CSIR-FRI/RE/BBA/2005/015

Importation of Okra, *Abelmoschus esculentus* from Ghana into the United States

A Qualitative, Pathway-Initiated Risk Assessment

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Executive Summary

This risk assessment examined the risks associated with the importation of okra (*Abelmoschus esculentus*) from Ghana into the United States. Information on pests associated with okra in Ghana and neighboring countries revealed that six quarantine pests could potentially be introduced into the United States via this pathway. The quarantine pests likely to follow the pathway were all lepidopterous insects:

Cryptophlebia leucotreta (Meyrick) (Lepidoptera: Tortricidae)
Earias biplaga Walker (Lepidoptera: Noctuidae)
Earias insulana (Boisduval) (Lepidoptera: Noctuidae)
Helicoverpa armigera (Hubner) (Lepidoptera: Noctuidae)
Spodoptera littoralis (Boisduval) (Lepidoptera: Noctuidae)
Leucinodes orbonalis Guenee (Lepidoptera: Pyralidae)

The quarantine pests were analyzed qualitatively based on international principles and internal guidelines as described in the PPQ Guidelines for Pathway-Initiated Pest Risk Assessments, Version 5.02 (USDA APHIS, 2000). This document examined pest biology in the context of Consequences of Introduction and Likelihood of Introduction. These elements were used to estimate the Pest Risk Potential. All of these pests pose phytosanitary risks to American agriculture. Port-of-entry inspections, as a sole mitigation measure, are considered insufficient to safeguard U.S. agriculture from all of these pests, and additional phytosanitary measures are necessary to reduce risks to acceptable levels.

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A. Introduction

This risk assessment was prepared for the Animal and Plant Health Inspection Service, (APHIS), U. S. Department of Agriculture (USDA) through a working group meeting of Ghanaian risk analysts, APHIS PPQ analysts and APHIS PPD analysts held in Accra, Ghana May 23-June 3, 2005. This working meeting was sponsored by the PRA advisor to the USAID West Africa Regional Program. The original risk assessment draft from which this one proceeded was completed by the Ministry of Food and Agriculture (MoFA) of Ghana as a result of training provided under an USDA/ICD/APHIS and Ghana PPQ Project [ATRIP Agricultural Grades and Standard Activity (PASA #641-P00-00-0042)].

This is a qualitative pest risk assessment that expresses risk in terms of high, medium, or low. Importing a new commodity gives exotic pests a potential pathway into the United States; this risk assessment is "pathway-initiated" in response to that threat.

International plant protection organizations, such as the North American Plant Protection Organization (NAPPO) and 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 assessment are consistent with guidelines provided by NAPPO, IPPC, and FAO. Biological and phytosanitary terms (*e.g.*, *introduction*, *quarantine pest*) conform with the NAPPO Compendium of Phytosanitary Terms (Hopper, 1995) and the Definitions and Abbreviations (Introduction Section) in International Standards for Phytosanitary Measures: Guidelines for Pest Risk Analysis (FAO, 1996).

FAO (1996) defines *pest risk assessment* as "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; Hopper, 1995). Thus, pest risk assessments should consider both the consequences and likelihood of introduction of quarantine pests.

B. Risk Assessment

1. Initiating Event: Proposed Action

The USDA developed this risk assessment in response to a request by Ghana for a permit to import Okra (*Abelmoschus esculentus*) into the United States. The USDA has the authority to regulate imports of fruits and vegetables from foreign countries into the United States under Title 7, Part 319, Section 56 of the United States Code of Federal Regulations (7 CFR §319.56). The purpose of this risk assessment is to determine the likelihood that exotic plant pests would enter the United States with this commodity.

2. Assessment of Weed Potential of *Abelmoschus esculentus.*

This step examines the potential of the commodity to become a weed after it enters the United States (Table 1). If the assessment were to indicate significant weed potential, then a "pest-initiated" risk assessment would be conducted.

Table 1. Assessment of the Weed Potential of *Abelmoschus esculentus*

Commodity: Okra, Abelmoschus esculentus

Phase 1: Many varieties of *Abelmoschus esculentus* are widely cultivated in the United States.
Phase 2: Is the species listed in:

- No *Geographical Atlas of World Weeds* (Holm *et al.*, 1979)
- No *World's Worst Weeds: Natural History and Distribution* (Holm, 1997)
- No Report of the Technical Committee to Evaluate Noxious Weeds; Exotic Weeds for Federal Noxious Weed Act (Gunn and Ritchie, 1982)
- No *Economically Important Foreign Weeds* (Reed, 1977)
- No Weed Science Society of America list (WSSA, 1989)
- No Is there any literature reference indicating weed potential, *e.g.,* AGRICOLA, CAB, 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 weed potential, but that there are weeds associated with the cultivation of *Abelmoschus esculentus*.

Phase 3: The literature indicates that *Abelmoschus esculentus* is not likely to become a weed in the United States because of imports from Ghana.

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

Decision History for *Abelmoschus esculentus* from Africa

1992. Okra from Nigeria. The request was denied because no approved treatment existed. The chief pests of concern were *Pectinophora gossypiella, Helicoverpa armigera*, and *Cryptophlebia leucotreta.*

1991. Okra from Senegal. The request was denied because of "Lack of pest data and quarantine treatment." The decision listed *Bactrocera ciliatus, Pectinophora gossypiella, Helicoverpa armigera,* and *Cryptophlebia leucotreta* as the chief pests of concern.

1989. Okra from Sierra Leone. The request was denied because of no treatments for *Earias insulana.* The decision also mentioned *Pectinophora gossypiella* as a pest of concern.

1989. Okra from Liberia. The request was denied because of "No acceptable treatment for a complex of exotic insect pests." The decision listed internal feeders such as *Earias insulana*, for which there was no treatment, and *Pectinophora gossypiella.*

Pest Interceptions

Between 1985 and 2004, U.S. agricultural inspectors intercepted numerous pests of okra, generally from passenger baggage (PIN, 2003). The following is a list of pests that were intercepted both on *Abelmoschus esculentus* from anywhere in the world and from Ghana on any commodity.

