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PESTICIDE EVALUATION REPORT & SAFER USE ACTION PLAN (PERSUAP)

USAID/SENEGAL ECONOMIC GROWTH AGRICULTURAL ACTIVITIES

July 2016

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EXECUTIVE SUMMARY

USAID/SENEGAL AGRICULTURAL PORTFOLIO

Senegal is one of the countries where the USAID Feed the Future (FtF) program is being implemented. FtF is a Multi-Year Strategy that outlines the five-year strategic plan for the U.S. Government's global hunger and food security initiative. FtF program activities under USAID/Senegal's Development Objective (DO) 1, "Increased, Inclusive Economic Growth." contribute to USAID/Senegal's goal to increase the agriculture sector's contribution to economic growth through an inclusive, private sector-led value chain approach**.** Specifically, USAID/Senegal's primary FtF goal is to establish formal agriculture production and market systems in three selected value chains: rice, maize and millet. USAID funded nutrition programs in Senegal focus on other crops including cereals, legumes, tubers, green leafy vegetables, vegetables, fruit and also on livestock.

PEST MANAGEMENT NEEDS OF USAID/SENEGAL DO1 AGRICULTURAL ACTIVITIES

Effective pest management is required to achieve intended development outcomes in these USAID/Senegal agricultural activities. Even in the context of USAID's policy commitment to integrated pest management (IPM), effective pest management often requires the use of products defined as pesticides by the US Environmental Protection Agency (USEPA).

Pest management needs for USAID/Senegal target crops are detailed in Annex A: *Pests & Diseases of Target Crops & Available & Recommended Control Methods,* Annex A in this PERSUAP.

PURPOSE & SCOPE OF THIS PERSUAP

Procurement or use of pesticides on USAID-funded or managed activities requires compliance with the Agency's pesticide procedures, 22 CFR 216.3(b). In compliance with these procedures, this Pesticide Evaluation Report and Safer Use Action Plan (PERSUAP):

- Establishes the set of pesticides for which procurement, use or support for use is authorized for agricultural activities across the USAID/Senegal portfolio.
- Establishes the conditions under which the authorized pesticides may be procured, used, or their use supported to best ensure user, consumer and environmental safety.

These requirements come into effect upon approval of the PERSUAP, which addresses the following production value chains: rice, maize, millet, legumes, tubers, green leafy vegetables, vegetables, fruit and livestock. In addition to production, seed treatment and post-harvest storage are addressed.

In addition to current USAID/Senegal agricultural projects/activities, this PERSUAP is designed to provide for the needs of *future* USAID/Senegal agricultural activities addressing these production value chains.

Should future—or current—activities address different value chains or require the procurement, use or support to use of pesticide active ingredients (AIs) not authorized by this PERSUAP or for uses not authorized by this PERSUAP, an amendment to this PERSUAP will be necessary.

A PERSUAP pertinent to Senegal was produced for the *USAID/* US Global Development Lab's project *Cotton Activities In Four Target Countries Implemented By The Better Cotton Initiative (BCI)*[1], in India, Pakistan, Mozambique and Senegal, and was approved 11/23/2016.

STRUCTURE

Sections 1 and 2 provide an introduction to the PERSUAP purpose and scope and pesticide management needs of agricultural activities across the USAID/Senegal portfolio.

Section 3 gives a brief account of the Senegal environmental context, agricultural practices, and the system of environmental protection and pesticide regulation.

The **Pesticide Evaluation Report (PER, Sections 4 and 5)** establishes the set of authorized pesticides and requirements for safer use, which culminates with an assessment of the 12 pesticide risk evaluation factors (a through l) required by 22 CFR 216.3(b).

The **Safer Use Action Plan (SUAP; Section 6)** provides a succinct, definitive stand-alone statement of compliance requirements, synthesized from the 12-factor analysis. It also provides a mandatory template (sub-section 6.4) for assigning responsibilities and timelines for implementation of these requirements. Each project subject to this PERSUAP must complete this SUAP template and submit to its Agreement/Contract Officer's Representative (A/COR) and Mission Environmental Officer (MEO) for approval.

BASIS OF SELECTION AND RESTRICTIONS THAT APPLY TO PESTICIDES APPROVED FOR USE/SUPPORT VIA THIS PERSUAP

Upon approval of this PERSUAP, pesticides containing the Active Ingredients (AIs) listed in **Table 1** (at end of this Executive Summary) are permitted for procurement/use/support by USAID/Senegal agricultural activities. These pesticides have an identified use within an Integrated Pest Management (IPM)scheme; are registered by the US Environmental Protection Agency (EPA) and by the CILSS-CSP[2], and are chosen conservatively with respect to their environmental and human health risk profiles*[3].

Table I specifies AI- and product-specific risk-reducing conditions. Two of these restrictions are as follows:

- **No Acute Toxicity Class I Products.** While these AIs have been chosen conservatively with regard to their risk profiles, some products with these approved AIs may nonetheless be EPA Acute Toxicity class 1 or equivalent on the basis of their acute oral, dermal or inhalation toxicity. All products in which methanol (methyl alcohol used as a solvent) is present at 4 percent or more are also Class I. Such products are marked with the skull and crossbones symbol and the word "POISON" or "DANGER" or equivalent.

  Under this PERSUAP, such products may ONLY be used by professionally trained certified and registered pest control specialists and NEVER by smallholder farmers. **This restriction is set out prominently at the**

[1] http://gemini.info.usaid.gov/repository/pdf/49770.pdf

[2] Senegal is a member of the Comité permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel (CILSS) – the Permanent Interstate Committee for Drought Control in the Sahel. Through its Comité Sahélien des Pesticides (CSP) – the Sahelian Pesticides Committee, CILSS addresses registration and regulation of pesticides of its members, including Senegal, Therefore, AIs approved under this PERSUAP are all CSP-CILSS registered.

[3] Human health and ecological toxicological summaries and U.S. Environmental Protection Agency (US EPA) registration status for each pesticide are presented in Table B-1 in Annex B.

top of Table 1.

- **Some Products Require Label Approval.** Similarly, some approved AIs are present in products designated as Restricted Use Pesticides (RUPs) by EPA.[4] Generally, AIs for which a significant percentage of US products are RUP have been rejected by this PERSUAP. However, a few such AIs are approved under this PERSUAP where they meet an important pest management need for which there is no reasonable alternative. For such AIs, the conditions in Table 1 require IPs to submit the label of the proposed product together with the intended use to USAID for COR and MEO approval prior to procurement or use. To approve the use, the MEO must verify that the closest US-registered analogue to the product is not RUP.

Low-risk AIs not requiring approval under this PERSUAP. Note that some particularly low-risk AIs are exempt from regulation under the US Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and therefore may can be used by implementing partners without approval via this PERSUAP. These are listed at http://www.epa.gov/sites/production/files/2015-12/documents/minrisk-active-ingredients-tolerances-2015-12-15.pdf. (A list of pesticides Inert Ingredients that are exempt from FIFRA is available at: http://www.epa.gov/sites/production/files/2015-01/documents/section25b_inerts.pdf.)

In addition to these and other restrictions set out in Table 1, approval of the AIs listed in Table 1 is SUBJECT to conditions enumerated in the **Safer Use Action Plan and Compliance Tracker** ("SUAP Tracker") provided in Section 6.4. In summary these conditions are as follows:

A. Pesticide support must be governed by a set of locally adapted, crop- and pest-specific IPM-based pest management plans and observe enumerated use restrictions. (The PERSUAP provides key information for Implementing Partners (IPs) to develop these plans.)
B. Appropriate project staff and beneficiaries must be trained in safe pesticide use and pesticide first aid;
C. Projects must require the use and maintenance of appropriate Personal Protective Equipment (PPE)—as well as safe pesticide purchase, handling, storage and disposal practices;
D. Projects must be systematic in their pesticide-related record-keeping and monitoring.

Mandatory use of the "SUAP Tracker." Any project subject to this PERSUAP must submit a completed SUAP Tracker to its AOR/COR and MEO 30 days before the implementation of the activity and must update it annually. The tracker is a mandatory tool for assigning responsibilities and timelines for implementation of PERSUAP requirements, and for tracking compliance

Note: With respect to pesticides, the SUAP Tracker satisfies the requirement for an environmental mitigation and monitoring plan (EMMP). Project EMMPs should simply incorporate the SUAP Tracker by reference

[4] In the United States, the same AIs can be in products that are designated by EPA as Restricted Use Pesticides (RUP) as well as in products designated as General Use Pesticides (GUP). RUPs are pesticides which are not available to the general public in the United States. The "Restricted Use" classification restricts a product to use by a certificated pesticide applicator or under the direct supervision of a certified applicator. This means that a license is required to purchase and apply the product. Certification programs are administered by the federal government, individual states, and by company policies that vary from state to state (see http://www2.epa.gov/pesticide-worker-safety/restricted-use-products-rup-report). Products can be designated RUP because of human acute (immediate) and chronic (long-term) toxicity/health risk, physical hazards such as risks of fire or explosion, and eco-toxicity hazards such as potential risks of water pollution and risk to flora and fauna.. Restrictions can apply to the particular crop, formulations, concentrations or uses.

LIST OF APPROVED AIs WITH CAUTIONS AND RESTRICTIONS

IMPORTANT NOTE: any product containing these AIs that is marked with **skull and crossbones** or the words "**danger**" or "**poison**" or equivalent may ONLY be used by professionally trained certified and registered pest control specialists and NEVER by smallholder farmers.

Where required by the Advisory column in the table below, IPs must submit pesticide product label to MEO/A/COR for review and approval against USEPA restrictions. MEO/A/COR will review product label against USEPA guidance for restricted use pesticides provided at https://www.epa.gov/pesticide-worker-safety/restricted-use-products-rup-report

IPs must review pesticide label's PPE requirements and environmental hazards statement. Always keep pesticides away from water sources. AIs that have been identified as potential groundwater contaminants are identified in the Advisory column below.

TABLE 1. PESTICIDES (AIs) **APPROVED** WITH CAUTIONARY ADVICE AND MANDATORY RESTRICTIONS (BASED ON INFORMATION PROVIDED IN ANNEX B)

HERBICIDES	ADVISORY
2,4-D acid, ester or salts	Possible carcinogen, suspected endocrine disruptor, potential groundwater contaminant Salt and acid forms can be extreme eye irritants Many products containing this AI are RUP—IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Acetochlor	Potential groundwater contaminant All products in combination with Atrazine are RUP. Few other products are also RUP. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Bensulfuron methyl	Potential groundwater contaminant.
Bispyribac sodium	Potential groundwater contaminant
Clethodim	Potential groundwater contaminant
Clomazone	Potential groundwater contaminant
Dicamba	Potential groundwater contaminant, potential developmental/reproductive toxin. Included in many RUP products. Check all ingredients for approval.

TABLE 1. PESTICIDES (AIs) **APPROVED** WITH CAUTIONARY ADVICE AND MANDATORY RESTRICTIONS (BASED ON INFORMATION PROVIDED IN ANNEX B)

Diuron	Known water pollutant, use care around open water
Fluazifop-P-butyl	Potential developmental/reproductive toxin
Fluometuron	
Glyphosate and Glyphosate salts	Some Glyphosate products are classified as Acute Toxicity I due to potential for eye irritation and are RUP. Do not use products that have Danger sign. In 2015, Glyphosate was identified as a potential carcinogen by USEPA. Glyphosate-isopropyl ammonium products are RUP. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Nicosulfuron	Potential groundwater contaminant. When combined with Atrazine, this AI is RUP. Do not use.
Orthosulfamuron	Potential groundwater contaminant, possible carcinogen
Oxadiazon	Potential carcinogen and developmental/reproductive toxin
Pendimethalin	Possible carcinogen, suspected endocrine disruptor. Highly toxic to fish and aquatic invertebrate.
Penoxysulam/penoxsulam	Potential groundwater contaminant, possible carcinogen
Prometryn	Potential ground water contaminant
Propanil	Possible carcinogen, suspected endocrine disruptor. Moderately toxic to birds and aquatic organisms.
Tembotrione	Possible carcinogen
Terbutylazine	Also microbicide and algaecide
Tribenuron methyl	Possible carcinogen
Triclopyr	Slightly to moderately toxic to aquatic organisms RUP when combined with Picloram (potassium salt),

TABLE 1. PESTICIDES (AIs) **APPROVED** WITH CAUTIONARY ADVICE AND MANDATORY RESTRICTIONS (BASED ON INFORMATION PROVIDED IN ANNEX B)

	do not use
FUNGICIDES	ADVISORY
Azoxystrobin	Potential groundwater contaminant RUP when combined with some ingredients. All product ingredients must be approved for use. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Difenoconazole	Possible carcinogen, suspected endocrine disruptor (used in treated seed)
Copper hydroxide	Microbicide, nematicide and fertilizer
Copper sulfate (pentahydrate)	Use only acute toxicity Class II or III products; not Class I
Iprodione	Highly toxic to crustaceans
Mancozeb	Potential groundwater contaminant, carcinogen and developmental/reproductive toxin
Mefenoxam/ Metalaxyl-M	Potential groundwater contaminant (used in treated seed)
Miclobutanil	Likely developmental/reproductive toxin, suspected endocrine disruptor
Tebuconazole	Potential ground water contaminant, possible carcinogen, suspected endocrine disruptor RUP in combination with Lambda-cyhalothrin, do not use
INSECTICIDES	ADVISORY
Abamectin (Avermectin)	Potential reproductive and developmental toxin, suspected endocrine disruptor. Many products are RUP. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Acetamiprid	Do not use during flowering to protect foraging honeybees When combined with Bifenthrin RUP, do not use

