* breeding (30-35°C and 70% relative humidity). Since there are no specific control measures known for *C. analis* chances of establishment is likely to be high once introduced.
Likelihood of Spread	Medium	Infestation can begin in the field where eggs are laid on maturing pods and threshed beans are susceptible to attack throughout storage. Probabilities for the beetle to spread is attributed by the fact that eggs are laid and firmly glued to the surface of the host seed. However, the natural enemy for *C. analis* known as *Dinarmus basalis* has been tested into storage systems and resulted in a great reduction in numbers of bruchids and ensured the maintenance of seeds of good quality during storage, hence the rate of spread can critically reduce if appropriately used
Economic impact	High	As with other *Callosobruchus* species, *C. analis* has been recorded as a pest of stored legume species. However, because several earlier authors made no distinction between *C. analis* and *C. maculatus*, host associations reported in earlier papers may be misleading (Southgate et al., 1957; Haines, 1989). Nyarko, (2013), has shown to be of significant consideration in the production, marketing and consumption of legumes including dry beans: since it can destroy it both in the field and at storage. The values of dried pulses are strongly influenced by bruchid infestation in local market particularly in Sub Saharan Africa. Entry of the pest in the PRA area will obviously increase cost of storage such as fumigation and storage in haematic bags.
Overall Risk rating	High	Beans are produced as a staple food by around 87% and consumed by over 41% of the population of EAC. Chances of the *C. analis* to be introduced and spread in the PRA area are high due to the fact that eggs are firmly glued to the surface of the host seeds and the beetles can survive during transport. The pest has shown to be of significant consideration in the production, marketing and consumption of legumes including dry beans: since it can destroy it both in the

		field and at storage. The values of dried pulses are strongly influenced by bruchid infestation in local market particularly in Sub Saharan Africa. Entry of the pest in the PRA area will obviously increase cost of storage such as fumigation and need for storage in haematic bags.
Category (QP, RNQP, NRP)	QP	
Requires Risk Management (yes / no)	YES	

Table 14: Technical evaluation of risk factors for *Elsinoe phaseoli*

Pest	*Elsinoe phaseoli* (Bean scab)	
Type	Fungi	
Pathway	Seed for planting and grain for consumption	
Factors	**Overall Risk Rating**	
Likelihood of Entry	HIGH	The overall likelihood that *Elsinoe phaseoli* may be introduced and survive within East African region is high. This is especially because the pest is adapted to a broad range of environmental temperatures. Three out of five of the countries have the pest and there is a lot of trade in beans. Management and control measures are available at production level require to be implemented.
Likelihood of Establishment	MODERATE	The PRA area has suitable hosts and environmental conditions. The pest can be borne internally and externally and has wide host ranges that are easily available. However, there are management practices that can contain the pest thereby reducing the chances of establishment.
Likelihood of Spread	HIGH	Although there is no known vector for the pest, it is likely to spread if introduced into the PRA area. This is because the pest the pest could move to a region of higher economic importance due to widespread demand for both bean seed and grain and there are no known natural enemies.
Economic impact	HIGH	Up to 70% losses have been recorded as a result of the pest
Overall Risk rating	HIGH	It is a quarantine pest and risk management is required.
Category (QP, RNQP, NRP)	QP	
Requires Risk Management (yes / no)	Yes	

Table 15: Technical evaluation of risk factors *for Cochliobolus sativus*

Pest	*Cochliobolus sativus* (root and foot rot)	
Type	Fungi	
Pathway	Seed for planting and grain for consumption	
Factors	**Overall Risk Rating**	
Likelihood of Entry	Negligible	All of the small cereals and numerous grasses are hosts of the pest *Cochliobolus sativus*, with wheat, rice and barley being the most economically important hosts. Other hosts recorded are *Agropyron* spp, *Avena sativa*, *Bromus* spp, *Buchloe dactyliodes* and Sorghum. There is no information provided on pest to be seed transmitted in beans, although the CPC, 2015 mentions beans as main hosts which is not highlighted in any other reference. Because of not having tangible evidenced reference on any economic impact of this pest on bean as well as the pest being seed transmitted in beans, THE PRA STOPS.
Category (QP, RNQP, NRP)	NRP	
Requires Risk Management (yes / no)	No	