Pest	Interceptions on okra worldwide	Interception from West Africa on any commodity
Pectinophora gossypiella (Saunders) (Lepidoptera: Gelechiidae)	1,602	8
Earias sp. (Lepidoptera: Noctuidae)	101	40
Earias insulana (Boisduval) (Lepidoptera: Noctuidae)	95	11
Helicoverpa sp. (Lepidoptera: Noctuidae)	30	79
Hypothenemus sp. (Coleoptera: Scolytidae)	16	38

Pest	Interceptions on okra worldwide	Interception from West Africa on any commodity
Heliothis sp. (Lepidoptera: Noctuidae)	7	64
Cladosporium sp. (Fungi:)	7	25
Cryptophlebia sp. (Lepidoptera: Tortricidae)	6	1003
Aleurodicus dispersus Russell (Homoptera: Aleyrodidae)	5	8
Ceratitis capitata (Wiedemann) (Diptera: Tephritidae)	4	89
Helicoverpa armigera (Hubner) (Lepidoptera: Noctuidae)	4	4
Leucinodes orbonalis Guenee (Lepidoptera: Pyralidae)	4	3365
Diaphania sp. (Lepidoptera: Crambidae)	3	53
Spodoptera sp. (Lepidoptera: Noctuidae)	3	11

4. Pest Categorization–Identification of Quarantine Pests and Quarantine Pests Likely to Follow the Pathway

Common pests that are associated with *Abelmoschus esculentus* and occur in Ghana are listed in Table 2. This list includes information on the presence or absence of these pests in the United States, the affected plant part(s), the quarantine status of the pest with respect to the United States, pest-host association, and pertinent references for pest distribution and biology.

Pests identified only to genus or higher taxa were not considered for further analysis. Genera can contain many species; it is unrealistic to analyze an entire genus in which many species may not be pests. If pests identified only to higher taxa are intercepted in the future, the USDA may re-evaluate their risk. Intercepted pests are sometimes not identified to the species level because the current taxonomic knowledge is limited, the pest is too immature, or the specimen is in poor condition. By necessity, pest risk assessments focus on the organisms for which biological information is available. The lack of identification at the species level does not rule out the possibility that a high-risk quarantine pest was intercepted, or that the intercepted pest was not a quarantine pest. Conversely, detailed assessments for known pests that inhabit a variety of ecological niches, such as the surfaces or interiors of fruit, stems or roots, allow effective mitigation measures to eliminate the known organisms as well as similar, but incompletely identified organisms that inhabit the same niche.

Table 2. Pests commonly associated with *Abelmoschus esculentus* in Ghana

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Acari						
Tenuipalpidae						
Brevipalpus californicus (Banks)	SG	HI US	F, L, S	No	Yes	CABI, 2004

1 BF = Burkina Faso; BN = Benin; CI = Côte d'Ivoire; CM = Cameroun; CV = Cape Verde; FL = Florida; GH = Ghana; GM = Gambia;GU = Guinea; LB = Liberia; ML = Mali;MT = Mauritania; NG = Nigeria; NR = Niger; PR = Puerto Rico; SL = Sierra Leone; SN = Senegal; STP = Sao Tome & Principe; TG = Togo; US = United States; VI = Virgin Islands

2 F = Fruits; Fw = Flower; L = Leaves; = Roots; S = Stems; Sd = Seeds; W = whole plants (directly or indirectly as a result or crown or root destruction).

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Tetranychidae						
Eutetranychus orientalis Klein	CV NG SG		L	Yes	No	CABI, 2004
Oligonychus gossypii (Zacher)	GH BE NG		L, S, W	Yes	No	Bolland *et al.*, 1998
Tetranychus cinnabarinus (Boisduval)	CV TG	HI US	F, L, S, W	No	Yes	CABI, 2004
Tetranychus sp.	GM NG		F,L	Yes	Yes	PIN, 2003
Tetranychus urticae Koch	SL	US	L	No	No	CABI, 2004
Coleoptera						
Bruchidae						
Spermophagus sp.	BF CV LB		Sd	Yes	No	PIN, 2003
Chrysomelidae						
Epilachna similis Thunberg						
Podagrica sjostedti Jacoby	GB GH NG SG		L	Yes	No	CABI, 2004; Cobbinah and Osei-Owusu, 1988; Vanlommel *et al.*, 1996
Podagrica uniformis (Jacoby)	GH NG		L	Yes	No	Obeng-Ofori and Sackey, 2003; Vanlommel *et al.*, 1996
Curculionidae						
Apion sp.	GM NG SN		F,Fw	Yes	No[3]	PIN, 2003
Dermestidae						
Trogoderma granarium Everts	ML NG SN		S	Yes	No	PIN, 2003
Elateridae						
Conoderus sp.	LB		F	Yes	No[4]	PIN, 2003
Meloidae						
Mylabris temporalis	GH		L	Yes	No	Obeng-Ofori and Sackey, 2003
Mylabris trifasciata	GH		L	Yes	No	Obeng-Ofori and Sackey, 2003
Scolytidae						
Hypothenemus sp.	CI GH LB NG		F	Yes	No	PIN, 2003

3 Apion sp. was never intercepted on fruits from West Africa, intercepted only once on cutflowers from Ghana since 1985 PIN, 2003)

4 Not a known pest of okra in West Africa. There are no convincing published studies of this with supporting expert taxonomic identification (CABI, 2004).

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Tetranychidae						
Eutetranychus orientalis Klein	CV NG SG		L	Yes	No	CABI, 2004
Oligonychus gossypii (Zacher)	GH BE NG		L, S, W	Yes	No	Bolland *et al.*, 1998
Tetranychus cinnabarinus (Boisduval)	CV TG	HI US	F, L, S, W	No	Yes	CABI, 2004
Tetranychus sp.	GM NG		F,L	Yes	Yes	PIN, 2003
Tetranychus urticae Koch	SL	US	L	No	No	CABI, 2004
Coleoptera						
Bruchidae						
Spermophagus sp.	BF CV LB		Sd	Yes	No	PIN, 2003
Chrysomelidae						
Epilachna similis Thunberg						
Podagrica sjostedti Jacoby	GB GH NG SG		L	Yes	No	CABI, 2004; Cobbinah and Osei-Owusu, 1988; Vanlommel *et al.*, 1996
Podagrica uniformis (Jacoby)	GH NG		L	Yes	No	Obeng-Ofori and Sackey, 2003; Vanlommel *et al.*, 1996
Curculionidae						
Apion sp.	GM NG SN		F,Fw	Yes	No[3]	PIN, 2003
Dermestidae						
Trogoderma granarium Everts	ML NG SN		S	Yes	No	PIN, 2003
Elateridae						
Conoderus sp.	LB		F	Yes	No[4]	PIN, 2003
Meloidae						
Mylabris temporalis	GH		L	Yes	No	Obeng-Ofori and Sackey, 2003
Mylabris trifasciata	GH		L	Yes	No	Obeng-Ofori and Sackey, 2003
Scolytidae						
Hypothenemus sp.	CI GH LB NG		F	Yes	No	PIN, 2003

3 Apion sp. was never intercepted on fruits from West Africa, intercepted only once on cutflowers from Ghana since 1985 PIN, 2003)
4 Not a known pest of okra in West Africa. There are no convincing published studies of this with supporting expert taxonomic identification (CABI, 2004).