TABLE 1. PESTICIDES (AIs) **APPROVED** WITH CAUTIONARY ADVICE AND MANDATORY RESTRICTIONS (BASED ON INFORMATION PROVIDED IN ANNEX B)

D-phenothrin	Highly toxic to fish and aquatic organisms, suspected endocrine disruptor
Azadirachtin (botanical neem extract) also nematicide	Suspected endocrine disruptor
Bacillus thuringiensis (Bt)	
Bacillus sphaericus	
Beta-cyfluthrin	Use only formulations of 10% or less AI, most formulations below 10% are GUP, and above 10% are RUP
Chlorantraniliprole	Potential groundwater contaminant When combined with Lambda-cyhalothrin RUP, do not use
Chlorothalonil	Do not use products with acute toxicity I for eye irritation. Potential groundwater contaminant, likely carcinogen,
Cyantraniliprole	
Cypermethrin Cypermethrin (alpha) Cypermethrin (beta)	Possible carcinogen, potential endocrine disruptor Many products are RUP. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use. Most Zeta-cypermethrin products are acute toxicity I, do not use
Deltamethrin	Highly toxic to some aquatic organisms Some products are RUP for some crops and applications. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Flubendiamide	Highly toxic to fish
Fludioxinil	Potential groundwater contaminant
Insecticidal soap	Recommended to use natural soaps and not to use detergents, dish soaps, or any products with degreasers, skin moisturizers, or synthetic chemicals.
Indoxacarb, S-isomer	High toxicity to bees and birds

TABLE 1. PESTICIDES (AIs) **APPROVED** WITH CAUTIONARY ADVICE AND MANDATORY RESTRICTIONS (BASED ON INFORMATION PROVIDED IN ANNEX B)

Imiprothrin	Highly toxic to fish
Imidacloprid	Linked to honey-bee colony collapse disorder. Should not be used during flowering, only during vegetative growth and for seed treatment. Several products and AI combinations are RUP. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Lambda-cyhalothrin	High toxic to fish and other aquatic organisms, toxic to bees. Many products and AI combinations are RUP. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Lufenuron	
Malathion	Toxic to bees When combined with gamma-Cyhalothrin RUP, do not use
Novaluron	Insect Growth Regulator (IGR) When combined with Bifenthrin RUP, do not use
Permethrin	May NOT be used for crop and wide area applications such as nurseries. Such uses are RUP. Weak carcinogen, suspected endocrine disruptor, Highly toxic to fish and aquatic organisms. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Pyriproxyfen	Insect Growth Regulator (IGR)
Pirimiphos-methyl	May interfere with proper functioning of the nervous system
Spinosad	Slightly to moderately toxic to some aquatic organism Some products are RUP when combined with Bifenthrin, or Lamda-cyhalothrin do not use
Spirotetramate	

TABLE 1. PESTICIDES (AIs) **APPROVED** WITH CAUTIONARY ADVICE AND MANDATORY RESTRICTIONS (BASED ON INFORMATION PROVIDED IN ANNEX B)

Tagetes oil	
Terbutryn	Possible groundwater contaminant, possible carcinogen, possible endocrine disruptor
Thiamethoxam	Potential ground water contaminant (used in treated seed) Some products and used are RUP. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Thyme oil	Exempt, not regulated
Trifloxysulfuron sodium	Potential groundwater contaminant
RODENTICIDE	ADVISORY
Brodifacoum	Use in bait traps only, Required to be enclosed in bait stations that are inaccessible to children and non-target animal species.
FUMIGANT	ADVISORY
Aluminum Phosphide	EPA Toxicity Class I. All products are marked DANGER. All warehouse pest control activities for protection of agricultural commodities must be performed only by trained and certified pest control specialists. Only products approved in Senegal for control of pests in warehouses and its surroundings can be used by the fumigators. In addition, Aluminum Phosphide fumigation must comply with the USAID Programmatic Environmental Assessment (PEA) for Phosphide Fumigation of Stored Agricultural Commodity (http://www.usaidgems.org/fumigationpea.htm); see Annex T-1 for guide to compliance requirements.

PESTICIDES CONSIDERED AND REJECTED BY THIS PERSUAP

Only pesticides specifically approved (i.e., appearing in the "lists of approved pesticides" above) under this PERSUAP are authorized for use in USAID/Senegal agricultural activities. The tables below document pesticides (as AIs) that were specifically considered and rejected by the analysis undertaken in this PERSUAP. This information is provided to support evaluation of future requests for amendment of this PERSUAP.

Toxicological summaries and US EPA registration status for each pesticide are presented in Table B-1 in Annex B.

Table 2. PESTICIDES REGISTERED BY CILSS BUT **REJECTED** BY THIS PERSUAP

PESTICIDES REJECTED	REASON FOR REJECTION
Aclonifen	Not registered by USEPA
Alletrin, d-trans allethrin	Used mostly for control of mosquitos and flies in homes and gardens
Asulam	Used mostly for cane sugar
Bendiocarb	Acute toxicity
Bifenthrin	Most products are RUP
Bromadiolone	Anti-coagulant rodenticide, RUP, certified for use only indoors
Cartap	Not EPA registered
Chlorpyrifos-ethyl	Most products are RUP
Cycloxidim	Not registered by USEPA
Cypermethrin (zeta)	High acute toxicity
Diflubenzuron	RUP, all products and uses
Dimefluthrin	Not registered by US EPA
Emamectin benzoate	Use mostly for ornamental trees, most products are RUP
Esbiothrin	Not registered by USEPA
Fenitrothion	Registered for use of ornamental crops only
Haloxyfop-R-mathyl	Not registered by USEPA
Hexazynone	Known groundwater contaminant, some products are acute toxicity I
Isoxadifen-ethyl	Not registered by USEPA
Mepiquat chloride	Plant growth regulator used exclusively on cotton
Mesothrione,	Most products are RUP
Metolachlor, S-Metolachlor	Most products are RUP
Methomyl	All methomyl products, except the 1% bait formulations, are classified as restricted use pesticides.
Oxadiargyl	No US Federally registered products containing this chemical
Oxamyl	Oxamyl is a “restricted use" (RUP) chemical due to acute toxicity and toxicity to birds and mammals.
Pencycuron	No US Federally registered products containing this chemical
Pyribenzoxim	Not registered by USEPA
Profenofos	Restricted to use on cotton solely
Pretilachlor	Not registered by USEPA
Propaquizafop	Not registered by USEPA
Pyriproxyfen	Alleged (not substantiated) link to microcephaly
Teflubenzuron	Not registered by EPA

Table 2. PESTICIDES REGISTERED BY CILSS BUT **REJECTED** BY THIS PERSUAP

PESTICIDES REJECTED	REASON FOR REJECTION
Transfluthrin	No US Federally registered products containing this chemical

TABLE 3. AIs BANNED BY STOCKHOLM CONVENTION THAT ARE BANNED IN SENEGAL

PESTICIDE	COMMON USES
Aldrin	Used mostly on corn and cotton
Chlordane	Used on agricultural crops, lawns, and gardens and as a fumigant for termite control
DDT	Malaria control
Dieldrin	Used mostly on corn and cotton
Dioxins (polychlorinated)	Byproduct of pesticides
Endrin	Pesticide used to control insects, rodents, and birds
Furan (polychlorinated)	By product of pesticides
Heptachlor	Used in households and Agriculture
Hexachlorobenzene	Fungicide used on seeds
Mirex	Insecticide and flame retardant
Toxaphen	Insecticide used primarily on cotton

TABLE 4. AIs BANNED BY THE ROTTERDAM CONVENTION THAT ARE BANNED IN SENEGAL

HERBICIDES
2,4,5-T and its salts and esters
Alachlor
Dinitro-ortho-cresol (DNOC) and its salts
Dinoseb and its salts and ester
FUNGICIDES
Benomyl (certain formulations)
Binapacryl
Captafol
Thiram (certain formulations)
INSECTICIDE
Aldicarb

Aldrin
Carbofuran (certain formulations)
Chlordane
Chlordimeform
Chlorobenzilate
DDT
Dieldrin
1,2-dibromoethane (EDB)
Endosulfan
Hexachlorocyclohexane (mixed isomers, some are pesticides)
Heptachlor
Hexachlorobenzene
Lindane
Methamidophos (certain formulations)
Methyl parathion (certain formulations)
Monocrotophos
Parathion
Pentachlorophenol and its salts and esters
Phosphamidon (certain formulations)
Toxaphene
RODENTICIDE
Fluoroacetamide

APPROVAL OF PESTICIDE EVALUATION REPORT & SAFE USE ACTION PLAN (PERSUAP) FOR USAID/SENEGAL ECONOMIC GROWTH AGRICULTURAL ACTIVITIES

CLEARANCE:

Mission Director:
USAID/Senegal
Lisa Franchett — Date: 10/26/2016

CONCURRENCE:

Bureau Environmental Officer
Africa Bureau
Brian ~~Hirch~~ Hirsch — Date: 01/03/2017

Approved: ☒ Disapproved: ☐

FILE N: Senegal EG Agriculture PERSUAP 2017

ADDITIONAL CLEARANCES:

Deputy Mission Environmental Officer:
USAID/Senegal
Oumou K. Ly — Date: 08/26/2016

Mission Environmental Officer:
USAID/Senegal
Abdourahmane Ndiaye — Date: 09/1/2016

Agriculture Cluster Team Lead:
EGO/USAID/Senegal
Abdoulaye Dia — Date: 08/29/2016

Senior Agriculture Specialist:
EGO/USAID/Senegal
Papa N. Dieye — Date: 08/30/2016

Office Director:
EGO/USAID/Senegal
Anne Williams — Date: 8/30/16

Program Office Director:
EGO/USAID/Senegal
Eric Davis — Date: 9/1/16

Resident Legal Officer:
USAID/Senegal
~~Daniele~~ jean-Pierre Kuntz — Date: 09/22/16

Deputy Mission Director:
USAID/Senegal
Sharon carter — Date: 10/16/2016

Regional Environmental Officer:
USAID/Sahel Regional Office
Camilien Saint-Cyr — Date: 09/16/2016

SENEGAL PESTICIDE EVALUATION REPORT & SAFER USE ACTION PLAN (PERSUAP)

FOR
USAID/SENEGAL AGRICULTURAL ACTIVITIES

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Submitted by: The Cadmus Group, Inc.
100 Fifth Avenue, Suite 100
Waltham, MA 02451
617-673-7000 Fax 617-673-7001
www.cadmusgroup.com

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ACRONYMS

AFR/WA	Africa/West Africa
AI	Active Ingredient
ANCAR	L'Agence Nationale de Conseil Agricole et Rural
AOR/COR	Agreement Officer Representative/Contracting Officer Representative
BEO	Bureau Environmental Officer
CDCS	Country Development Cooperation Strategy
CFR	Code of Federal Regulation
CILSS	Comité permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel
CNCR	National Council for Rural Co-operation
COMFISH	Collaborative Management for a Sustainable Fisheries Future
CORAF/WECARD	West and Central African Council for Agricultural Research and Development
CSP	Sahelian Pesticide Committee
DO	Development Objective
DPV	La Direction de la Protection des Végétaux
ECD	Environmental Compliance Database
EGO	Economic Growth Office
EMMP	Environmental Mitigation and Monitoring Plan
ERA	Education and Research in Agriculture
FAO	Food and Agriculture Organization
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
FtF	Feed the Future
GDP	Gross Domestic Product
GEMS	Global Environmental Management Support
GoS	Government of Senegal
GUP	General Use Pesticides
IEE	Initial Environmental Examination
IFAD	International Fund for Agricultural Development
INSAH	Institut du Sahel
IP	Implementing Partner
IPM	Integrated Pest Management
ISO	International Standards Organization
ISRA	Institut Sénégalais de Recherches Agricoles
ITCZ	Inter-Tropical Convergence Zone
MAB	Man and the Biosphere
MAER	Ministry of Agriculture and Rural Equipment
MEO	Mission Environmental Officer

MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoH	Ministry of Health
MRL	Maximum Residue Level
MSDS	Material Safety Data Sheet
NARS	National Agricultural Research Systems
NGO	Non-Governmental Organization
PCE	Project Croissance Economique
PER	Pesticide Evaluation Report
PERSUAP	Pesticide Evaluation Report and Safe Use Action Plan
PHI	Pre-Harvest Interval
PIC	Prior Informed Consent
PMP	Pest Management Plan
POPs	Persistent Organic Pollutants
PPE	Personal Protective Equipment
REO	Regional Environmental Officer
REI	Restricted Entry Interval
RUP	Restricted Use Pesticide
SFZ	Southern Forest Zone
SPRING	Strengthening Partnerships, Results, and Innovations in Nutrition Globally
SRV	Senegal River Valley
SUAP	Safe Use Action Plan
ULV	Ultra Low Volume
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
US EPA	United States Environmental Protection Agency
USGS	US Geographic Services
WHO	World Health Organization
WN	Wula Nafaa
WP	Wettable Powder

SECTION 1: INTRODUCTION

1.1 PURPOSE AND SCOPE

In compliance with USAID's Pesticide Procedures (under 22 Code of Federal Regulations (CFR) 216.3(b)), this 2015 Senegal Feed the Future (FtF) agricultural portfolio Pesticide Evaluation Report and Safer Use Action Plan (PERSUAP):

- **Establishes the set of pesticides** for which support is authorized on USAID/Senegal agricultural programmatic activities.
- **Establishes requirements attendant to support for these pesticides**, such that said use/support: (1) embodies the principles of safer pesticide use, and (2) per USAID policy, is within an Integrated Pest Management (IPM) framework.