Table 16: Technical evaluation of risk factors for Alfalfa mosaic virus

Pest	Alfalfa mosaic virus	
Type	Virus	
Pathway	Seed/ grain	
Factors	**Overall Risk rating**	
Likelihood of Entry	High	The pest is present in Tanzania, is also seed borne, no effective control measure used in exporting country, large volumes for both grain and seed likely to be imported, pest likely to survive in trucks to be used for transportation, Wide /countrywide distribution both for grain and seed as there are no designated zones for bean production and commodity also consumed country wide, there is high risk of introduction of the pest.
Likelihood of Establishment	High	The pest risk rated high because the host range is wide (includes cucurbits, cowpea, tomato, tobacco and potato) which are widely grown in the region, no effective management options available at production other than vector

		management. Environment conditions are conducive for the establishment of the pest because its host and vector range is large and available.
Likelihood of Spread	High	The pest is both seed and aphid transmitted; there are no known natural enemies.
Economic impact	Negligible	AMV is of local economic importance in celery, peppers, tomatoes, lucerne, peas, potatoes and *Trifolium* spp. It has a different economic impact on different crop types and the situation in which they are grown. (CPC 2015). No specific reports have been made on economic losses on beans however.
Overall Risk rating	Negligible	
Category (QP, RNQP, NRP)	NRP	
Requires Risk Management (yes / no)	No	

Table 17: Technical evaluation of risk factors for Bean Yellow mosaic virus

Pest	Bean Yellow mosaic virus (Bean yellow mosaic)	
Type	Virus	
Pathway	Seed for planting and grain for consumption	
Factors	**Overall Risk rating**	
Likelihood of Entry	Negligible	Despite there being uniform and favourable environment in the East African region and main and/or alternate hosts for the pest, the chances of introduction of the pest through seed into the PRA area is very negligible. This is because the pest is not reported to be transmitted through bean seed, though there are reports on very low seed borne aspects and transmission in faba bean. Some reports indicate low percentages of seed transmission (0.1-2.4% in faba beans. Pods are not affected during growth by the pest. The PRA stops.
Requires Risk Management (yes / no)	No	

Table 18: Technical evaluation of risk factors for *Pseudomonas marginalis pv marginalis*

Pest	*Pseudomonas marginalis pv marginalis* (Brown) Stevens Lettuce marginal leaf blight

Type	Bacteria	
Pathway	Seed for planting and grain for consumption	
Factors	**Overall Risk rating**	
Likelihood of Entry	Negligible	The seeds are not known to carry the pest during trade (CPC, 2015). Seed borne incidence; seed transmission is not recorded hence the PRA stops.
Category (QP, RNQP, NRP)	NRP	
Requires Risk Management (yes / no)	No	

Table 19: Technical evaluation of risk factors for *Pseudomonas syringae pv. tabaci*

Pest	*Pseudomonas syringae pv. tabaci* wildfire (beans)	
Type	Bacteria	
Pathway	Seed for planting and grain for consumption	
Factors	**Overall Risk rating**	
Likelihood of Entry	Negligible	The overall likelihood that *Pseudomonas syringae pv tabaci* may enter and survive in the East African region is negligible since the pest is not reported to be seed borne. PRA stops
Category (QP, RNQP, NRP)	NRP	
Requires Risk Management (yes / no)	No	

Table 20: Technical evaluation of risk factors for *Pseudomonas syringae pv. syringae*