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Tenebrionidae						
Lagria cuprina			L	Yes	No	Obeng-Ofori and Sackey, 2003
Lagria villosa Fabricius	GH		L	Yes	No	Obeng-Ofori and Sackey, 2003
Coleoptera						
Scarabaeidae						
Pachnoda interrupta (Olivier)	ML NG SG		F, R, Sd	Yes	No	CABI, 2004
Diptera						
Agromyzidae						
Liriomyza sativae Blanchard	NG	HI US GU PR	L	No	No	CABI, 2004
Liriomyza trifolii Burgess in Comstock, 1880	BN CI GU NG SG	HI US VI GU PR	L	No	No	CABI, 2004
Cecidomyiidae						
Contarinia sp.	GH NG		F,Fw	Yes	No[5]	PIN, 2003
Muscidae						
Atherigona orientalis Schiner	BF BN CV CI GH ML NR SL SG TG	HI US GU PR	F, Fw, L, Sd ,S, R, W	No	No	CABI, 2004
Tephritidae						
Ceratitis capitata (Wiedemann)	CV CI GM GH GU LB NG SN		F	Yes	No[6]	PIN, 2003
Hemiptera						
Aleyrodidae						
Bemisia tabaci Gennadius	BF BN CV CI GM GH GU NG SL SG TG	HI US GU PR	L	No	No	CABI, 2004
Aphididae						
Aphis gossypii Glover, 1877	BF CV CI GM GU ML NR NG SL SG TG	HI US GU NMI PR	F,FW,S,W	No	No	CABI, 2004
Myzus persicae Sulzer (1776)	BN CI GH NG SL	HI US PR	Fw, L, S, W	No	No	CABI, 2004

5 Not a known pest of West Africa. Never intercepted on fruits from West Africa, intercepted only once on cut flowers from Ghana since 1985 PIN, 2003.

6 Not a known pest of okra. Only four insect interceptions but never from west africa PIN, 2003

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Cicadellidae						
Amrasca biguttula biguttula Ishida = *Empoasca davastans* (Distant)	GH		L, S	Yes	No	CABI, 2004; Obeng-Ofori and Sackey, 2003
Coccidae						
Parasaissetia nigra (Nietner)	GH		L, S	Yes	No	Ben-Dov, 1993; Ben-Dov *et al.*, 2004; CABI, 2004; Hill, 1994
Saissetia coffeae (Walker)	CV CI GH NG SL TG	HI US VI GU PR	L, S	No	No	CABI, 2004
Diaspididae						
Aonidiella aurantii (Maskell)	GU	US PR	F, L., S	No	Yes	CABI, 2004
Pseudaulacaspis pentagona (Targioni-Tozzetti)	CV GH	US VI GU PR	L, R, S, W	No	No	CABI, 2004
Pentatomidae						
Hotea subfasciata	GH		S	Yes	No	Leston, 1972
Nezara viridula (Linnaeus)	BF BN CV CI GH GU ML NR NG SL SG TG	HI US VI GU PR	F,Fw, Sd, R, S	No	Yes	CABI, 2004
Pseudococcidae						
Ferrisia virgata (Cockerell)	CI GH GU NG SL SG TG	HI US VI PR	F, L, S	No	No	CABI, 2004
Maconellicoccus hirsutus (Green)	BF BN CI GM LB LB NR NG SG	HI US(FL) VI GU PR	F, Fw, L, S	Yes	No[7]	CABI, 2004
Phenacoccus sp.	NG		F	Yes	No[8]	PIN, 2003

7 Never intercepted on fruits from West Africa, intercepted only thrice on fruits from the Caribbean PIN, 2003.
8 Easy to detect and cull infested fruit CABI, 2004.

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Pyrrhocoridae						
Dysdercus superstitiosus (Fabricius)	GH, NG		Fw, Sd	Yes	No	Obeng-Ofori and Sackey, 2003
Lepidoptera						
Gelechiidae						
Pectinophora gossypiella (Saunders)	BF BN CI GH ML NR NG SL SG TG	HI US VI NMI PR	F, Fw	No	Yes	CABI, 2004
Noctuidae						
Agrotis ipsilon Hufnagel	BF BN CI LB LB ML SG TG	HI US	F, L, S, W	No	No	CABI, 2004
Agrotis segetum (Denis & Schiffermuller)	BN CV CI ML SG TG		L, R, S	Yes	No	CABI, 2004
Anomis flava Fabricius	GH	US	L	No	No	CABI, 2004; Hill, 1994; Pogue, 2004; Zhang, 1994
Earias biplaga Walker	BF BN CI GH GU ML NR NG SL TG		F, Sd, W	Yes	Yes	CABI, 2004
Earias insulana (Boisduval)	BF BN CI GH GU ML NR NG SL SG TG		F,Fw,L, S	Yes	Yes	CABI, 2004
Earias sp.	GH		F	Yes	Yes	PIN, 2003
Helicoverpa armigera (Hübner)	BF BN CV CI GM GH GU ML NR NG SL SG TG		F, Fw , L	Yes	Yes	CABI, 2004
Helicoverpa sp.	GH		F	Yes	Yes	PIN, 2003
Spodoptera exigua (Hübner)	BF BN CI GH GU ML NR SG TG	HI US	F, Fw, L	No	Yes	CABI, 2004
Spodoptera littoralis (Boisduval)	BF BN CV CI GM GH GU ML NR NG SL SG TG		F, L	Yes	No	CABI, 2004
Trichoplusia ni (Hübner)	CV GM NG SG	HI US VI PR	L, W	No	No	CABI, 2004