These requirements come into effect upon approval of the PERSUAP.

The set of authorized pesticides and requirements for safer use are established through the first sections of the document, the **Pesticide Evaluation Report (PER**), which culminates with an assessment of the 12 pesticide risk evaluation factors (a through l) required by 22 CFR 216.3(b).

The **Safer Use Action Plan (SUAP)** in Section 6 provides a succinct, stand-alone statement of compliance requirements, synthesized from the 12-factor analysis. It also provides a template for assigning responsibilities and timelines for implementation of these requirements. Each project subject to this PERSUAP must complete this SUAP template and submit to its Agreement Officer Representative/Contracting Officer Representative (AOR/COR), Deputy Mission Environmental Officer (DMEO) and Mission Environmental Officer (MEO).

BOX 1.

The 12 Pesticide ANALYSIS FACTORS

A. U.S. Environmental Protection Agency (US EPA) registration status of the proposed pesticides

B. Basis for selection of pesticides

C. Extent to which the proposed pesticide use is part of an IPM program

D. Proposed method or methods of application, including the availability of application and safety equipment

E. Any acute and long-term toxicological issues with the proposed use, and measures available to minimize such hazards

F. Effectiveness of the requested pesticide for the proposed use

G. Compatibility of the proposed pesticide use with target and non-target ecosystems

H. Conditions under which the pesticide is to be used, including climate, geography, hydrology, and soils

I. Availability of other pesticides or non-chemical control methods

J. Host country's ability to regulate or control the distribution, storage, use, and disposal of the requested pesticide

K. Provision for training of users and applicator

L. Provision made for monitoring the use and effectiveness of each pesticide

1.2 REGULATORY REQUIREMENTS, THE PERSUAP CONCEPT, AND ANALYTICAL APPROACH

REGULATORY REQUIREMENTS ATTENDANT TO USAID-FUNDED SUPPORT FOR PESTICIDES

All USAID-funded activities are subject to pre-implementation environmental review, starting with a screening process that determines the level of potential environmental risk. Activities considered as

having moderate or unknown risks are subject to an Initial Environmental Examination (IEE). USAID's pre-implementation environmental review procedures are defined by 22 CFR 216.

If USAID funds are to be used to procure, directly fund or support the use of pesticides, 22 CFR 216.3(b) requires that 12 factors be analyzed as the basis for approving the use of any pesticides, and as the basis for establishing the requirements attendant to that use to control risks to human health and the environment (see Box 1).[5] The PER analyzes the 12 factors and SUAP establishes the attendant requirements or conditions for USAID-supported activities.

Pesticides are agents used to kill or control any pest, including insects, rodents or birds, unwanted plants (weeds), fungi, or microorganisms such as bacteria and viruses. Though often misunderstood to refer only to insecticides, the term pesticide also applies to herbicides, fungicides, micro-biocides, rodenticides, and various other substances used to control pests.6 Pesticides are by design poisons, and their use entails a degree of risk to the environment including humans, animals, birds, fish, bees, and other living organisms.

USAID POLICY: INTEGRATED PEST MANAGEMENT

Since the early 1990s USAID has been committed to the philosophy and practice of IPM as official policy. There is not a single standard international definition for IPM, but there is wide agreement on its basic elements. Under IPM:

- "First line" defenses against pest damage are a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties.
- Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism.
- Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.

IPM is strongly promoted as part of 22 CFR 216.3 Factor C.

THE PERSUAP

The USAID Africa Bureau initially developed the PERSUAP framework for pesticide compliance; the PERSUAP was subsequently adopted by other USAID Bureaus. Formally the PERSUAP constitutes an amendment to a program's or project's IEE, to address the requirements of 22 CFR 216.3(b) with particular emphasis on assuring that pesticide use occurs within an IPM framework.

A PERSUAP consists of two core parts, a PER and a SUAP. The PER characterizes pest management needs for the subject USAID projects, the availability of pesticides, the level of pesticide awareness among potential beneficiaries, and the critical local context. This information then informs the assessment of the 12 pesticide risk evaluation factors (a through l, see box above) required by 22 CFR 216.3(b). The PER thereby establishes the set of authorized pesticides and requirements for Safer Use.

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5 Specifically, Reg. 216.3(b)(1)(i) stipulates: "When a project includes assistance for procurement or use, or both, of pesticides registered for the same or similar uses by US EPA without restriction, the IEE for the project shall include a separate section evaluating the economic, social and environmental risks and benefits of the planned pesticide use to determine whether the use may result in significant environmental impact. Factors to be considered in such an evaluation shall include, but not be limited to the following" (see Box 1).

6 "Types of Pesticides" About Pesticides. 05 Aug 2014. United States Environmental Protection Agency. 09 Aug 2015 http://www.epa.gov/pesticides/about/types.htm.

The SUAP (Section 6) provides a succinct, stand-alone statement of compliance requirements, synthesized from the 12-factor analysis. It also provides a template for assigning responsibilities and timelines for implementation of these requirements.

Each project subject to this PERSUAP must complete this SUAP template (found in Section 6.4) and submit to its AOR/COR, DMEO and MEO at the date specified by the MEO.

USAID/SENEGAL PEST MANAGEMENT NEEDS FOR AGRICULTURAL PROJECTS

This PERSUAP addresses the pesticide safer use and handling issues for activities under USAID/Senegal CDCS DO 1. Under this strategy, the agricultural activities in key value chains are part of the latest in the series of investments under the FtF program. These USAID/Senegal investments provide technical assistance, training, materials, and other resources to improve food security through professionalization, strengthened agricultural production and market systems, improved access to finance, and rational management of natural resources under strong governance.

The assessment of "pesticide and pest management local context" that begins with the PER is a key feature of the PERSUAP approach. This assessment is needed because it provides essential input to the 12-factor analysis. The purpose of the 12-factor analysis is to select appropriate pesticides and safe use measures. This approach requires taking into consideration the context in which the products will be used, the particular elements of the program, and the different capacities of the partners and stakeholders involved.

1.3 DEVELOPMENT OF THIS PERSUAP

USAID/Senegal and its Implementing Partners (IPs) are currently implementing the FtF Naatal Mbay ("Flourishing Agriculture" in the Wolof language), Nutrition Led Agriculture Project Yaajeende, Education and Research in Agriculture Project (ERA), Collaborative Management for a Sustainable Fisheries Future (COMFISH) Fisheries Project, and Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING) – Scaling Up Nutrition-Led Agriculture in Senegal. The "parent" IEE which this PERSUAP responds to is **USAID Senegal's Food Security and Natural Resource Management IEE (**Senegal Food Security (DOCX) (PDF)[7] was approved 04/22/2016.

While this PERSUAP is developed primarily to address the needs of these projects activities, it is envisioned to serve as a base for the needs of future agricultural projects. This PERSUAP is also meant to serve other possible future projects, including those that may support agricultural activities via grants or sub-grants.

This PERSUAP is developed based on the format developed by the core Global Environmental Management Support (GEMS) team and draws from other documents developed for Senegal, such as the PERSUAP developed for Projet Croissance Economique (PCE) and for Wula Nafaa (WN) projects.

Activities of the West and Central African Council for Agricultural Research and Development (CORAF/WECARD) coordinated by FtF that are implemented by member National Agricultural Research Systems (NARS) in West Africa, are covered by a separate PERSUAP developed in 2014 for Activities Number #: 624-A-00-09-0037-00 and # 624-A-12-00007-00.

Regional West Africa activities are covered by the West Africa Regional Programmatic PERSUAP (P-PERSUAP) Covering Nine Target Countries (including Senegal) with USAID West Africa Programs

[7] http://gemini.info.usaid.gov/repository/doc/47126.docx

developed in 2014 on Purchase Order AID-624-O-14-000003 and can be found on the Environmental Compliance Database (ECD) http://gemini.info.usaid.gov/egat/envcomp/repository/pdf/42966.pdf

Currently, USAID/Senegal funded projects determined to include pesticide procurement, use, or support to procurement or use include only FtF Senegal Naatal Mbay Cereal Value Chain activity and SPRING. If other projects and activities have pesticide procurement or use needs that are not covered by this or NARS activities PERSUAP, an Amendment to the this PERSUAP analyzing and approving the new pesticide active ingredient (AI) must be prepared and approved by the Office of West African Affairs (AFR/WA) Bureau Environmental Officer (BEO) before that new pesticide may be procured, used, or promoted in FtF programs in Senegal.

The PERSUAP development is based on analyzing and characterizing the AIs of the subject pesticides with respect to: chemical class, Senegal registration status, US EPA registration, Restricted Use Pesticide (RUP) status, European Union (EU) registration status, World Health Organization (WHO) and US EPA acute human toxicity classifications, chronic human health issues, groundwater pollution potential, and eco-toxicity to different classes of organisms. This phase also includes identification of potential IPM measures for specific pest-crop combinations, as recommended by international agricultural research centers and similar sources.

This PERSUAP reviews pesticides to be used for main production crops identified by USAID/Senegal. The PERSUAP examines and determines whether each pesticide (i.e., Active Ingredients (AI)) is appropriate for USAID-supported activities.

- The criteria for approval of pesticide use (broadly defined) for USAID support include:
- Pesticide (AI and product) must be registered in Senegal;
- Active ingredients must be registered by US EPA for same or similar use; and
- Similar product containing this active ingredient(s) must be registered in the U.S.

Additional conditions apply to use of pesticides by smallholder farmers: RUPs and pesticides with US EPA acute toxicity risk Classification I are not approved for use by smallholder farmers in Senegal. These pesticides can be used only by trained and registered pest control professionals and/or trained agricultural specialists. Training and certification must be recognized by the Senegalese government authorities.

SECTION 2: PROJECTS THAT WERE THE BASIS OF THIS PERSUAP DEVELOPMENT

This PERSUAP was developed based on pest management and control needs of the following active projects:

Program/Activity: Nataal Mbay (Flourishing Agriculture)

Implementing Partner: Engility

Time Period of Implementation: 2015 – 2020

Basic objectives/Purpose: The Nataal Mbay project aims to strengthen and improve agricultural production, natural resource management and marketing in key agricultural value chains. Among other activities, *Naatal Mbay* supports the wide dissemination of technologies and best practices successfully introduced by its predecessor USAID/PCE (Economic Growth Project) so that they benefit a larger number of producers in the rice, corn and millet value chains.

The project interventions include: Production of irrigated rice in the Senegal River Valley; millet, maize and some rain-fed rice in the center-south peanut basin zone; and rain-fed rice and maize in Casamance (forming what is called South Forest Zone with the center/south peanut basin).

Program/Activity: SPRING

Implementing Partner: John Snow Inc. (JSI)

Time Period of Implementation: 2015 – 2020

Basic objectives/Purpose: SPRING work on Senegal aims to deliver nutrition specific and nutrition sensitive agriculture interventions. The project will focus on a number of crops including cereals, legumes, tubers, green leafy vegetables, vegetables, fruits and also on livestock.

SECTION 3: ENVIRONMENTAL CONTEXT

3.1 PRIORITY GEOGRAPHIC PLACES/AREAS OF PROJECT INTERVENTION

Figure 1. Senegal Administrative Map

Source: http://wolofresources.org/maps/dept.htm

For the purposes of the FtF program, three staple grain value chains (rice, maize, and millet) were selected for their associated high growth potential, scalability, and potential to leverage other United States Government (USG), Government of Senegal (GoS), and development partners' investments. Other GoS-prioritized sectors are important to the overall agricultural economy, however, it was determined that these three Senegalese staples greatly influence daily diets in the poorest regions, hold the greatest potential for reducing under nutrition and poverty, and offer geographic focus to increase the impact of the USG's overall development investments in two agro-ecological zones: the Senegal River Valley (SRV) and the Southern Forest Zone (SFZ).

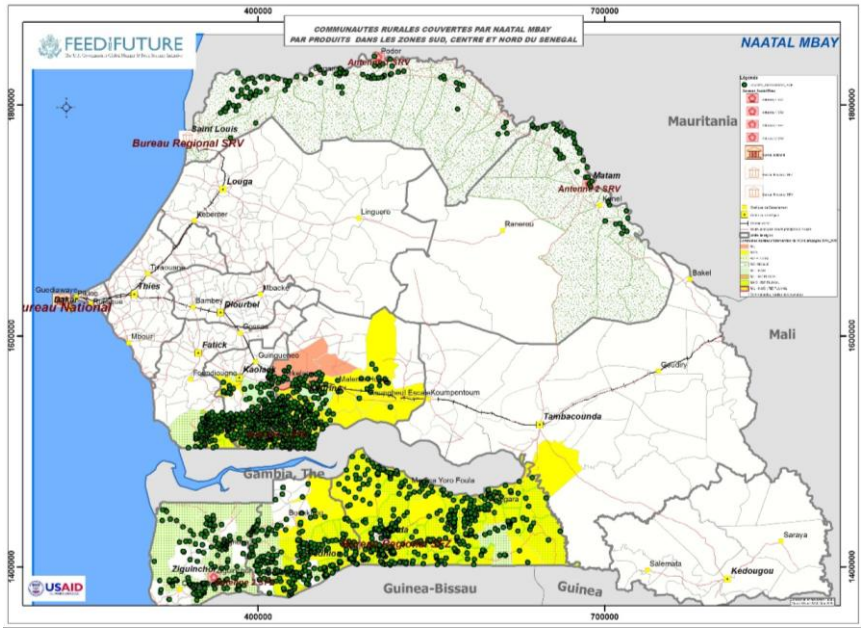
In the SRV and the SFZ, combined USG and donor investments are expected to create corridors of agricultural productivity and improve the private sector business environment, facilitating "agricultural growth corridors." These two focus zones touch on parts of nine administrative regions representing 42.6 percent of Senegal's population and include the five poorest regions: Fatick, Kedougou, Kolda, Matam, and Tambacounda. However, since value chain development is used to satisfy urban market demand, the FtF impact will be broader than these targeted areas and beneficiaries. In fact, the coastal and western regions (Dakar, Kaolack, Touba, Thies, and Saint-Louis) are the most important markets for cereals.