Pest	*Pseudomonas syringae pv. syringae* van Hall 1902. Bacterial brown spot (beans)	
Type	Bacteria	
Pathway	Seed for planting and grain for consumption	
Factors	**Overall Risk rating**	
Likelihood of Entry	HIGH	The overall likelihood that *Pseudomonas syringae* pv *syringae* may enter and survive in the East African region is high since

		the pest is seed transmitted and there is no seed treatment known against the pest which may be used as a control measure in country of origin. Transit temperatures (inside trucks which are the mode of transport) are likely to favour survival of pest; the wide usage of grain/seed within the EAC member countries also likely to increase the risk element.
Likelihood of Establishment	HIGH	The PRA area has a suitable environment for the establishment of *Pseudomonas syringae pv syringae.* Also, the host range is wide and includes important crops such as citrus fruits, cucurbits, barley, tomato, tobacco, mango, maize, rice sorghum and avocado. The pathogen is also is found in soil and water and on plant surfaces worldwide. No effective seed treatment has been established.
Likelihood of Spread	Medium	The pest is likely to spread through both seed and grain; is transmitted and disseminated through living plants and vegetative propagation material and by wind-driven rain; the alternative hosts are readily available and the commodity is commonly traded (moved), even though antagonisitic bacteria reported in the region have been reported as natural enemies. Also, there are no known vectors.
Economic impact	HIGH	The fact that up to 55% loses has been recorded in bean as a result of the pest, it is important to put measures to ensure the introduction, establishment and spread of the pest does not occur. This will safeguard the economic importance realised from bean production in view of this pest.
Overall Risk rating	HIGH	It is a quarantine pest and risk management is required.
Category (QP, RNQP, NRP)	QP	
Requires Risk Management (yes / no)	YES	

Table 21: Technical evaluation of risk factors for Cucumber Mosaic Virus

Pest	Cucumber Mosaic Virus	
Type	Virus	
Pathway	Seed for planting and grain for consumption	
Factors	**Overall Risk rating**	
Likelihood of Entry	High	Large volumes of bean which are frequently traded within EAC member states. Since CMV is seed transmitted and it causes a systemic infection in most host plants possibilities of entry into PRA area is most likely to be due to the fact that the pest is

		widespread in Tanzania and has been reported to be present in Kenya and Uganda. Most CMV strains are sometimes symptomless on host seeds therefore the reliable information that can be use by plant inspectors at the border posts are field inspection that has to confirm that the fields were inspected during active growth and found free from CMV. Since the beans can be sourced from different fields it is difficult to ascertain whether this condition was fulfilled. Majority of beans grain traded in the region are distributed in the small retails shop across the region
Likelihood of Establishment	High	CMV has a wide host range and it known to infect more than 800 species of both monocotyledonous and dicotyledonous plants from over 85 families. Control measures for CMV are mainly preventive. Since the conventional methods of virus control are difficult to apply due to the wide host range of CMV which infects many weeds that can act as virus reservoirs and infect crops in adjacent fields possibilities of the virus to establish in the PRA area is most likely to be high but negligible for grain.
Likelihood of Spread	High	Despite the fact that beans are mainly imported to urban area where are mainly used for human consumption. The virus can spread quickly due to the presence of wide suitable hosts and vectors in the PRA area. The virus is vector transmitted. Over 80 species of aphids can transmit CMV in a non-persistent manner. The most common aphid vectors are *Myzus persicae* and *Aphis gossypii* which are present in EAC region. Other known routes of virus transmission are by mechanical inoculation and through seed. Over 10% seed transmission has been recorded in the following species: *Echinocystis lobata, Glycine max, Lupinus angustifolius, Phaseolus vulgaris, Spergula arvensis, Stellaria media, Vigna radiata, Vigna unguiculata.*
Economic impact	High	There is no specific information currently available on yield-loss estimates in vegetables affected by CMV, but the total devastation has been reported in various crops Worldwide (Gallitelli, 2000). CMV has the widest host range of any virus and is one of the most damaging viruses of temperate agricultural crops worldwide (Gallitelli, 2000). It is also emerging as a major virus, especially in the tropics. It has devastated high-value vegetable.
Overall Risk rating	High	CMV is seed transmitted, it causes a systemic infection in most host plants possibilities of entry into PRA area is most likely due to the fact that the pest is widespread in Tanzania and has been reported to be present in Kenya and Uganda.