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Pyralidae						
Haritalodes derogata (Fabricius)	BF BN CI GH ML NR NG SL SG TG		L	Yes	No	CABI, 2004
Leucinodes orbonalis Guenee	GH SL NG		F	Yes	Yes	CABI, 2004
Pyralidae sp.	GH		F	Yes	Yes	PIN, 2003
Sylepta derogata	GH		L	Yes	No	Cobbinah and Osei-Owusu, 1988; Obeng-Ofori and Sackey, 2003
Tortricidae						
Cryptophlebia leucotreta (Meyrick)	BF BN CV CI GM GH ML NR NG SL SG TG		F, L, Sd	Yes	Yes	CABI, 2004
Cryptophlebia sp.	GH NG TG		F	Yes	Yes	PIN, 2003
Orthoptera						
Acrididae						
Diabolocatantops axillaris (Thunberg)	BF BN CV GH GU ML NR NG SG		F,Fw,L, R,	Yes	No	CABI, 2004
Zonocerus variegatus (L.)	BF BN Chad CV GH GU LB ML NR NG SG SL TG		F, Fw, L, S, Sd, W	Yes	No	CABI, 2004; Obeng-Ofori and Sackey, 2003
Thysanoptera						
Thripidae						
Scirtothrips aurantii Faure	GH		L, S	Yes	No	PIN, 2003
Thrips hawaiiensis (Morgan)	NG SL	HI US GU	F,Fw, L	No	Yes	CABI, 2004
Nematode						
Hoplolaimidae						
Helicotylenchus dihystera (Cobb) Sher	BF CI LB LB NG SG	HI US PR	L, R, W	No	No	CABI, 2004
Scutellonema bradys (Steiner & Lehew) Andrassy	CI GM GH GU NG SG TG	US PR	R	No	No	CABI, 2004

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Scutellonema clathricaudatum Whitehead	BF BN CI ML NR NG SL		L, R. W	Yes	No	CABI, 2004
Rotylenchulus reniformis Linford & Oliveira	GH	US	R	No	No	Potter and Olthof, 1990CABI, 2004
Longidoridae						
Xiphinema ifacolum Luc	CI GU LB LB SL		L, R, W	Yes	No	CABI, 2004
Meloidogynidae						
Meloidogyne arenaria (Neal) Chitwood	CI GM GH LB LB NG SG	HI US PR	L, R, W	No	No	CABI, 2004
Meloidogyne incognita (Kofoid & White) Chitwood	BF CI GM GH GU LB LB NR NG SG	HI US PR	L, R, W	No	No	CABI, 2004
Meloidogyne javanica (Treub) Chitwood	CI GM GH LB LB NG SG	HI US PR	L, R, W	No	No	CABI, 2004
Pratylenchidae						
Hirschmanniella oryzae (van Breda de Haan) Luc&Goodey	CI GM GH GU NR NG SL SG	US	L, R, W	No	No	CABI, 2004
Pratylenchus brachyurus (Godfrey) Filipjev & Schuurmans Stekhoven	BN CI GM GU NG SG TG	HI US PR	L, R, Sd, W	No	No	CABI, 2004
Pratylenchus loosi Loof. (Tylenchida: Pratylenchidae)	SG		L, R. S. W	Yes	No	CABI, 2004
Pratylenchus penetrans (Cobb)	NG	US	L,R ,W	No	No	CABI, 2004
Fungi						
Alternaria brassicae (Berk.) Sacc.	CI SG	HI US PR	F, Fw, L, Sd.S, W	No	Yes	CABI, 2004
Armillaria mellea (Vahl) P. Kumm.	GH	US	R	No	No	Oduro, 1998
Aspergillus niger Tiegh.	BF CI GU NR NG	US PR	F, Fw, L, Sd. S, R, W	No	Yes	CABI, 2004

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Botryodiplodia theobromae (Pat.) Griffiths & Maubl. [anamorph]	West Africa	US	F	No	Yes	CABI, 2004; Oduro, 1998
Cercospora hibiscina	GH		L	Yes	No	Oduro, 1998
Cercospora malayensis F.Stev. & Solh.	GH		L	Yes	No	CABI, 2004; Oduro, 1998
Cercospora sp.	GH	US	L	No	No	Oduro, 1998
Choanephora cucurbitarum (Berk. & Ravenel)	BN NG SG	US PR	F,Fw,Sd,L, S,W	No	Yes	CABI, 2004; Oduro, 1998
Cladosporium sp.	Chad GH GU LB NG SN		F	Yes	No[9]	PIN, 2003
Cochliobolus lunatus R.R. Nelson & Haasis	BF BN GH NR NG	HI US PR	Fw, L, Sd	No	Yes	CABI, 2004
Colletotrichum sp.	GH GU LB NG		F	Yes	Yes	PIN, 2003
Colletotrichum dematium (Pers.) Grove	BF NR NG	US PR	F	No	Yes	CABI, 2004
Colletotrichum lindemuthianum (Sacc. & Magnus) Briosi & Cavara	GH	US	F S Sd	No	Yes	Gonzalez-Chavira *et al.*, 2004; Oduro, 1998
Corynespora cassiicola	GH	US	L, Sd	No	Yes	Oduro, 1998
Fusarium oxysporum Schlecht.	BF BN CI GH GU ML NR NG SL SG TG	HI US VI GU PR	L, W	No	No	CABI, 2004
Fusarium pallidoroseum (Cooke) Sacc. = F. semitectum Berk. & Rav.	GH	US	F, L	No	Yes	Oduro, 1998
Irinopsis aciculosa	GH		L	Yes	No	Oduro, 1998