Figure 2. FtF Target Regions Map

Source: http://www.feedthefuture.gov/country/senegal

The Nataal Mbay project targets farmers in the Senegal River Valley, those in the groundnut basin, and those in the Casamance in the South. Yaajeende works in Matam, Kedougou, Tambacounda, and Kolda.

Figure 3. Nataal Mbay Geographic Coverage



Source: Nataal Mbey project

SPRING will work in the areas of Kaolack, Fatick, and Kaffrine and expand to Ziguinchor and Sédhiou.

3.2 AGRICULTURE IN SENEGAL

AGRO-ECOLOGICAL ZONES

Senegal is divided into the following seven agro-ecological zones, based on biophysical and socioeconomic criteria: (i) the Senegal valley; (ii) the Niayes; (iii) Northern Groundnut Basin; (iv) Southern Groundnut Basin; (v) the Sylvopastoral Zone; (vi) Eastern Senegal and Upper Casamance; and (vii) Lower and Middle Casamance. These agro-ecological zones are extensive areas with specific natural and human features to clearly make a distinction between them. Each zone is a unique natural region, with its own potential and vulnerability to ecological and climatic hazards. FtF works mostly in the River Valley, Casamance, and some parts of the Southern Groundnut Basin.

The Senegal River Valley covers a 10 to 15 km strip, including the districts of Dagana, Podor, Matam and Bakel. This zone is characterized by alluvial plains and sandy uplands. From an ecological perspective, the Senegal River Valley is made up of a Walo (an inundated area with heavy soils and rice-fields), a delta (characterized by a sea climate), and a Jéri (pastoral region). Rainfed farming is almost nonexistent in the delta, and most output is derived from irrigation farming (resulting into recurrent soil salinity). In the mid-valley of Senegal and the delta, reproduction of soil fertility is ensured by flooding (silting makes permanent cultivation possible and reduces the need for fallowing). Regarding vulnerability to climate change, the River Valley is subjected to poor and irregular rainfall, growing invasive water plants, fewer fish-breeding areas, and floods in Saint-Louis associated with high water levels, coastal erosion and saline intrusion into the river.

Lower Casamance Lower and Middle Casamance are characterized by lowland soil acidification, water erosion, loss of forest diversity (partly due to bushfires), increased salinity, acidity, iron toxicity and acute mangrove degradation within the Casamance estuary. Casamance regions are subjected to the highest food insecurity rates in Senegal, partly exacerbated by the civil unrest of 2010-2012.8

Southern Groundnut Basin is highly populated and subject to ecosystem degradation and depletion of land resources (soil fertility and timber resources). In addition, soil regeneration has slowed as a result of upland soil acidification and lowland salinity.9

AGRICULTURE

Senegal is a net food importer, including rice. Though the GoS promotes self-sufficiency in agricultural production, droughts and poor soils make increasing production sustainability challenging. Agriculture employs about 75 per cent of the working population and comprises approximately 17 per cent of the Gross Domestic Product (GDP). Groundnuts, cotton, gum arabic and sugarcane are the primary cash crops. Millet, corn, sorghum and rice are the main food crops. Until recently most government subsidies and agricultural extension services were directed to groundnut production. Decreasing yields of groundnut due to environmental degradation and fluctuating world prices have encouraged attempts to increase domestic production of staple food crops.

The vast majority of crops in Senegal are rain-fed, making water availability one of the country's biggest agricultural challenges. Successive droughts and occasional flooding have also led to declining yields as soils have become degraded and eroded. Despite having the potential to irrigate up to 240,000 hectares, at

8 http://siteresources.worldbank.org/EXTSOCIALDEVELOPMENT/Resources/244362-1232059926563/5747581-1239131985528/5999762-1242914244952/Senegal_Report_Final_EN.pdf

9 http://p4arm.org/app/uploads/2015/02/Senegal000Agri0ctor0risk0assessment.pdf

present the country irrigates only one-third of this area. The Diamadam, built in the 1980s, was designed to reduce the risk of flooding, store water in the rainy season, aid irrigation in the dry season, and potentially enable double cropping. However, construction of the dam interrupted the natural flood regime, reducing the productivity of the floodplains and adversely affecting communities. In other places, widespread livelihood dependence on rain-fed agriculture and urban expansion into flood risk zones have aggravated the country's exposure to hydro-meteorological hazards.

While still important to the economy, groundnut production has reduced soil fertility to an extent that farmers are moving further inland as they look for new land for cultivation. Combined with a quadrupling of the population in the last 50 years, increased demand for land and fuel woods has contributed to deforestation. According to the World Bank, 450 square kilometers of Senegalese forest is lost annually, predominantly for agricultural purposes.10

3.3 PESTICIDES AND THE SENEGAL ENVIRONMENT

Pesticide use in Senegal is still relatively low. Pesticides tend to be used most intensively on cash crops such as vegetables and cotton. However, pesticides are often used as the dominant form of pest management for food staples that are highly susceptible to insect attacks. Increased pest incidence, lack of advice on alternative methods, a growing informal market in 'discount' and often unauthorized pesticides, a lack of willingness to pursue pest control subsidy without consideration to cost-effectiveness, and poor attention to the economics of pest control are factors that drive increased use of pesticides.11

A review of hazard ratings identified 10% of pesticides circulating in West African countries as belonging to WHO Class 1a or b, the most acutely toxic to humans. Pesticide poisoning data have not been collected in the Sahelian region until very recently, but some large-scale incidents have been reported and there are frequent reports of ill health and hospitalization. According to Pesticide Action Network (PAN), in Senegal, 24% of cotton farmers and 20% of vegetable farmers had witnessed or heard of cases of pesticide poisoning. A poison Centre was established several years ago at the University Hospital in Dakar, Senegal to collect poisoning data. The concepts underlying pesticide environmental impacts are not always well understood among users in Senegal, analytical facilities that support any monitoring of environmental residues are limited, and there is no routine assessment of pesticide contamination of surface waters. Mass fish and bird mortalities have been reported in Senegal, and pesticide use is one possible cause.12

10 http://www.new-ag.info/en/country/profile.php?a=530

11 http://www.julespretty.com/wp-content/uploads/2013/09/11.-williamson.pdf

12 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3928896/#RSTB20130491C24

SECTION 4: PER, PART 1—PEST MANAGEMENT NEEDS, PESTICIDES AVAILABLE, AND MANAGEMENT CAPACITY

This section provides key information that serves as critical input to the 12-factor analysis (per 22 CFR 216.3(b)) undertaken in Section 5. This includes the list of target crops covered and their pest management needs, and candidate pesticides to be assessed for Senegal. This section also includes information regarding the *local context* (e.g., knowledge and awareness of pesticide Safer Use principles) that is critical to decisions regarding which pesticides can be safely used in Senegal.

4.1 IDENTIFICATION OF TARGET ACTIVITIES

AGRICULTURAL PRODUCTION OF CROPS

The PERSUAP emphasizes IPM measures that include biological, mechanical, best agricultural practices, and, where necessary, chemical pesticides for the following crops: grain (rice, millet, maize), legumes, tubers, green leafy vegetables, vegetables, fruit and also on livestock.

AGRICULTURAL SEED TREATMENT

No pesticides were requested by IPs for seed treatment, however, it should be noted that procured seed is often pretreated with pesticides. Projects that procure pesticide treated seed must ensure that pesticides used for seed treatment are cleared by a PERSUAP. Based on previous recommendations, seed treatment for millet was included in this PERSUAP.

POSTHARVEST STORAGE

No pesticides were requested by IPs for use in storage, however, IPs expressed interest in recommending fumigation for stored maize to farmers. Only trained and certified pest control specialists are approved to conduct fumigation. Use of fumigants is allowed only by trained and certified professionals and via this use of fumigants by farmers is not approved by this PERSUAP.

Agricultural activities. Currently implemented projects Nataal Mbay and SPRING are planning to avoid use of chemical pesticides to the extent possible, however due to pest control challenges faced by Senegal producers, use of chemical pesticides is sometimes deemed necessary. **Livestock.** No pesticides where requested by IPs for treatment of livestock pests.

GRANTS AND LOANS

USAID regulations are intended to flow down from the direct recipients of funding to any sub-recipients (e.g., through subsequent grant or loans). Therefore, all projects that provide grants and loans for agricultural activities are responsible for ensuring enforcement of the requirements established by this PERSUAP.

4.2 PEST MANAGEMENT NEEDS FOR TARGET ACTIVITIES

Production and storage of quality grain in Senegal are constrained by pests including insects, diseases, weeds, mollusks, birds and rodents. As documented in Annex A, effective pest management is critical to achieving agricultural productivity objectives for each crop, and while non-chemical control methods have a critical role to play, there is often a need for complementary chemical controls. Weed infestation is one of the constraints of tuber and root crop production. Bacterial, fungal and viral diseases as well as insect and soil pests such as nematodes place major constraints on production. Blights, cankers, rots,

rusts, wilts and other diseases affect horticultural crops. These crops are attacked by caterpillars, beetles, sap-feeding insects, fly maggots or larvae, and other insect and non-insect pests such as mites, spiders and slugs. Use of pesticides for horticultural crops is generally higher than other crops. Seed treatments are used on many crops to control a variety of pests. Seed treatments are commonly used to ensure uniform stand establishment by protecting against soil-borne pathogens and insects. Seed treatment pesticides include bactericides, fungicides, and insecticides. Pesticides may be required for use on livestock to rid them of fleas, ticks, mosquitoes and other external parasites.

4.3 IPM PRACTICES

Crop protection specialists are increasingly aiming to develop pest control methods that are more compatible with the goals of a sustainable, productive, stable and equitable agriculture. To meet these goals, research must seek to integrate a range of complementary pest control methods in a mutually enhancing fashion, namely IPM. IPM focuses on five control areas:

- ***Cultural pest control***: is the use of farming or cultural practices associated with crop production that make the environment less favorable for survival, growth, or reproduction of pest species. For example the manipulation of sowing and harvest dates to minimize damage, intercropping, vegetation management and crop rotations.

- ***Biological control:*** the conservation of natural enemies, manipulation of natural enemy populations, and the introduction of exotic organisms; the reduction of pest numbers by predators, parasites, or pathogens.

- ***Physical and mechanical control:*** the application of direct or indirect measures that kill the pest, disrupt its physiology other than by chemical means, exclude it from an area, or adversely alter the pest's environment.

- ***Host plant resistance:*** the breeding and use of crop varieties that are less susceptible to pests (insects, diseases, nematodes, parasitic weed, birds).

- ***Judicious use of pesticides:*** Chemical, microbial, botanical pesticides used along with information on *economic thresholds,* which is the pest density at which management action should be taken to prevent an increasing pest population from reaching the economic injury level. The economic injury level is the smallest number of insects (amount of injury) that will cause yield losses equal to the insect management costs13 . The **economic threshold** is a key IPM decision-making tool. Thresholds are based on considerable amounts of research and/or field experience. If the economic threshold is approached, but not reached, pesticides should not be applied at that time. Instead, the field should be re-scouted within a few days to determine the status of the infestation. Pest populations can decline naturally due to mortality from natural enemies and unfavorable weather conditions. Also, many pests, such as caterpillars, change from an active feeding (larva) to a non-feeding stage (pupa) during their development. Such changes will often produce a natural decline in infestations as pupation occurs.14

- ***Legal/regulatory control:*** Enforcement of measures and policies that range from quarantine to land and water management practices. The prevention of the entry and establishment of undesirable plant and animal pests in a country or area and eradication, containment, or

13 http://cropwatch.unl.edu/archive/-/asset_publisher/VHeSpfv0Agju/content/the-economic-injury-level-and-the-economic-threshold-in-ipm

14 http://ipm.tamu.edu/about/glossary/economic-thresholds/

suppression of pests already established in limited areas (quarantines). This approach to pest management must involve area-wide operations that include many rural households and are enacted for the common good of both farmers and society at large.

In principle, the following broad program of action is advocated for developing IPM technologies for crop protection:

- Identify the major pests and quantify losses caused by them in a given agro-ecosystem;
- Study the biology, behavior and population dynamics of the pests to understand the features that may be exploited for pest management;
- Establish the role of local natural enemies and develop mass-rearing, or mass-culture for disease agents on insects;
- Study and develop other suitable components of IPM, such as intercropping and other cultural practices;
- Integrate these components into an appropriate IPM technology and test for compatibility and efficacy under different ecological conditions; and
- Develop a simple protocol for monitoring the impact of IPM technology in the field.15

Several strategies have been developed for the conservation of soil and water to maintain productivity including rainwater harvesting, live barriers, supplementary irrigation, minimum tillage, mulching, bunded basins, and tree planting (Drechsel et al. 2004).