		The virus is vector transmitted. Over 80 species of aphids can transmit CMV in a non-persistent manner. The most common aphid vectors are *Myzus persicae* and *Aphis gossypii* which are present in EAC region. Other known routes of virus transmission are by mechanical inoculation of which bean seeds has been proved to transmit the virus. There is no specific information currently available on yield-loss estimates in vegetables affected by CMV, but the total devastation has been reported in various crops Worldwide (Gallitelli, 2000).
Category (QP, RNQP, NRP)	QP	
Requires Risk Management (yes / no)	YES	

Table 22: Technical evaluation of risk factors for *Callosobruchus chinensis*

Pest	***Callosobruchus chinensis*** (Linnaeus, 1758) Chinese bruchid	
Type (insect, fungus, virus etc)	Insect	
Pathway	Grain (for consumption) and seed	
Factors	**Overall Risk rating**	
Likelihood of Entry	Negligible	*C. chinensis* is a major pest of chickpeas, lentils, green gram, broad beans, soybean adzuki bean and cowpeas in various tropical regions. It also attacks other pulses on occasions, but appears to be incapable of developing on common beans (*Phaseolus vulgaris*) hence the PRA stops
Category (QP, RNQP, NRP)	NRP	
Requires Risk Management (yes / no)	No	

Table 23: Technical evaluation of risk factors for *Callosobruchus maculatus*

Pest	*Callosobruchus maculatus* (Fabricius,1775) (cowpea weevil)	
Type	Insect	
Pathway	Grain for consumption and seed for planting	
Factors	**Overall Risk rating**	

Likelihood of Entry	Negligible	The optimum development conditions for *C. maculatus* are around 32°C and 90% RH; the minimum development period for *C. maculatus* is about 21 days. *Callosobruchus maculates* has high probability to be introduced in the importing country because the temperature in warehouse and transport is favourable so the pest can survive during transport. However, alpha-amylase inhibitors prevent development of *C. maculatus* on a number of legumes including *Phaseolus vulgaris* hence the risk rating is negligible and the PRA stops.
Category (QP, RNQP, NRP)	NRP	
Requires Risk Management (yes / no)	No	

Table 24: Technical evaluation of risk factors for *Callosobruchus phaseoli*

Pest	*Callosobruchus phaseoli* (Gyllenhal 1833)	
Type	Insect	
Pathway	Grains and seed	
Factors	**Overall Risk rating**	
Likelihood of Entry	Negligible	*C. phaseoli* has been reported in Kenya, Tanzania and Uganda. Due to the fact that Rwanda and Burundi import huge quantity of beans from the mentioned countries, especially Uganda and Tanzania; there is a high risk of introduction of *C. Phaseoli* in Rwanda and Burundi. However, common beans are not known to be main host of the pest. *C. phaseoli* frequently attacks dolichos beans (*Lablab purpureus*) but is also found on cowpeas and green gram (CPC, 2015) hence PRA stops
Category (QP, RNQP, NRP)	NRP	
Requires Risk Management (yes / no)	No	

Table 25: Technical evaluation of risk factors for *Ditylenchus dipsaci*

Pest	*Ditylenchus dipsaci* Filip'ev, 1936 (stem and bulb nematode)
Type	Nematode
Pathway	Seed for planting and grain for consumption

Factors	Overall Risk rating	
Likelihood of Entry	**Medium**	Few occurrences have been reported in Kenya. Kenya exports an important quantity of bean seed in the region. Although, seed born incidence is low, the pest is seed transmitted. Considering the seed born aspect of the pest and is liable to be carried on dry seeds and planting material of host plants. Maximum activity and invasive ability are generally between 10 and 20°C, hence pest likely to survive transit.
Likelihood of Establishment	High	Environment conditions are conducive for the development of the pest as the maximum activity and invasive ability is generally between 10 and 20°C. In clay soils, *D. dipsaci* may persist for many years. Cool, moist conditions favour invasion of young plant tissue by this nematode. The pest is known to attack over 450 different plant species, including many weeds. Most of main hosts of the pest such as maize, Allium, pea, potato is grown in PRA area, thus the pest can be easily established.
Likelihood of Spread	Medium	In international trade *D. dipsaci* is liable to be carried on dry seeds and planting material of host plants. In the field the fourth-stage juvenile can withstand desiccation for many years, and although soil densities seem to decrease rapidly, the nematode can survive for years without a host plant. It can also survive on a number of weeds. Irrigation water and cultivation by contaminated farm tools and machinery are also sources of inoculum dissemination.
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.
Overall Risk rating	High	Likely to follow pathway and has high economic consequences
Category (QP, RNQP, NRP)	QP	
Requires Risk Management (yes / no)	Yes	