9 Leaf spot. If it is a scab, fruit can be culled through casual inspection.

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Lasiodiplodia theobromae (Pat.) Griffon & Maubl. = *Botryodiplodia theobromae* Pat., = Diplodianatalensis Pole-Evans, teleomorph = Physalospora rhodina (Berkeley & Curtis) Cooke	BF GM GH GU NG SG TG	US GU PR	F,Fw, L, S, Sd	No	Yes	CABI, 2004
Leveillula taurica (Lév.) G. Arnaud	CI GM GH GU NR NG SL SG TG	HI US PR	L, S	No	Yes	CABI, 2004
Macrophomina phaseolina (Tassi) Goid	BF BN CI GM NR NG SL SG TG	US PR	L, R, Sd, S, W	No	No	CABI, 2004
Nectria haematococca Berk. & Broome	GH	US	L,S,R,W	No	No	CABI, 2004
Oidium abelmoschi Thuem.	GH	US	L, S	No	No	Farr *et al.*, 2004
Penicillium digitatum (Pers.: Fr.) Sacc.	NG	US	F	No	Yes	CABI, 2004
Phomopsis longicolla Hobbs	SG	US PR	F,Sd	No	Yes	CABI, 2004
Pseudocercospora abelmoschi (Ellis & Everh.) Deighton	GH	US	L	No	No	Farr *et al.*, 1989; MoFA, 2000
Puccinia sp.	NG		F	Yes	Yes	PIN, 2003
Pythium aphanidermatum (Edson) Fitzp.	CI GH ML NG SL SG TG	HI US PR	R, W	No	No	CABI, 2004
Sclerotinia sclerotiorum (Lib.) de Bary	NG	HI US	F, Fw, L, R, Sd. W	No	Yes	CABI, 2004
Verticillium dahliae Kleb.	NG	US	L, S, W	No	No	CABI, 2004

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Virus						
Cotton leaf curl virus	BK BN CI GH NG NR TG		L	Yes	No	CABI, 2004; Oduro, 1998
Cucumber Mosaic Virus	CI GH NG SL TG	HI US PR	F, L, W	No	No	CABI, 2004
Hibiscus yellow vein mosaic	GH		L	Yes	No	Oduro, 1998
Okra leaf curl virus	GH		W	Yes	No	Brunt *et al.*, 1996+; N' Guessan *et al.*, 1992
Okra mosaic virus	NG			Yes		Vanlommel *et al.*, 1996

Quarantine Pests Selected for Further Analysis.

Cryptophlebia leucotreta (Meyrick) (Lepidoptera: Tortricidae)
Earias biplaga Walker (Lepidoptera: Noctuidae)
Earias insulana (Boisduval) (Lepidoptera: Noctuidae)
Helicoverpa armigera (Hubner) (Lepidoptera: Noctuidae)
Spodoptera littoralis (Boisduval) (Lepidoptera: Noctuidae)
Leucinodes orbonalis Guenee (Lepidoptera: Pyralidae)

5. 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. For each risk element, pests are assigned a rating of Low (1 point), Medium (2 points) or High (3 points) (USDA, 2000). A Cumulative Risk Rating is then calculated by summing all risk element values. The values determined for the Consequences of Introduction for each pest are summarized in Table 3.

The major sources of uncertainty in this risk assessment are similar to those in other risk assessments: the use of a developing process (Orr *et al.*, 1993; USDA, 2000), the approach used to combine risk elements (Bier, 1999; Morgan and Henrion, 1990), and the evaluation of risk by comparisons to lists of factors within the guidelines (Orr *et al.*, 1993). To address this last source of uncertainty, of factor lists were interpreted as illustrative and not exhaustive. Other traditionally recognized sources of uncertainty are the quality of the biological information (Gallegos and Bonano, 1993), which includes uncertainty whenever biological information is lacking on the regional flora and fauna. Inherent biological variation within a population of organisms also introduces uncertainty (Morgan and Henrion, 1990).

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 U.S. "Plant Hardiness Zones" in which the species might achieve pest status (USDA, 1990). Risk ratings are based on the following criteria:

Low (1): the species is only likely to become established in one hardiness zone
Medium (2): the species is likely to become established in two or three hardiness zones
High (3): the species is likely to become established in four or more hardiness 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. In the context of the National Environmental Policy Act (NEPA) (7CFR§372), significance is qualitative and encompasses the likelihood and severity of an environmental impact. The act describes an environmental pest as: "expected to have direct impacts on species listed by Federal Agencies as endangered or threatened (50CFR§17.11 and §17.12), by infesting/infecting a listed plant. If the pest attacks other species within the genus or other genera within the family, and preference/no preference tests have not been conducted with the listed plant and the pest, then the plant is assumed to be a host; pest is expected to have indirect impacts on species listed by Federal Agencies as endangered or threatened 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.

Consequences of Introduction: *Cryptophlebia leucotreta* Meyrick (Lepidoptera: Tortricidae)	**Risk Value**
Risk Element #1: Climate – Host Interaction *Cryptophlebia leucotreta* is distributed throughout Africa (CABI, 2004). Its occurrence corresponds with U.S. Plant Hardiness Zones 9-11 (USDA, 1990).	Medium (2)
Risk Element #2: Host Range There are more than 70 species identified as host species to *C. leucotreta* (CABI, 2004). Primary species include Rutaceae (*Citrus* spp., *Citrus sinensis*), Malvaceae (*Gossypium* spp., *Abelmoschus esculentus*, *Abutilon hybridum*), Poaceae (*Zea mays*, *Sorghum*), Euphorbiaceae (*Ricinus communis*), Theaceae (*Camellia sinensis*), Lauraceae (*Persea Americana*), Myrtaceae (*Psidium guajava*), Oxalidaceae (*Averrhoa carambola*), Bromeliaceae (*Ananas comosus*), Annonaceae (*Annona muricata*), Bombacaceae (*Ceiba pentandra*), Rubiaceae (*Coffea Arabica*), Solanaceae (*Capsicum*), Sapindaceae (*Litchi chinensis*), Anacardiaceae (*Mangifera indica*), Oleaceae (*Olea europaea* subsp. *europaea*), Rosaceae (*Prunus persica*), Punicaceae (*Punica granatum*), and Proteaceae (*Macadamia* spp., *Macadamia ternifolia*).	High (3)
Risk Element #3: Dispersal Potential Females can lay between 100 – 400 eggs overnight (CABI, 2004), and typically lay 12 eggs per fruit (Bedford *et al.*, 1998). It is rare for them to lay more than 20 eggs per fruit; however, 65 eggs have been observed on a single fruit (Bedford *et al.*, 1998). Survival of the first instar is temperature dependent (low winter temperatures can be lethal) (Bedford *et al.*, 1998). The life cycle varies with the season, although *C. leucotreta* typically has 2-3 generations per year (Bedford *et al.*, 1998). Adults are attracted to light (CABI, 2004). Larvae can be internationally transported via fruit, pods, inflorescence and cones (CABI, 2004).	High (3)