4.4 CURRENT PESTICIDE USE/AVAILABILITY

Cereal crops usually receive little pesticides treatment contrasting with rice which can receive substantial pesticides, especially in the valley of the Senegal River. Pesticide use is dominated by insecticides, many of which are organophosphates, which can adversely affect the health of farmers. Powder formulations are most prevalent, followed by liquid and Ultra Low Volume (ULV). The intensification in use of pesticides is often justified by invasion of locusts. While figures are usually available for spraying against migratory pest outbreaks, the marketing and use of other pesticides is not well recorded and not transparent. There is little control over the quantity and quality of products used. Pesticides usually arrive in large containers in the villages where demand is high and then blend into the informal market. The sellers of household goods and food are often also sellers of pesticides. Pesticides are often repackaged into smaller containers for sale to farmers.16

Vegetable producers in Senegal face problems including soils heavily infested with nematodes. White fly (Bemisia tabacii) attacks almost all vegetable crops, especially tomatoes. Desire for increased yields and productivity and lack of knowledge of alternative IPM methods leads to increased use of pesticides. Leafy greens can be particularly susceptible to aphids. Some of the improved vegetable varieties can be more

15 http://www.fastonline.org/CD3WD_40/CD3WD/AGRIC/G49ABE/EN/B5_11.HTM#B5_11_2

16 Silent Invaders, Pesticides, Livelihoods and Women's Health; Pesticide Action Network UK, 2003; ISBN 81 250 25995; https://books.google.com/books?id=nZhLeS7yg9wC&pg=PA78&lpg=PA78&dq=availability+of+pesticides+in+Senegal&source=bl&ots=cUJ2J4ETQd&sig=52mapoOX5Yv71RvxMV714FPy08g&hl=en&sa=X&ved=0CEsQ6AEwB2oVChMI4fz7x5iuyAIVA5QeCh3ZhAsv#v=onepage&q=availability%20of%20pesticides%20in%20Senegal&f=false

susceptible to pests and disease. Informal trade in pesticides for control of vegetable pests is flourishing in Senegal contributing to growing pest resistance and disruption of natural control mechanisms. 17

The use of chemical pesticides in tuber production is increasing in developing countries. Because farmers use pieces of tuber to plant their next crop, any pests and diseases in the soil get carried over into that crop. Because of the increasing human population in West Africa there is greater pressure on the land to produce food and farmers have to use shorter fallow periods. This is exacerbating the problem because there is insufficient time for populations of soil-borne pests and diseases to decrease and hence the disease-loading on harvested tubers is increasing. The chemicals used to address this problem are frequently highly toxic and applied with little or no protective equipment.

Production of fruit and exports is increasing in Senegal. However the production for export is concentrated in fewer hands as smallholders are sub-contracted less and less because of their inability to ensure both quality and safety compliance required by the EU.

In survey conducted in Senegal in 2006, more than 80% of farmers said that they prioritize chemical pesticide controls over alternative methods. Local village shops where a source of pesticides for about 63% of the surveyed farmers, 34% of farmers said they bought from authorized distributors, and 3% bought at a weekly markets. Informal sales where there is little awareness about quality and safety pose a risk both to humans and the environment.18

4.5 AVAILABLE PERSONAL PROTECTIVE EQUIPMENT (PPE) AND APPLICATION EQUIPMENT

Farmers are at risk of exposure to occupational hazardous factors including pesticides, dust, bacteria, and molds. The proportion of farmers using PPE in Senegal is, by all accounts, very small. Some farmers wear a mask, gum boots and gloves; others wear long sleeved shirts and trousers but usually no overalls. Commonly, farmers do not possess a complete set of equipment and do not wear complete protection. Cost and availability are quoted as the most influential factors for not wearing PPE.

4.6 PESTICIDE KNOWLEDGE AND AWARENESS

As reported by observations and previous PERSUAPs, a relatively low level of literacy among Senegalese farmers is reportedly limiting the potential for written information to be used to reduce pesticide risks. Even if labels can be read, they are not always understood. Farmers have no training in pesticide use and may misinterpret environmental risk information including pictograms. In Senegal some efforts has been made to improve the levels of literacy of the rural population and of women in particular. However, while farmers can often read in their own language, they cannot understand instructions in French or English. Many accidents are caused by this lack of knowledge.

It is often assumed that men apply pesticides and therefore are most affected. However, women and children can in fact be disproportionately exposed to pesticides. In Senegal women play many roles as farmers in their own fields and as workers in their husband's fields. Women are responsible for many aspects of rain-fed cultivation of rice. In most societies in Senegal the decision making is in the hands of men and therefore it is usually the husband that buys pesticides. Any information that was potentially acquired by the husband at the input store is not necessarily passed on to the women. If any type of product is available or left over at home, this product will likely be used as soon as pest damage occurs.

17 http://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/7932.pdf

18 http://www.pan-uk.org/archive/Projects/Fairness/PN71/pn71p12.pdf

Homesteads are often very close to the field. As such, exposure to pesticides is a concern for expectant mothers and mothers with infants or toddlers. Children's exposure to pesticides is greater than adults because of their size, distinctive diet and play activities. Children and women are exposed to pesticides at home through spraying near the home, entering sprayed fields, pesticide stored in the home, and contaminated clothing. The amount of pesticide actually reaching the target pest is often low, and a greater part of the pesticide used ends up affecting people directly or through contaminating the environment. It is therefore imperative to facilitate access to information about pesticide risks and required safety measures by women.

4.7 AGRICULTURAL EXTENSION

Senegal's agricultural and rural extension agency L'Agence Nationale de Conseil Agricole et Rural (ANCAR)19 is providing rural extension services by developing partnerships with stakeholders in agriculture. This approach uses public and private sectors, Non-Governmental Organizations (NGOs) and other community or farmer-based organizations in the delivery of agricultural extension and advisory services to farmers.

The involvement of the private sector in policy design and implementation has been enhanced through the National Council for Rural Co-operation (CNCR). The CNCR represents producers' associations and plays a central role in dialogue between the government, donors and producers on agro-related issues. The state's direct control over agricultural marketing has been reduced and agricultural trade has been liberalized. Currently, the Ministry of Agriculture outsources its agricultural extension services to the private sector and is expected to focus on its role in agricultural policy formation.20

4.8 LIST OF CANDIDATE PESTICIDES

The final input to the PER analysis is the list of candidate pesticides analyzed for this PERSUAP (i.e., the pesticides being evaluated for suitability of procurement, use, or support with USAID funding).

Only herbicides were requested by the USAID/Senegal FtF IPs. Pesticides requested by current FtF IPs, those approved by the Global Food Security Response Program (FtF USAID-Wula Nafaa & Projet Croissance Economique (PCE)), are listed below:

TABLE 5. AIS REQUESTED BY FTF

LIST OF AIS REQUESTED BY PCE PROJECT IN 2010	PRODUCT
Millet	
Glyphosate	Glyphader 75 SG (registered)
Maize	
Glyphosate 360 g/l	Dominator 360 SL Typhon 360 EC or similar registered products
Pendimethalin	Activus 500 EC, Alligator 400 EC
Aluminum Phosphide	
Rice	
Propanil	Propa 360 (expires in 2015) if renewed or similar product

19 http://www.ancar.sn/
20 http://www.worldwide-extension.org/africa/senegal/s-senegal

TABLE 5. AIS REQUESTED BY FTF

LIST OF AIS REQUESTED BY PCE PROJECT IN 2010	PRODUCT
Bensulfuron methyl	Londax (not on CILSS CSP list) , Herbiriz 10 WP is on the list
Isooctyl Ester of 2,4-D	Weedon

SECTION 5: PER, PART 2—THE 12-FACTOR ANALYSIS

This section integrates, as key inputs, the information compiled in Section 4 into the analysis of the 12 factors required by 22 CFR 216.3(b) to assess the candidate pesticides for use/support with USAID funds, and to determine the specific conditions attendant to their use.

FACTOR A: US EPA REGISTRATION STATUS OF THE PROPOSED PESTICIDES

Senegal is a member state of the Comité permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel (CILSS) – the permanent interstate committee for drought control in the Sahel. CILSS is pooling together national and international expertise and financial resources for better assessment of pesticides and evaluation of procedures for pesticides registration. CILSS promotes circulation of less harmful pesticides in the Sahelian environment and minimizes uncontrolled movement of pesticides across the member states. The Sahelian Pesticide Committee (CSP), the common pesticide registration body, assesses registration dossiers submitted by the agro-chemical industry and grants sales permits valid for all its Member States.21

In the U.S., the US EPA regulates pesticides through the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended. USAID-funded programs are limited to procuring, using, and/or supporting the use of pesticides containing active ingredients and/or products registered by the US EPA for the same or similar uses. Emphasis is placed on "similar use" because some crops and their pest species found overseas are not present in the U.S. Therefore, pesticides may not be registered for the "exact" use anticipated by the USAID project.

Moreover, US EPA designates some products as Restricted Use Pesticides (RUPs). US EPA classifies a particular pesticide as restricted if it determines that the pesticide may be hazardous to human health or to the environment *even when used according to the label*. In the U.S., the pesticides and active ingredients that are labeled RUP can only be sold to and used by certified applicators or persons under their direct supervision, and only for those purposes covered by the applicator's certification (such as for row crops, tree crops, or structural pests).

22 CFR 216 requires a full environmental assessment before use of a RUP can be supported with USAID funds, *except* for RUPs so designated solely for reason of user hazard. RUPs designated solely for reason of user hazard can be authorized for procurement or use with USAID funding on the basis of a *user hazard analysis* in the PERSUAP. In this case, the recipient government must be made aware of the hazard, and a mitigation action will be made and implemented with additional technical assistance.

The analysis of smallholder pesticide knowledge and awareness in Senegal (see Section 4.6) indicates that it would not be appropriate to authorize USAID funds to support user-hazard RUPs for smallholder production. RUP pesticides are allowed in these programs only with a caveat that they will be used, recommended for use, or supported for use by trained pest control specialists. Training must be recognized by the Senegal government authorities.

Table B-1 (Annex B) provides the US EPA registration status of all candidate pesticides, including RUP designation. Pesticides that are not registered in Senegal or by US EPA are disallowed.

21 http://www.insah.org/doc/pdf/RCenglish.pdf

FACTOR B: BASIS FOR SELECTION OF PESTICIDES

The following criteria were applied to develop the final list of approved pesticides. These criteria are applied over the remaining factors of this PER analysis:

CILSS CSP Registration Status

Pesticides must have an active registration in Senegal. Senegal has no independent pesticide registration process. All AIs and products for all uses are regulated by CILSS CSP.

US EPA Registration Status

Pesticides must have active registration in the U.S. for the same or similar crops and pests.

Toxicity/Safety

Pesticide selection must be appropriate not only to the Senegal context but also to the targeted beneficiaries and local conditions. USAID FtF programs in Senegal work mostly with smallholders. This context is characterized by:

- Effective pesticide enforcement in nascent stage;
- Agricultural workers and smallholder farmers not wearing PPE (assuming they wear only the most basic of protective clothing and equipment);
- Limited assistance to implement IPM theory or principles;
- In some cases, the limited ability of smallholder farmers to read or comprehend pesticide labels and safety warnings due to illiteracy;
- Inability to properly identify pests, their population levels, and economic thresholds;
- Inadequate knowledge of pesticides and their dangers, particularly long-term hazards;
- Potential for not following the label and misuse of pesticides;
- Unsafe modes of storage, transportation, handling and disposal of pesticides;
- Potential use of poor quality water that requires modification of label instructions.

Because of the limited knowledge about the hazards of pesticide use, little availability of PPE, poor water quality and absence of government oversight capability, only class III and IV pesticides can be endorsed for use by smallholders.

Additional scrutiny is placed on class II products, which are endorsed only in the following circumstances:

1. The classification is for irritation rather than toxicity per se.
2. The classification is for products with higher concentrations of the AI, so if available products/formulations are known to have a lower concentration, or lower concentrations formulations are mandated, those products/formulations will fall into class III.
3. The mode of use (e.g., restriction to seed treatment) limits adverse human or eco-toxicological effects.

Excluded from use are US EPA Toxicity Class I (extremely toxic) AIs. Also excluded from use are AIs that are internationally classified as Persistent Organic Pollutants (POPs) or as Prior Informed Consent (PIC) chemicals by the Rotterdam Convention, and known carcinogens.

Need

The pesticide must serve a known pest management need for target USAID/Senegal activities. Both current and potential future needs will be considered by the PERSUAP.

Efficacy in local circumstances

Pesticides must be shown to be effective for crops/seeds under climates/conditions similar to those found in USAID/Senegal intervention areas.

Availability

Pesticides must be available in Senegal. Pesticides procured or supported with USAID funds must be legal (registered) in the host country.

Each pesticide endorsed for use under this PERSUAP was re-evaluated against these criteria over the course of the 12-factor analysis presented in this PER.

FACTOR C: EXTENT TO WHICH THE PROPOSED PESTICIDE USE IS PART OF AN IPM PROGRAM

In accordance with this PERSUAP, IPs will promote IPM practices in their activities through demonstrations and direct trainings of farmers, input dealers and extension agents. The existing IP programs and all future agricultural programs will introduce IPM practices to farmers and suggest methods for non-chemical controls. Farmers are expected to adopt IPM and are encouraged to use biological/natural products.

The strategy of USAID partners working with farmers in Senegal will be to stress agronomic improvements based on the adoption of better technologies such as improved crop varieties, agronomic practices, and use of indigenous pest control practices, avoiding synthetic petroleum-based pesticides.

Considering the limited number of extension agents, the IPs should incorporate proper pesticide management within their core farmer training programs and recommendations. Agricultural activities support should fully incorporate IPM as the basis for effective pest management. An IP will often have little control over the actions of beneficiaries in the field. In these situations, IPs will promote and support the use of integrated pest management plans (IPMPs) to the greatest extent practicable.