3.1 Overall Summary of Pest Risk Analysis results

The summary information on all pests assessed is in **Table 26.**

Table 26. Risk Analysis results for pests of concern to EAC region on bean grain/seed transited within EAC countries.

Pest	**Pest risk Analysis**						
	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)**
Cochliobolus lunatus (glume mould of rice)	High	Medium	Medium	Negligible	Negligible	NRP	NO
Cochliobolus sativus (root and foot rot)	Negligible PRA STOPS					NRP	No
Sclerotinia sclerotiorum (Lib) de Bary Cottony soft rot	Medium	Medium	Medium	Medium	Medium for seed but negligible for grain	QP	Yes
Lasiodiplodia theobromae (Pat) Griffiths & Maubl Syn (diplodia pod rot of cocoa)	Medium	Medium	Medium	Negligible	Negligible	NRP	No
Fusarium oxysporium fsp *phaseoli*	High	Medium	High	Low	Low for seed; Negligible for grain	QP	Yes
Fusarium solani fsp *phaseoli*	High	High	High	Low	Low for seed; Negligible for grain	QP	Yes
Choanephora cucurbitarum (Choanephora rot)	Low	Medium	Medium	Medium	Medium for seed but negligible for grain	QP	Yes
Alternaria brassicicola (dark leaf spot of cabbage)	High	High	Medium	Negligible	Negligible	NRP	No
Elsinoe phaseoli (Bean scab)	High	Moderate	High	High	High for seed but negligible for grain	QP	Yes
Alcidodes leucogrammus (Erichson) (Stripped bean weevil)	Negligible (PRA STOPS)					NRP	No

Bruchidius atrolineatus Pic	Negligible PRA stops					NRP	No
Callosobruchus analis (Fabricius) (bean weevil)	High	High	Medium	High	High	QP	Yes
Callosobruchus chinensis (Linnaeus, 1758) Chinese bruchid	Negligible PRA stops					NRP	No
Callosobruchus maculatus (Fabricius,1775) (cowpea weevil)	Negligible PRA stops					NRP	No
Callosobruchus phaseoli (Gyllenhal 1833)	Negligible PRA stops					NRP	No
Pseudomonas marginalis pv marginalis	Negligible PRA stops					NRP	No
Pseudomonas syringae pv. tabaci wildfire (beans)	Negligible PRA stops					NRP	No
Pseudomonas syringae pv. syringae van Hall 1902. Bacterial brown spot (beans)	High	High	Medium	High	High for seed but negligible for grain	QP	Yes
Alfalfa mosaic virus (Alfalfa yellow spot)	High	High	High	Negligible	Negligible	NRP	No
Bean Yellow Mosaic Virus	Negligible PRA Stops					NRP	No
Cucumber Mosaic Virus	High	High	High	High	High for seed but negligible for grain	QP	Yes
Ditylenchus dipsaci (Kühn,) Filip'ev stem, bulb nematode	Medium	High	Medium	High	High for seed but negligible for grain	QP	Yes