Risk Element #4: Economic Impact *Cryptophlebia leucotreta* is a serious pest of South African citrus. Losses in late crop of cotton ranges between 42-90% in Uganda. (CABI, 2004). Host species include several important crops, and the damages caused by this species would be high once it is introduced and established in the United States. In 2002, U.S. cotton production was worth more than $3593 million (NASS, 2003). In addition to cotton species, citrus and corn production for the year 2002 in U.S. Plant Hardiness Zones 9-12 valued at $2605 million and $1040 million, respectively (NASS, 2003). In South Africa, crop damages can be as high as 50% on citrus species (Bedford *et al.*, 1998).	High (3)
Risk Element #5: Environmental Impact This species has a potential to attack Endangered and Threatened species, such as *Quercus hinckleyi* (TX) (USFWS, 2002). There are several controls available; however, it is difficult to establish effective controls because the moth has many alternative hosts (CABI, 2004). Introduction and establishment of *C. leucotreta* in the United States would stimulate chemical or biological control programs.	High (3)

Consequences of Introduction: *Earias biplaga* (Lepidoptera: Noctuidae)	Risk Value
Risk Element #1: Climate – Host Interaction *Earias biplaga* occurs in USDA Plant Hardiness Zones 9-13, ranging throughout Africa (CABI, 2004; USDA, 1990).	Medium[10] (2)
Risk Element #2: Host Range This insect has multiple hosts in the family Malvaceae, and others in the families Bombacaceae and Sterculiaceae (CABI, 2004).	High (3)
Risk Element #3: Dispersal Potential Noctuid moths are generally strong fliers capable of flying miles in one night (Rochester *et al.*, 2002). Females of E. biplaga lay from 100-400 eggs (CABI, 2004).	High (3)
Risk Element #4: Economic Impact *Earias biplaga* is a pest of okra, cotton, and cocoa in Africa (CABI, 2004). This insect has the potential to lower yields and increase the cost of production for U.S. cotton growers if it should become established in the United States. In 2002, U.S. cotton production was worth more than $3,593 million (NASS, 1997).	High (3)
Risk Element #5: Environmental Impact *Earias biplaga* feeds on hosts in the genus *Hibiscus*, which contain endangered species in Hawaii. These endangered species are: *Hibiscus arnottianus ssp. immaculatus, H. brackenridgei, H. clayi,* and *H. waimeae ssp. hannerae.* Chemical controls are available to control E. biplaga. Introduction and establishment of E. biplaga may stimulate chemical controls in the United States.	High (3)

10 Although Plant Hardiness Zones cover more than 3 zones, climate-host interaction is rated medium because Plant Zones 9-13 are tropical zones.

Consequences of Introduction: *Earias insulana* (Lepidoptera: Noctuidae)	Risk Value
Risk Element #1: Climate – Host Interaction *Earias insulana* occurs in USDA Plant Hardiness Zones 6-13, ranging throughout Africa, southern Europe, and southeast Asia (CABI, 2004).	High (3)
Risk Element #2: Host Range This insect feeds on multiple hosts in the families Malvaceae and Poaceae (CABI, 2004).	High (3)
Risk Element #3: Dispersal Potential Noctuid moths are generally strong fliers capable of flying miles in one night (Rochester *et al.*, 2002). Females of *E. insulana* lay an average of 128.4 eggs in one study Anwar *et al.*, 1973.	High (3)
Risk Element #4: Economic Impact *Earias insulana* is a pest of cotton in Pakistan (Chamberlain *et al.*, 1993), Egypt (Rashad and Ammar, 1984) and India (Dhawan *et al.*, 1992) as well as being a pest of okra and other members of the family Malvaceae (CABI, 2004). This insect has the potential to lower yields and increase the cost of production for U.S. cotton growers if it should become established in the United States. In 2002, U.S. cotton production was worth more than $3,593 million (NASS, 1997).	High (3)
Risk Element #5: Environmental Impact *Earias insulana* feeds on hosts in two genera, *Abutilon* and *Hibiscus*, which contain endangered species in Hawaii. These endangered species are: *Abutilon eremitopetalum, A. menziesii, A. sandwicense, Hibiscus arnottianus ssp. immaculatus, H. brackenridgei, H. clayi,* and *H. waimeae ssp. hannerae.* There are number of studies to examine methods and effectiveness of controls, such as cultural, host-resistant, biological, and chemical controls. In Egypt, India, and Yemen Democratic Republic, integrated pest management programs were established. Introduction and establishment of *E. insulana* may stimulate chemical and biological controls in the United States.	High (3)

Consequences of Introduction: *Helicoverpa armigera* (Lepidoptera: Noctuidae)	Risk Value
Risk Element #1: Climate – Host Interaction Climate-Host Interaction, This insect is widely distributed and known to occur in all parts of Europe, Middle East, Central and South Asia, Far East, Africa, Australia, and Oceania (CABI, 2003). Establishment is possible in U.S. Plant Hardiness Zones 5-11.	High (3)
Risk Element #2: Host Range *Helicoverpa armigera* is polyphagous. It infests crop and non-crop hosts representing over 10 genera and over four families (Zhang, 1994). It is a major pest of cotton (*Gossypium* spp.), pigeon pea (*Cajanus cajan*), chickpea (*Cicer arietinum*), tomato (*Lycopersicum esculentum*), sorghum (*Sorghum* spp.) and cowpea (*Vigna unguiculata*). Other hosts include groundnut (*Arachis hypogaea*), okra (*Abelmoschus esculentus*), peas (*Pisum sativum*), soybeans (*Glycine max*), other legumes, tobacco (*Nicotiana tabacum*), potatoes (*Solanum tuberosum*), maize (*Zea mays*), flax (*Linu.n usitatissimum*), a number of fruits (*Prunus* spp. and *Citrus* spp.), forest trees and a range of vegetable crops (CABI, 2004).	High (3)