IPMP is a systematic plan which brings together different pest control tactics into one program.22 Direct pesticide use and direct extension activities by USAID/Senegal programs will be governed by IPM-based crop- and pest-specific IPMPs. The crop-by-crop pest and control measures tables in Annex A are intended to serve as suggestions and drafts of these plans, which will be refined by the agriculture sector IPs.

IPMPs will necessarily be at a level of technical complexity appropriate to the local context, but will embody core IPM principles: emphasis on use of non-chemical controls (building on existing practices, see Section 4.3), with need-based, targeted use of relative-least-toxicity pesticides.

22 "Private Pesticide Applicator Safety Education Manual." Private Pesticide Applicator Manual. University of Minnesota. Web. 18 Aug. 2015. http://www.extension.umn.edu/agriculture/pesticide-safety/ppatmanual.html .

IP pesticide recommendations must stress to farmers pest recognition and a few well-timed applications, rather than applying pesticides for blanket protection from seeding to harvest. For promotion of IPM, pesticide accounting programs and decision tools for use of common pesticides need to be implemented by the IPs.

FACTOR D: PROPOSED METHOD OR METHODS OF APPLICATION, INCLUDING THE AVAILABILITY OF APPLICATION AND SAFETY EQUIPMENT

CROP PRODUCTION

To get the best results without using a significant quantity of pesticides, different application methods are appropriate. The methods used will depend on the type of the crop, pest and pesticide formulation. The method of application must be always consistent with the label.23

As part of the SUAP (Section 6.4), farmers and farm workers must be trained in effective, efficient and safe mixing, handling and application of pesticides and proper maintenance of application equipment. Pollution can be caused by leaking nozzles of the sprayer as well as by accidental spills and during filling, rinsing and disposal of solution.

The SUAP Section 6.4 also promotes the use of safety equipment and its proper maintenance. According to the 2007 PERSUAP, in general, application and safety equipment are available in urban and peri-urban centers at agro-chemical supply stores. In the Senegal River Valley (SRV), masks, gloves, and boots are available, but are highly underutilized (likely due to cost and other factors discussed below). In the south, safety equipment may not be available.24

Sprayers, and masks, boots and gloves are more commonly available than items such as goggles, waterproof aprons and coveralls. The masks are usually dust masks that protect against larger particles. Proper respirators are not commonly available on the market. Small farmers rarely use safety equipment. Gloves and boots are the most common safety equipment used. Product labels regarding safety gear are rarely complied with. The reasons given for not wearing safety equipment are uncomfortable for use in heat and humidity, cost of the equipment, and lack of understanding of the risks involved in the exposure to pesticides, particularly environmental hazards and potential impacts of chronic exposure.

COMMODITY PROTECTION

Post-harvest commodity protection is anticipated to be part of IPs activities. No use of fumigants by untrained and uncertified farmers is approved by this PERSUAP. For further guidelines please see: http://www.usaidgems.org/Documents/FumigationPEA/FumigPEAToolAnnexes_Dec2013_UpdateAnnexUpdated.pdf

In addition, only pesticides included in this PERSUAP are approved for use by FtF Senegal projects. Should current or future projects necessitate use of pesticide AIs or products not covered by this PERSUAP, or covered for different uses, an amendment to this PERSUAP will be necessary.

SEED TREATMENT

It is anticipated that use of pesticide treated seed will be part of IP activities. The IPs questioned, however, did not request approval for pesticides used in seed treatment.

23 http://www.extension.umn.edu/agriculture/pesticide-safety/ppat_manual/Chapter%209.pdf
24 http://www.agf.gov.bc.ca/pesticides/d_1.htm

LIVESTOCK TREATMENT

No pesticides were requested for treatment of external livestock parasites

FACTOR E: ANY ACUTE AND LONG-TERM TOXICOLOGICAL HAZARDS, EITHER HUMAN OR ENVIRONMENTAL, ASSOCIATED WITH THE PROPOSED USE, AND MEASURES AVAILABLE TO MINIMIZE SUCH HAZARDS

Table B-1 in Annex B summarizes the toxicological profile of the full candidate pesticide list. For situations in which IPs have direct control over pesticide use, they will be required to implement/observe core risk mitigation measures identified by the product label and the extended pesticide profiles available on the Materials Safety Data Sheet (MSDS). Where MSDSs are not available in-country from dealers, they can be found online, requested from the manufacturer. In some cases, the MSDS for a similar product can be substituted for the product used. In situations in which IP oversight is limited, they will be required to take all practicable measures to support and promote implementation of these measures. The toxicological information in Annex B supplemented by additional information on pesticide labels and profiles in MSDSs allows screening of the candidate pesticides against additional criteria enumerated under Factor B—Basis for selection of the pesticide.

Before registering a pesticide product and allowing a manufacturer to bring their product to the market, an assigned government agency (US EPA in US; CILSS, CSP in WA) evaluates product toxicity. Potential registrants must generate scientific data necessary to address concerns pertaining to the identity, composition, potential adverse effects, and environmental fate of each pesticide.

Pesticide manufacturers are required to generate scientific data about acute, sub-chronic, and chronic effects of each product. Acute effects are harmful effects in an organism through a single or short-term exposure and include oral (ingestion), dermal (skin) toxicity and irritation, skin sensitization (an allergic response following skin contact), inhalation, and eye irritation.

The usual expression of acute toxicity is LD_{50}, which is the average lethal dose in milligrams per body weight in kilograms (mg/kg) required to kill 50 percent of a test population. Toxicity tests are conducted on experimental animals, such as white rats, mice, and rabbits. Because toxicity depends upon body weight, the amount of chemical considered lethal for a child is less than the amount for an adult. Conversely, it takes more to kill a large animal than a small one.

The 'signal' word (e.g. Danger, Warning, Caution) on the pesticide label applies to the most toxic method or route of exposure Generally, if ingested, class I substances can be lethal to an average-sized adult person at a dose of less than 5 g (0.18 oz.), Class II at 5 - 30 g (0.18 - 1.058 oz.), and Class III at more than 30 g (1.058 oz.).[25] The table below provides details on US EPA acute toxicity categories I to IV.

TABLE 6. US EPA TOXICITY CATEGORIES

STUDY	CATEGORY I	CATEGORY II	CATEGORY III	CATEGORY IV
Acute oral	Up to and including 50 mg/kg	>50 through 500 mg/kg	>500 through 5,000 mg/kg	>5,000 mg/kg

25 http://sitem.herts.ac.uk/aeru/ppdb/en/docs/Background_and_Support.pdf

TABLE 6. US EPA TOXICITY CATEGORIES

STUDY	CATEGORY I	CATEGORY II	CATEGORY III	CATEGORY IV
Acute dermal	Up to and including 200 mg/kg	>200 through 2,000 mg/kg	>2,000 through 5,000 mg/kg	>5,000 mg/kg
Acute inhalation (based on 4 hour exposure)	Up to and including 0.05 mg/L	>0.05 through 0.5 mg/L	>0.5 through 2 mg/L	>2 mg/L
Primary eye irritation	Corrosive (irreversible destruction of ocular tissue) or corneal involvement or irritation persisting for more than 21 days	Corneal involvement or other eye irritation clearing in 8-21 days	Corneal involvement or other eye irritation clearing in 7 days or less	Minimal effects clearing in less than 24 hours
Primary skin irritation	Corrosive (tissue destruction into the dermis and/or scarring)	Severe irritation at 72 hours (severe erythema or edema)	Moderate irritation at 72 hours (moderate erythema)	Mild or slight irritation at 72 hours (no irritation or slight erythema)

Sub-chronic effects are the ability of a toxic substance to cause effects for more than one year but less than the lifetime of the exposed organism. Chronic toxicity is the ability of a substance or mixture of substances to cause harmful effects over an extended period, usually upon repeated or continuous exposure, sometimes lasting for the entire life of the exposed organism. Chronic toxicity tests include tests for carcinogenicity, mutagenicity, reproductive and developmental toxicity, neurotoxicity, and general metabolism studies.

Ecological toxicity includes potential for air, water and soil pollution, and effect on non-target organisms including mammals, birds, aquatic organisms, amphibians and reptiles, non-target insects, and non-target plants.

Pesticides banned by Rotterdam and Stockholm conventions and banned for use in Senegal. All RUP products are allowed for use only by trained professionals. Products with acute toxicity class I (Red Label, Words Danger-Poison, skull and crossbones on the pictogram) are rejected by this PERSUAP for use except where specified for use by trained professionals.[26] Products with toxicity class II and potential chronic effects are allowed for use only by trained individuals using proper PPE.

The SUAP in Section 6 identifies restrictions on the set of AIs that are supported for use only by trained and certified agricultural or pest control professionals, based on toxicity screening. The SUAP details measures for minimizing pesticide risks. These measures will include: (1) adoption of IPM approach that emphasized prevention, (2) sanitation and exclusion of pests, (3) use of traditional practices, and (4) utilizing pesticides only as a last resort when other options have failed. Note that the toxicity table in Annex B also provides a key reference for development of crop- and pest-specific pest management plans.

26"Hazard Communication Standard Pictogram." Hazard Communication Standard Pictogram. United States Department of Labor. Web. 18 Aug. 2015. https://www.osha.gov/Publications/HazComm_QuickCard_Pictogram.html

FACTOR F: EFFECTIVENESS OF THE REQUESTED PESTICIDES FOR THE PROPOSED USE

Pest management needs are documented on a crop-by-crop basis in Annex A. For each crop, the tables in Annex A identify pest-specific suggested controls. Three sources of data have been used to specify these proposed uses; while none of these sources is complete on their own, together they offer a high degree of assurance that the pesticides will be effective for their proposed use:

1. The proposed pesticide uses are consistent with their US EPA registrations; in each case, US EPA has registered these pesticides for use on the same or similar crops and against the same or similar pests. Such registration requires that the effectiveness of the pesticides be demonstrated. This demonstration of effectiveness is within the U.S. agro-environmental context.
2. All pesticides endorsed for use are also registered for use by CILSS.
3. Each of the recommended uses has been cross-checked against information provided by pesticide label, and registration and label information was supplemented from published literature or recommendations available from other countries, as well as from online searches.

In general, development of resistance is a key threat to pesticide effectiveness. The introduction of pesticides and continuous use over time enhances the probability that resistance will develop. The use of pesticides within an IPM framework, as required by this PERSUAP, is a key measure to prevent resistance development.

Monitoring is required to confirm that the pesticides being recommended will perform as expected. Evaluation of pesticide efficacy (and of pest management plans more generally) is a required part of demonstration plot management. Monitoring for and reporting of resistance development is a required element of SUAP compliance reporting. Counterfeit or obsolete products and product adulteration should be addressed by current programs through building awareness among farmers and the introduction of programs promoting quality control.

FACTOR G: COMPATIBILITY OF THE PROPOSED PESTICIDE USE WITH TARGET AND NON-TARGET ECOSYSTEMS

THE DETRIMENTAL ENVIRONMENTAL IMPACT OF PESTICIDES

consists of the effects of pesticides on non-target species. Over 98 percent of sprayed insecticides and 95 percent of herbicides reach a destination other than their target species, because they are sprayed or spread across entire agricultural fields. Runoff can carry pesticides into aquatic environments while wind can carry them to other fields, grazing areas, human settlements, and undeveloped areas, potentially affecting other species.

PESTICIDES IN SOIL

When pesticides are applied in the field, the effect of soil-applied pesticides can sometimes be short-lived. In fact, in some instances they may enhance the population of certain soil microorganisms. Soil organisms are responsible for contributing to the decomposition of dead animal and plant material into organic matter, which is an important component of soil fraction. Other microorganisms can be involved in the natural control of soil pests. Aside from their direct effects on pest organisms, soil microbes are a major agent in degrading pesticides. The breakdown of pesticides is beneficial from a crop rotation standpoint and for food residue concerns. It also provides herbicide selectivity in some instances. The value of certain soil bacteria that have a symbiotic relationship with leguminous plants in fixing nitrogen translates into reduced synthetic nitrogen fertilizer inputs and increased crop yields.

Chemical degradation of pesticides in soils is governed by a variety of factors, such as pH, presence of water, and the presence of various catalysts and reagents capable of attacking reactive compounds. Many insecticides have been shown to undergo photoreactions to form products that are either more toxic or less toxic than the parent compounds.27

Each pesticide or pesticide class comes with a specific set of environmental concerns.28 Some pesticides result in detrimental impacts to birds, beneficial insects, fish and animals. Before applying a pesticide, it is important to become familiar with the area to be treated and its surroundings. Some pesticides are less "environmentally friendly" than others and may not be selected for sites with special concerns.