4.0: Pest Risk Management

4.1 Pest Risk Potential and Pests Requiring Phytosanitary Measures

The evaluation for introduction and the analysis of economic and environmental impacts is summarized in table 25 where a total of 9 pests comprising of One (**1) insect** (*Callosobruchus analis* (Fabricius) (bean weevil), one (**1) nematode** (*Ditylenchus dipsaci* (Kühn,) Filip'ev stem , bulb nematode), five (**5) fungi** (*Sclerotinia sclerotiorum* (Lib) de Bary Cottony soft rot, *Fusarium* *oxysporium* fsp *phaseoli, Fusarium solani* fsp *phaseoli, Choanephora cucurbitarum* (Choanephora rot) and *Elsinoe phaseoli* (Bean scab), one (**1) bacteria** (*Pseudomonas syringae pv. syringae* van Hall 1902. Bacterial brown spot (beans) and one **(1) virus** (Cucumber Mosaic Virus) were classified as quarantine pests requiring Phytosanitary measures/actions for bean seed and grain. However, all of these pests were found to have negligible overall risk in bean grain except *Callosobruchus analis* (bean weevil). However, according to McGuire and Sperling, 2015 and Tugume et al., 2019, grain is used as seed by small holder farmers in Africa to a tune of between 91-96% within the respective countries but there in literature indicating imported bean grain will be used for planting.

4.2 Table 27. Proposed Import conditions/Risk Management options for bean seeds

Pests	Proposed Phytosanitary measures
1. *Ditylenchus dipsaci* (Kühn,) Filip'ev stem, bulb nematode	Official statement that: -- the place of production is officially inspected and is known to be free from *Ditylenchus dipsaci* -- Seeds have been officially tested and found to be free from *D. dipsaci* prior to export -- Seeds maybe confined in a post-entry quarantine facility for monitoring NB: Details to be stated in the phytosanitary certificate
2. *Pseudomonas syringae pv. syringae* van Hall 1902. Bacterial brown spot (beans)	Official statement that: -The place of production is officially inspected and is known to be free from *Pseudomonas syringae pv. syringae* -The mother plants have undergone inspection and testing during active growth to confirm absence of *P. syringae pv. syringae*. -Seeds/grain have been officially tested and found to be free from *P. syringae pv. syringae* prior to export -Sampling and testing of seeds/grain to be done at the port of entry - Seeds may be confined in a post-entry quarantine facility for monitoring NB: Details to be stated in the phytosanitary certificate
3. *Sclerotinia sclerotiorum* (Lib) de Bary Cottony *4.* *Fusarium oxysporium* fsp *phaseoli* *5.* *Fusarium solani* fsp *phaseoli* *6.* *Choanephora cucurbitarum* (Choanephora rot) *7.* *Elsinoe phaseoli* (Bean scab)	Official statement that: -The mother plants have undergone inspection and testing during active growth to confirm absence of the listed fungi -Prior to export, the seeds/grain were appropriately treated to protect them from the said organisms. Seeds have been officially tested and found to be free from listed fungi prior to export -Sampling and testing of seeds/grain may be done at the port of entry NB: Details to be stated in the phytosanitary certificate
8. Cucumber Mosaic Virus	Official statement that:

	--Cucumber mosaic virus is not known to occur in the area of production --The mother plants were inspected during active growth and found free from Cucumber mosaic virus -Seeds have been officially tested and found to be free from Cucumber mosaic virus prior to export -Sampling and testing of seeds to be done at port of entry NB: Details to be stated in the phytosanitary certificate

4.3 Table 28. Proposed Import conditions/Risk Management options for bean grain

Pests	Proposed Phytosanitary measures
Callosobruchus analis (Fabricius) (bean weevil)	Official statement that: --The grains should only be used for consumption and processing. -- Prior to export, the grains should be appropriately treated to protect them from *Callosobruchus analis* and other inspect pest for beans. The grains should be fit for human consumption The consignment will be inspected at port of entry Condition of release: The importer must undertake in writing to guarantee to use the entire consignment of material imported (even where consists of small commercial samples) for processing or consumption only. NB: Details to be stated in the phytosanitary certificate

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USDA / APHIS / PPQ PEST ALERT:*Chrysodeixis chalcites* (Esper) (Lepidoptera: Noctuidae) Golden Twin Spot **http://iris.biosci.ohio-state.edu/pestalert/chalcites.html** Last acessed 14th October 2005

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