Risk Element #3: Dispersal Potential	
Risk Element #3: Dispersal Potential As with other noctuids, the pest is capable of flying long distances of many miles to disperse. Internal larvae may be dispersed long distances in fruits (CABI, 2004). Females may lay over 700 eggs during their lifetime and there may be up to six generations per year (CABI, 2004) and may produce two to six generations depending on the climatic conditions (Smith *et al.*, 1997). Larvae have limited mobility, but adults are capable of flight (CABI, 2004; Smith *et al.*, 1997).	High (3)
Risk Element #4: Economic Impact Economic Impact, Larvae are major pests of tomato, maize, cotton, and other crops (CABI, 2004), becoming major pests if they establish. For example, in India, losses of up to 50% of the potato crop have been recorded (CABI, 2004). As an A2 pest for Europe, establishment in the United States could lead to loss of export markets (EPPO, 2003).	High (3)
Risk Element #5: Environmental Impact A wide range of wild plant species support larval development of *H. armigera*. Among others, larvae can feed on the genera *Allium*, *Amaranthus*, *Helianthus*, *Helianthus*, *Prunus, Solanum,* and *Vigna* (CABI, 2004), which contain threatened or endangered species (USFWS, 2002). *Helicoverpa armigera* is very similar to *H. virescens* in phylogeny and in behavior (Farrow and Daly, 1987). *Heliothis virescens* is widespread in the United States so it is unlikely that the introduction of the similar species, *H. armigera*, would have a large environmental impact.	Medium (2)

Consequences of Introduction: *Spodoptera littoralis* (Lepidoptera: Noctuidae)	**Risk Value**
Risk Element #1: Climate – Host Interaction Climate-Host Interaction, This insect is found in Africa, southern Europe, and the Middle East (CABI, 2004). It could become established in U.S. Plant Hardiness Zones 8-11.	High (3)
Risk Element #2: Host Range The host range of *S. littoralis* covers over 40 families, containing at least 87 species of plants of economic importance (CABI, 2004). For example: cotton (*Gossypium spp.*), tobacco (*Nicotiana tabacum*), potato (*Solanum tuberosum*), tomato (*Lycopersicum esculentum*), onion (*Allium cepa*), citrus (*Citrus spp.*), beans (P*haseolus spp.*), carrots (*Daucus carota*), peppers (*Capsicum annuum*), grapes (*Vitis spp.*), alfalfa (*Medicago sativa*) and various grasses (CABI, 2004).	High (3)
Risk Element #3: Dispersal Potential Noctuids can disperse over long distances (Farrow and Daly, 1987). Adult *S. litttoralis* fly at night, with a flight range of 1.5 km in a 4-hour period (CABI, 2004). In optimal climates, the pest can have up to 7 overlapping generations per year, with an average of 20-1000 eggs produced by each female (CABI, 2004).	High (3)
Risk Element #4: Economic Impact *Spodoptera littoralis* is one of the most destructive agricultural lepidopterous pests within this subtropical and tropical range (CABI, 2004). It can attack numerous economically important crops throughout the year. It lowers crop yield, increases production costs, and will cause market loss as a new quarantine pest.	High (3)

Risk Element #5: Environmental Impact	Medium
Threatened and endangered and species of *Allium*, *Solanum*, *Vigna*, *Amaranthus*, *Prunus*, *Hibiscus*, *Trifolium* and Quercus may be at risk since these genera are known to be hosts for *S. littoralis*. New control measures would be unlikely because the current practices in commercial agriculture address a complex of similar noctuid pests.	(2)

Consequences of Introduction: *Leucinodes orbonalis* (Lepidoptera: Pyralidae)	**Risk Value**
Risk Element #1: Climate – Host Interaction Climate-Host Interaction, This insect is found in sub-Saharan Africa and India corresponding to U.S. Plant Hardiness Zones 10-13 (CABI, 2004). Only zone 10 occurs in the southern extremes of the United States ({USDA, 1990 #5819}).	Medium (2)
Risk Element #2: Host Range *Leucinodes orbonalis* feeds primarily on hosts in the family Solanaceae, but has been recorded on plants in the families Convolvulaceae and Fabaceae (CABI, 2004)	High (3)
Risk Element #3: Dispersal Potential Suresh et al., ({, 1996 #12370}) recorded fecundity of 62 and 164 eggs per female, but Singh and Singh ({, 2001 #15335}) recorded an average of 174 eggs per female. Adult behavior has been little studied, but other moths in the family Pyralidae have been shown to be capable of medium to long range flight (Cherry and Wilson, 2005; Shirai, 1998)	High (3)
Risk Element #4: Economic Impact This insect causes extensive damage to okra and eggplant, lowering the yield and marketability of the crops ({Frempong, 1979 #11860}{Youdeowei, 2002 #15482}).	High (3)
Risk Element #5: Environmental Impact *Leucinodes orbonalis* feeds on plants in the genus *Solanum*, which also contains the endangered species *Solanum drymophilum* in Puerto Rico and *S. incompletum* and *S. sandwicense* in Hawaii.	Medium (2)

For each pest, the sum of the five risk elements gives a Cumulative Risk Rating. This Cumulative Risk Rating is considered to be a biological indicator of the potential of the pest to establish, spread, and cause economic and environmental impacts. The summary of risk ratings for Consequences of Introduction is shown in Table 3.

Low: 5-8 points
Medium: 9-12 points
High: 13-15 points

Table 3. Risk Rating for Consequences of Introduction

Pest	Risk Element 1 Climate/Host Interaction	Risk Element 2 Host Range	Risk Element 3 Dispersal Potential	Risk Element 4 Economic Impact	Risk Element 5 Environmental Impact	Cumulative Risk Rating
Cryptophlebia leucotreta	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Earias biplaga	Medium	High	High	High	High	High

	(2)	(3)	(3)	(3)	(3)	(14)
Earias insulana	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Helicoverpa armigera	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (14)
Spodoptera littoralis	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (14)
Leucinodes orbonalis	Medium (2)	High (3)	High (3)	High (3)	Medium (2)	High (13)

6. Introduction Potential

Each pest is rated with respect to its Likelihood of Introduction, which is based on two separate components. First, an estimate is made concerning the quality of the commodity likely to be imported (Risk Element #6). Second, pest opportunity (Risk Element # 7) is estimated using five biological features. Details of those two Risk Elements and their rating criteria are provided in USDA APHIS (2000); the ratings and cumulative score for Risk Element #6 and #7, i.e., the "Likelihood of Introduction Risk Rating" are shown in Table 4.