PESTICIDE DRIFT

Pesticide dust or droplets can drift through the air at the time of application or soon after to sites other than the area intended. Pesticide droplets are produced by spray nozzles used in application equipment for spraying pesticides on crops and home gardens. Pesticide drift can pose health risks when sprays and dusts are carried by the wind and deposited on other areas such as nearby homes and schools, adjacent fields, water bodies, wildlife and plants.29

EFFECT ON NON-TARGET TERRESTRIAL ORGANISMS

Animals and humans can be poisoned by pesticide residues that remain on food. Poisoning can occur when wild animals or people enter sprayed fields or nearby areas shortly after spraying. Reductions in bird populations have been found to be associated with periods and areas in which pesticides are used. Granular formulations have been found most toxic to birds when they mistake the granules for food. Pesticides also affect birds indirectly by reducing food sources. Wild bees, certain wasps, honeybees, and other insects are important pollinating agents of crops. Some pesticides are harmful to these pollinators, causing direct losses of the insect populations and indirect losses of crop yield because of the lack of adequate pollination. Pesticides can be harmful to other beneficial organisms that include various insects, mites, nematodes, fungi, bacteria, and other microorganisms that feed on or parasitize pest species. There are several different classes of pesticides that have a wide range of toxicity to honey bees. Neonicotinoids are the group of pesticides most commonly implicated as a contributing cause of widespread honey bee losses, both through direct toxic action and chronic effects on the immune system. Organophosphate compounds have a wide range of toxicity levels on bees. Pyrethroids are not considered to have lethal effect and **Insect Growth Regulators have been found to have low toxicity levels on bees.**30

SURFACE WATER POLLUTION

Pesticides can pollute surface water and have adverse effects on people and animals drinking this water, fish, aquatic invertebrates and aquatic plants. Fish and other aquatic biota may be harmed by pesticide-contaminated water. Amphibians have permeable skin that is highly absorbent, making them extremely susceptible to pesticides. Pesticides can also harm beneficial aquatic insects that pray on pests.

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27 Perry, A.S., and R.Y. Perry. "Effects in Arid Regions." John Wiley & Sons Ltd, 1989. Web. 18 Aug. 2015. http://dge.stanford.edu/SCOPE/SCOPE_38/SCOPE_38_4.2_Perry_155-194.pdf .

28 Originally published in 1987 as Pesticide Use and the Environment, Nevada Pesticide Applicator's Certification Workbook, SP-87-07, by W. Johnson, J. Knight, C. Moses, J. Carpenter, and R. Wilson. Updated in 2012 by M. Hefner and S. Donaldson, University of Nevada Cooperative Extension, and J. Carpenter, Nevada Department of Agriculture. http://www.unce.unr.edu/programs/sites/pesticide/files/pdf/PesticideUseAndEnvironment.pdf

29 http://www2.epa.gov/reducing-pesticide-drift/introduction-pesticide-drift

30 "Types of Pesticides." Types of Pesticides. Web. 18 Aug. 2015. http://www.pollinator.ca/canpolin/typesofpesticides.html .

MARINE POLLUTION

Pollution to the marine environment can come from land and air sources. Pesticide pollution can impact marine life, mangrove forests and people.

GROUNDWATER POLLUTION

Pesticides that are mobile in soil may pollute groundwater. Leaching occurrences into the groundwater will depend on type of pesticide used, soil texture, pattern of pesticide use, amount of organic matter in the soil, and depth of the water table.

HUMID AND ARID ECOSYSTEMS

Pest management in humid areas is more complex than in arid ecosystems because of the greater number of pests that need to be controlled. Most agricultural practices are similar in humid and arid areas, except water and pest management frequency of application and pest control complexity.

FUNGICIDES

Some fungicides can irritate skin and eyes, while others may cause throat irritation and coughing when inhaled. Prolonged inhalation of certain fungicides, such can cause neural and visual disturbances. The long-term effects of fungicides on humans are still unknown, but some may be mutagenic - permanently silencing or reprogramming normal genes, with the effect possibly lasting several generations.31 Pesticides can cause harm to the fetus or embryo during pregnancy, causing birth defects while the mother shows no signs of toxicity. Pregnant and lactating women must be informed not to handle pesticides determined or suspected to cause reproductive and developmental harm, e.g., birth defects and impairment of normal growth and development.

Regular use of fungicides can potentially pose a risk to the environment, particularly if residues persist in the soil or migrate off-site and enter waterways. Reading the MSDS and the label is extremely important for minimizing adverse impacts of pesticides on human health and the environment.

HERBICIDES

Because plants and mammals differ in organization and physiology, it might be expected that herbicides would constitute little or no chemical hazard to mammals. However, surfactants in herbicide formulations can be more toxic to mammals (including humans) than the active ingredients. Some herbicide products have the signal words signal words "Danger-Corrosive" or "Danger-Poison" on the label. Herbicides with these signal words are not approved for use of this PERSUAP. "Warning" also appears as a signal word for herbicides with label statements indicating that they can cause eye or skin irritation or burns or may be harmful if swallowed, inhaled, or absorbed through the skin. Herbicides with the word "Caution" mean that the product has low oral, dermal, and inhalation toxicity and has little or no irritability to either the eyes or the skin.

Herbicides are believed to present a bigger concern because their concentration in the water supply, due to runoff from agricultural use. Herbicides can be slightly, moderately or highly toxic to aquatic organisms. They may cause reduction of sensitive species and abundance of tolerant species.[98] Long term effects of concern include endocrine disruption and carcinogenicity. Resistance of weeds to herbicides is becoming a worldwide problem. All herbicide labels warn the user to keep the product out of lakes and streams. Many herbicides, including glyphosate are carrying label statements about groundwater

31 http://www2.epa.gov/sites/production/files/documents/rmpp_6thed_ch16_fungicides.pdf

contamination. Care must be taken to ensure that such product is not used where groundwater contamination is likely.32 In 2015, Glyphosate was identified as a potential carcinogen by USEPA and the State of California became the first State to require labeling of Glyphosate products such as Roundup as potential carcinogens. World Health Organization's research arm also recently found that the chemical is probably carcinogenic to humans, and research has also linked glyphosate to the steep decline of monarch butterflies. Scientists have increasingly raised new alarms about potential negative health impacts tied to Glyphosate, including a recent study suggesting that long-term exposure to tiny amounts of the chemical (thousands of times lower than what is allowed in drinking water in the US) could lead to liver and kidney problems.

PESTICIDES THAT ARE LABELED AS NATURAL OR ORGANIC are not necessarily harmless to humans or the environment. Many are quite safe to use but some have hazards associated with them. Other problems can emerge from poor pesticide management practices. Over time, repeated application increases pest resistance, while its effects on other species can facilitate the pest's resurgence.33

TOXICOLOGY INFORMATION

For each candidate pesticide, Table B-1 in Annex B provides toxicology information for a range of non-target organisms: mammals (for which human toxicity results are proxies), birds, fish, aquatic invertebrates, beneficial arthropods (invertebrate animal having an exoskeleton, e.g., crab, shrimp), honeybees, earthworms. The US EPA registration process requires that toxicity of a pesticide against each of these classes of organisms be assessed by a standardized test.

Four basic chemical characteristics control pesticide movement in the environment: solubility, adsorption, volatility and persistence. Solubility is the ability of a pesticide to dissolve in a solvent, usually water. Adsorption is the ability of a pesticide to bind with soil particles. Volatility is the ability of a pesticide to turn into a gas or vapor. Persistence is the ability of a pesticide to remain in its original active form and not break down into an inactive form.34 Pesticide likelihood to pollute are also based on how much pesticide is applied, its formulation, and how and where the pesticide is applied.

In addition to a pesticide's toxicity level to the class of non-target organism in question, the solubility, adsorption, persistence, and volatility of a pesticide in the environment and its ultimate mobility (e.g., potential to enter groundwater, move and remain in soil and sediment, stay in the air) strongly affect the significance of adverse effects on non-target organisms. Annex B provides additional information on this topic.

32 https://ipm.illinois.edu/pubs/iapmh/11chapter.pdf

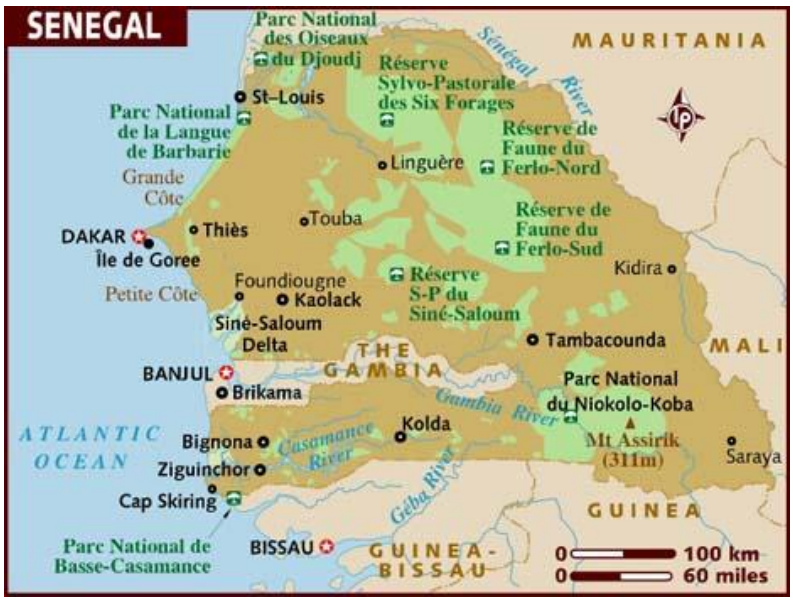
33 "Pesticides: Environmental Effects." EPA. Environmental Protection Agency. Web. 18 Aug. 2015. http://www.epa.gov/pesticides/ecosystem/ .

34 Originally published in 1987 as Pesticide Use and the Environment, Nevada Pesticide Applicator's Certification Workbook, SP-87-07, by W. Johnson, J. Knight, C. Moses, J. Carpenter, and R. Wilson. Updated in 2012 by M. Hefner and S. Donaldson, University of Nevada Cooperative Extension, and J. Carpenter, Nevada Department of Agriculture. http://www.unce.unr.edu/programs/sites/pesticide/files/pdf/PesticideUseAndEnvironment.pdf

FACTOR H: THE CONDITIONS UNDER WHICH THE PESTICIDE IS TO BE USED, INCLUDING CLIMATE, FLORA, FAUNA, GEOGRAPHY, HYDROLOGY, AND SOILS

Senegal is located in the northwestern portion of the African continent. The country's total area is 196,190 km², of which 4,190 km² is water. Senegal is one of few countries to have a near-enclave within its borders—the small nation of The Gambia.

Figure 4: Map of Senegal



Source: lonelyplant.com

THE TOPOGRAPHY

Senegal is generally quite flat (elevations below 50 m on nearly 75% of the territory). Broken terrain and steep slopes are found only in the extreme southeast.

The highest altitudes (highest point 581 m) are found in the far south-east of the foothills of the Fouta. Senegal lies on the African Tectonic Plate. It is the westernmost part of a broad savannah extending across the Sahel. Most of the country lies upon a low sedimentary basin characterized by an expanse of flat and undulating plains with sparse grasses and woody shrubs.

CLIMATE

Senegal's climate is conditioned by the tropical latitude of the country and by the seasonal migration of the Inter-Tropical Convergence Zone (ITCZ)—the line or front of low pressure at which hot, dry continental air meets moist oceanic air and produces heavy rainfall. The prevailing winds are also characterized by their origin: the dry winds that originate in the continental interior and the moist maritime winds that bring the rains.

The dry winds, sometimes called the dry monsoon, consist of the northeast trade winds. In winter and spring, when these winds are strongest, they are known as the 'Harmattan.' They bring only a very light rain, which the Wolof people of Senegal call the heug. The moist rain-bearing winds blow primarily from the west and northwest. Beginning in June with the northward passage of the ITCZ, these winds usher in

the summer monsoon. As the ITCZ returns southward beginning in September, the rainy season draws to a close. The slow north-south migration of the ITCZ results in a longer, heavier rainy season in the southern part of the country.35 May to November is usually hot, humid and rainy with strong southeast winds, while December to April month are dominated by hot, dry, harmattan wind.

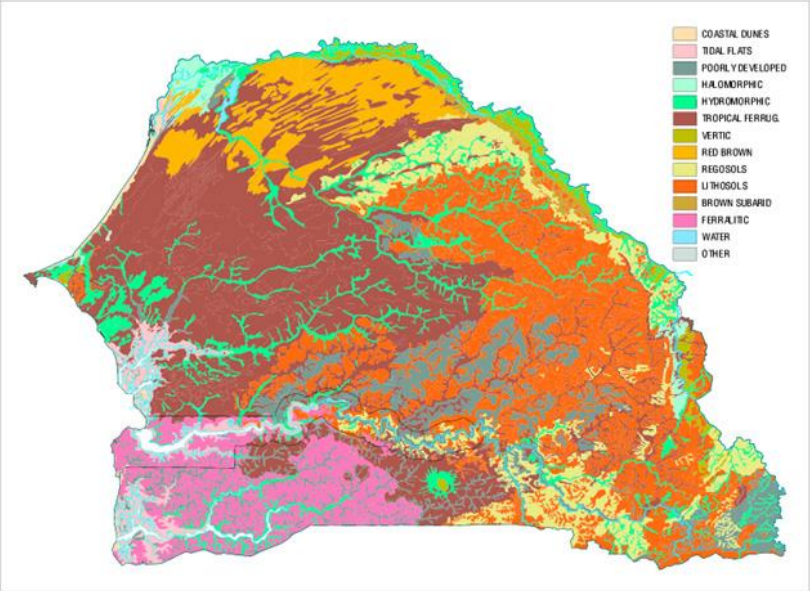
Broadly, the Senegal climate can be attributed to three regions: the Coastal, the Sahel, and the Southern region. The Sahel comprises the Sahelian - arid, Sahelo-Sudanian and the Sudanic – semi-arid zones, and the Southern region includes Sudano-Guinean- sub-humid and Sub-Guinean - humid climates.