Risk Element #6: Pest Opportunity (Survival and Access to Suitable Habitat and Hosts)

For each pest, the following six sub-elements were considered:

1. Quantity of commodity imported annually:
The likelihood that an exotic pest will be introduced depends on the amount of potentially infested commodity that is imported. For qualitative pest risk assessments, the amount of commodity imported is estimated in units of standard 40 foot long shipping containers. In those cases where the quantity of a commodity imported is provided in terms of kilograms, pounds, number of items, etc., the number of units is converted the units into terms of 40 foot shipping containers.

Low (1 point): < 10 containers/year
Medium (2 points): 10 – 100 containers/year
High (3 points): > 100 containers/year

Total okra production in Ghana in 2003 was 100,000 metric tons (FAO, 2005). Sea shipping containers which are 40 foot in length hold approximately 40,000 pounds (20 U.S. tons); this is used for various estimate of commodity shipment (USTRIS, 2005). Anticipated volume of okra to be exported from Ghana is unknown; however, high volume of okra (> 100 containers/year) is likely to be shipped into the United States. Therefore, Quantity of commodity imported annually is rated High (3).

2. Survive postharvest treatment:
For this sub-element, postharvest treatment refers to any manipulation, handling, or specific phytosanitary treatment to which the commodity is subjected. Examples of postharvest treatment include culling, washing, chemical treatment, cold storage, etc. If there is no postharvest treatment, the estimate the likelihood of this sub-element is High.

The false codling moth, *Cryptophlebia leucotreta*, the Egyptian stem borer, *Earias biplaga,* the spiny bollworm, *Earias insulana,* the cotton bollworm, *Helcoverpa armigera,* and *Spodoptera littoralis* are rated Medium. Okra will not be washed but inspected in the packing house to cull out malformed or damaged fruits. Therefore, all the insects are rated Medium.

3. Survive Shipment:
The shipping conditions of okra from Ghana are unknown, but would probably be short in duration owing to the perishable nature of fresh okra. All pests are rated High for this risk element.

4. Not be detected at the port of entry:
Unless specific protocols with special inspection of the commodity in question are in place, standard inspection protocols for like commodities are assumed. If no inspection is planned, estimate this sub-element as High.

All the species are rated Medium. Fruits are harvested early to avoid overly mature fruits and attack by the borers. The entry points in fruits are visible and could be detected by inspection.

5. Imported or move subsequently to an area with an environment suitable for survival:
Cryptophlebia leucotreta, Earias biplaga, and *Leucinodes orbonalis* are rated Medium because they are tropical and subtropical species. Tropical and subtropical locations are limited in the United States; in the continental United States, those regions are limited to the South and the West Coast, which comprise an estimated 10-12% of the total land area of the continental United States.
Earias insulana, Helicoverpa armigera, and *Spodoptera littoralis* are rated High because suitable habitats contain not only subtropical and tropical zones but also temperate zones

6. **Come into contact with host material suitable for reproduction:**
Even if the final destination of infested commodities is conducive for pest survival, suitable host material must be available in order for the pest to survive. Consider the complete host range of the pest species.

Cryptophlebia leucotreta, Earias biplaga, E. insulana, Helicoverpa armigera, *Leucinodes orbonalis* and *Spodoptera littoralis* are rated High. All five pests have wide range of host species. *Cryptophlebia leucotreta* and *Helicoverpa armigera* are polyphagous species. *Earias* species attack cotton, rice, and maize which are widely distributed throughout the United States.

A summary of the ratings for Likelihood of Introduction is depicted in Table 4.

Low: 6 – 9 points
Medium: 10 – 14 points
High: 15 – 18 points

Table 4. Risk Rating for Likelihood of Introduction: (Risk Element #6)

Pest	Subelement 1 Quantity imported annually	Subelement 2 Survive postharvest treatment	Subelement 3 Survive shipment	Subelement 4 Not detected at port of entry	Subelement 5 Moved to suitable habitat	Subelement 6 Contact with host material	Cumulative Risk Rating
Cryptophlebia leucotreta	High (3)	Medium (2)	High (3)	Medium (2)	Medium (2)	High (3)	High (15)
Earias biplaga	High (3)	Medium (2)	High (3)	Medium (2)	Medium (2)	High (3)	High (15)
Earias insulana	High (3)	Medium (2)	High (3)	Medium (2)	Medium (3)	High (3)	High (16)
Helicoverpa armigera	High (3)	Medium (2)	High (3)	Medium (2)	High (3)	High (3)	High (16)
Spodoptera littoralis	High (3)	Medium (2)	High (3)	Medium (2)	High (3)	High (3)	High (16)
Leucinodes orbonalis	High (3)	Medium (2)	High (3)	Medium (2)	Medium (2)	High (3)	High (15)

C. Conclusion – Pest Risk Potential and Pests Requiring Phytosanitary Measures
To estimate the Pest Risk Potential for each pest, the Cumulative Risk Rating for the consequences of Introduction and the Cumulative Risk Rating for the Likelihood of Introduction are summed in Table 5. The Pest Potential rating is as follows:

Low: 11 – 18 points
Medium: 19 – 26 points
High: 27 – 33 points

Table 5. Summary of pest risk potential

Pest	Consequences of Introduction	Likelihood of Introduction	Pest Risk Potential	Risk Rate
Cryptophlebia leucotreta	High (15)	High (15)	30	**High**
Earias biplaga	High (14)	High (15)	29	**High**

Earias insulana	High (15)	High (16)	31	**High**
Helicoverpa armigera	High (14)	High (16)	30	**High**
Spodoptera littoralis	High (14)	High (16)	30	**High**
Leucinodes orbonalis	High (13)	High (15)	28	**High**

Pest Risk Potential ratings have the following suggested meanings (APHIS, 2000):

Low: Pest will typically not require specific mitigation procedures. The port-of-entry inspection to which all imported commodities are subjected can be expected to provide sufficient phytosanitary security.

Medium: Specific phytosanitary measures may be necessary.

High: Specific phytosanitary measures are strongly recommended. Port-of-entry inspection is not considered sufficient to provide phytosanitary security.

As stated in the Guidelines (APHIS, 2000) detailed examination and choice of appropriate sanitary and phytosanitary measures to mitigate pest risk for commodities with particular pest risk potential scores or ratings is undertaken as part of the pest risk management phase and is not discussed in this document. The appropriate risk management strategy for a particular pest depends on the risk posed by that pest.

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