CLIMATE CHANGE

According to US Geographic Services (USGS) Senegal is becoming substantially hotter. Since 1975, temperatures have increased by almost 0.9°C across much of Senegal. Transition to an even warmer climate could reduce crop harvests and pasture availability, amplifying the impact of droughts. There were recent rainfall variations in Senegal. While the rainfall increased from the 1980s to1990s, for the past ten years it has remained steady, and it remains to be seen if the earlier rainfall increases will persist.36

THE SOILS of Senegal range from dry sandy soils in the north, to tropical ferruginous soils in the central region, and to ferralitic soils in the South. Overall, soil fertility is low and soils are mostly fragile, making them highly susceptible to water and wind erosion (USGS/EROS, op. cit.). The soil texture of most fresh water river valleys tends to be high in clay and silt content. Soils in these valleys are classified as "generally good soils", i.e., they do not have serious limitations and are able to produce good yields of suitable, climatically adapted crops.

Figure 5: Senegal Soils Map



Source: http://lca.usgs.gov/lca/biodiversity_senegal/mapgallery.php

35 (http://www.britannica.com/EBchecked/topic/534445/Senegal/55044/Climate)
36 http://pubs.usgs.gov/fs/2012/3123/FS12-3123.pdf

HYDROLOGY

The largest water resource in the country is the Senegal River in the North, shared with Mauritania, Mali and Guinea. While the water of the Senegal River is abundant, water in most of the rest of the country is scarce. Other major surface water bodies include the Casamance River, the Gambia River, the Saloum River, the Geba River, the Falémé River and the Tamna lagoon near Thiès. In arid and semi-arid regions groundwater is generally the only perennially available source of water and the availability and security of these resources is of major concern. Senegal has about 3 billion cubic meters per year of renewable groundwater resource including deep and shallow aquifers. Groundwater overexploitation is reportedly has become a serious problem in parts of Senegal and villagers need to drill as deep as 80 meters to pump water.37

SENEGAL RIVER VALLEY

The Senegal River is the longest in West Africa, with four countries (Guinea, Mali, Mauritania and Senegal) sharing its Basin. Riparian communities living on the floodplains in the Middle Valley Region in Senegal are particularly dependent on the river, with fishers, pastoralists and flood recession agriculturalists sharing the production potential of these vast wetlands. Manantali Dam, built in 1988 to generate hydropower, and to provide water for irrigation and increased navigation, was also designed to ultimately stop flooding of the Middle Valley floodplains. It was envisaged that the riparian people in that area would transform to rice growers on irrigated land. Studies showed substantial realized and potential ecological and social losses from such a policy, and considerable costs as well as benefits involved in the move to irrigated agriculture. [38]

Figure 6: Senegal River Basin Map

Source: http://webworld.unesco.org/water/wwap/case_studies/senegal_river/

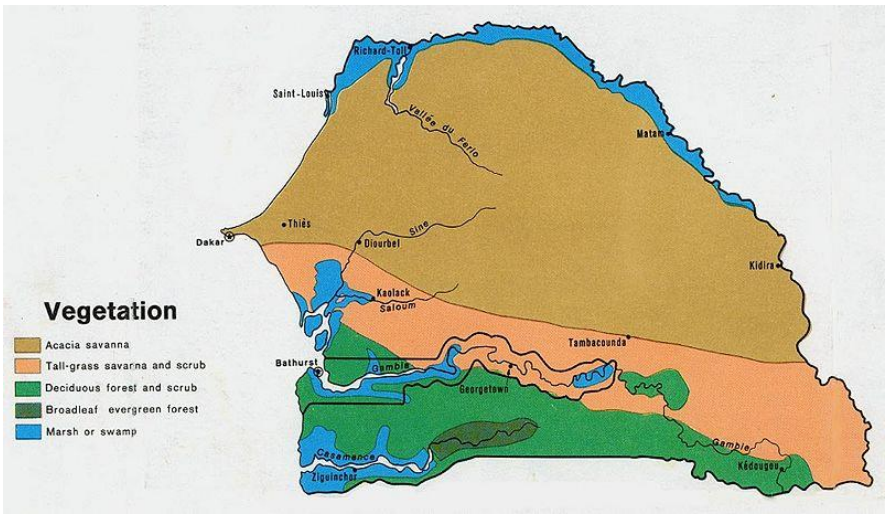
37 https://en.wikipedia.org/wiki/Water_supply_and_sanitation_in_Senegal
38 https://cmsdata.iucn.org/downloads/senegal.pdf

BIODIVERSITY

Vegetation change caused by extreme annual rainfall differences between the semi-arid north and the wetter south. For nine months of the year, the Sahel is a vast expanse of brown. Greenery comes with the rainy season, but can be quickly consumed by grazing animals or farmers in search of crop lands. Extensive cultivated fields of grain crops are limited to the delta Senegal River. To the south the Sudanian vegetation includes savannah woodland and dry woodland. With onset of rainy season the area is quickly transformed by vigorous vegetation growth. The Senegal River Delta is affected by invasive alien species.

The Guinian region is found in the Soutwest corner of Senegal. It is a region of semi-evergreen dense forest. Many of these forests has been cut and replaced with cultivation of rice, groundnuts and manioc. Despite the relatively high rainfall the South has a distinct dry season that lasts seven to eight month.39

Figure 7: Senegal Vegetation Map



Source http://www.newworldencyclopedia.org/entry/File:Senegal_gambia_veg_1972.jpg

PROTECTED AREAS

Senegal has a large protected area network; in addition, rural populations protect many sites as places of worship. In total, 10 percent of the country's territory is currently under protection. Some of the plant and animal species can be now found only in the protected areas and some of Senegal's plants, mammals, reptiles, fish and birds are on the list of endangered species.[40]

The Forest Code defines classified forests, reforestation or restoration areas, national parks, strict nature reserves and special reserves, and provides for the classification and declassification of forests, and for the administration of protected areas. Senegal is a signatory to the Bern Convention, which is of particular importance to migratory birds. The Bern Convention is a binding international legal instrument in the field of nature conservation, covering most of the natural heritage of the European continent and extending to some States of Africa.

39https://books.google.com/books?id=dNSrPncx8NkC&pg=PA23&lpg=PA23&dq=guinean+zone+vegetation+senegal&source=bl&ots=qsEe2lNMs5&sig=s__bzSdOA7IG_eqF21OmC6JVBZs&hl=en&sa=X&ved=0CC8Q6AEwAmoVChMIprf6_Ji2yAIVB10eCh3wpw58#v=onepage&q=guinean%20zone%20vegetation%20senegal&f=false

40 http://earthsendangered.com/search-regions3.asp?search=1&sgroup=allgroups&ID=485

The National Parks Service, incorporated within the National Parks Directorate, is primarily responsible for the protection of wildlife within national parks. It functions as a paramilitary organization and has trained armed guards for prevention of poaching. National Parks *(Parc National)* are areas where hunting, capturing animals or exploitation of flora, soil or subsoil is prohibited. In some locations public access for educational or recreational purposes is permitted.

Special reserves (*Réserve spéciale*) are areas in which partial or total, temporary or permanent restrictions may be necessary in certain circumstances (including scientific explorations, tourism, etc). Classified forests (*Forêt classée*) are area of bamboo, forage trees, palms and other vegetation exploited for various products e.g. wood and fruit. These areas are not utilized for agricultural production.[41]

Senegal protected areas include[42]:

TABLE 7: SENEGAL PROTECTED AREAS:

TYPE OF PROTECTED AREA	NAME
International Parks	Reserve des éléphants du Fleuve Senegambien
National Parks	Basse-Casamance Delta du Saloum Djoudj (World Heritage Convention site) Iles de la Madeleine Langue de Barbarie Niokolo-Koba (World Heritage Convention site)
Nature Reserves	Dindefello Special Faunal and Floral Reserve Kassel Special Bird
Hunting Reserves	Maka-Diama
Wildlife Reserves	Ferlo-Nord Ferlo-Sud Gueumbeul Ndiael Popenguine
Classified Forests	Samba Dia
Special Reserves	Kalissaye
Wetlands of International Importance (Ramsar)	Bassin du Ndiaël

41 Source: UNEP-WCMC, Ministère de l'Environnement et de la Protection de la Nature

42 http://www.parks.it/world/SN/Eindex.html

TABLE 7: SENEGAL PROTECTED AREAS:

TYPE OF PROTECTED AREA	NAME
	Delta du Saloum Djoudj Gueumbeul Tocc-tocc
World Heritage Convention Sites	Djoudj National Bird Sanctuary Island of Gorée Niokolo-Koba National Park The Island of Saint-Louis
United Nations Educational, Scientific and Cultural Organization (UNESCO) – Man and the Biosphere (MAB) Reserves	Delta du Saloum Forêt classée de Samba Dia Park national du Niokolo-Koba

Senegal has five designated Ramsar sites, which signify designated wetlands of importance, as guided by the Ramsar Convention on Wetlands. The Ramsar Convention is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. In helping to maintain and preserve the biodiversity and productivity of wetlands, countries party to the Ramsar Convention must work to identify wetland areas—lakes and rivers, underground aquifers, swamps and marshes, wet grasslands, peatlands, oases, estuaries, deltas and tidal flats, mangroves and other coastal areas, coral reefs, and all human-made sites such as fish ponds, rice paddies, reservoirs and salt pans—to protect while pledging support for transnational wetlands.[43]

1. **Gueumbeul.** Designated September 29, 1985, Gueumbeul is an extensive saline lagoon surounded by Sahelian vegetation. It is fed by seasonal rainfall and saltwater inflow from the Senegal River. Various waterfowl are supported by Gueumbeul, as well as Palearcic migrants and nesting Afrotropical species. The site also contains an experimental breeding center for Sahelian mammals and reptiles. Human activities in the area include nature conservation and education, tourism and recreation.[44]
2. **Djoudj.** Designated June 16, 1993, Djoudj is an inland delta with a complex system of brackish lakes and pools linked through channels of the Senegal River floodplain. Water levels are controlled artificially. Vegetation in the area consists of Sahelian Tamarix and savannah with herbs and grasses in dry areas and reedbeds in flooded areas. Up to 400,000 birds can be present in January for breeding, staging and wintering, making this site an internationally important bird area. The main human activities in the area are nature conservation and ecotourism, and in

43 (Ramsar n.d.)

44 Ibid

surrounding areas, rice cultivation, livestock rearing and hunting.[45] The Djoudj National Bird Sanctuary is also a UNESCO Natural World Heritage site.[46]

3. **Bassin du Ndiaël.** Designated July 11, 1977, the Bassin du Ndiael is a basin of saline soil in the Senegal River floodplain. Vegetation is mostly annual grasses and Acacia scrub. In the 1960's, the natural hydrology of the region was changed to improve agricultural conditions, leading to drought and its subsequent listing as a Ramsar site. A hydrological restoration plan is in place to return the site to its prior international importance. There are a large number of wintering migrant birds visiting the area now, highlighting the success of this restoration plan. [47]
4. **Delta du Saloum.** Designated April 3, 1984, the Saloum Delta consists of mangrove forests dissected by saline channels, lagoons, islands and islets. The area also has dune areas with dry, open forest. The site is home to varied fauna, including breeding turtles and nesting water birds. Human activities in the area include nature conservation, tourism and pastoralism. Surrounding areas are used for agriculture, livestock, fishing and hunting. Management issues in the area include illegal gathering of mollusk, bird and turtle eggs and exploitation of plant products.[48]
5. **Réserve Naturelle Communautaire de Tocc Tocc.** Designated fairly recently on December this site is a permanent coastal freshwater lake which provides a habitat for spawning, nursery and feeding for almost a hundred fish species. The site serves as home for a large colony of water birds, the freshwater Adanson's mud turtle (Pelusios adansonii) and the iconic and vulnerable West African Manatee (Trichechus senegalensis). As well as acting as a reservoir of biodiversity, the site supports the hydrological balance of the Senegal River basin and provides services including groundwater recharge and flood control, and also desalination of brackish water for agricultural purposes. It is also a source of livelihoods for resident populations, which engage mainly in artisanal fisheries and harvesting of forest products such as Cyperus articulatus, a sedge species used as a base in the perfume industry. The main threats facing the site are overfishing and the uncontrolled abstraction of the water.[49]

45 Ibid

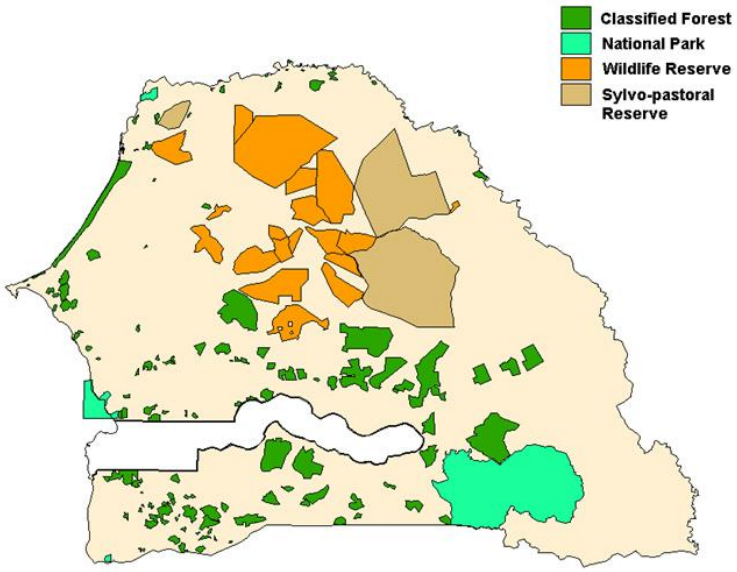
46 Senegal, UNESCO; accessed via the internet on 25 August 2015 at: http://whc.unesco.org/en/statesparties/sn

47 Ibid

48 Ibid

49 http://www.ramsar.org/wetland/senegal

Figure 8: Senegal Protected Areas



Source: http://lca.usgs.gov/lca/biodiversity_senegal/results.php

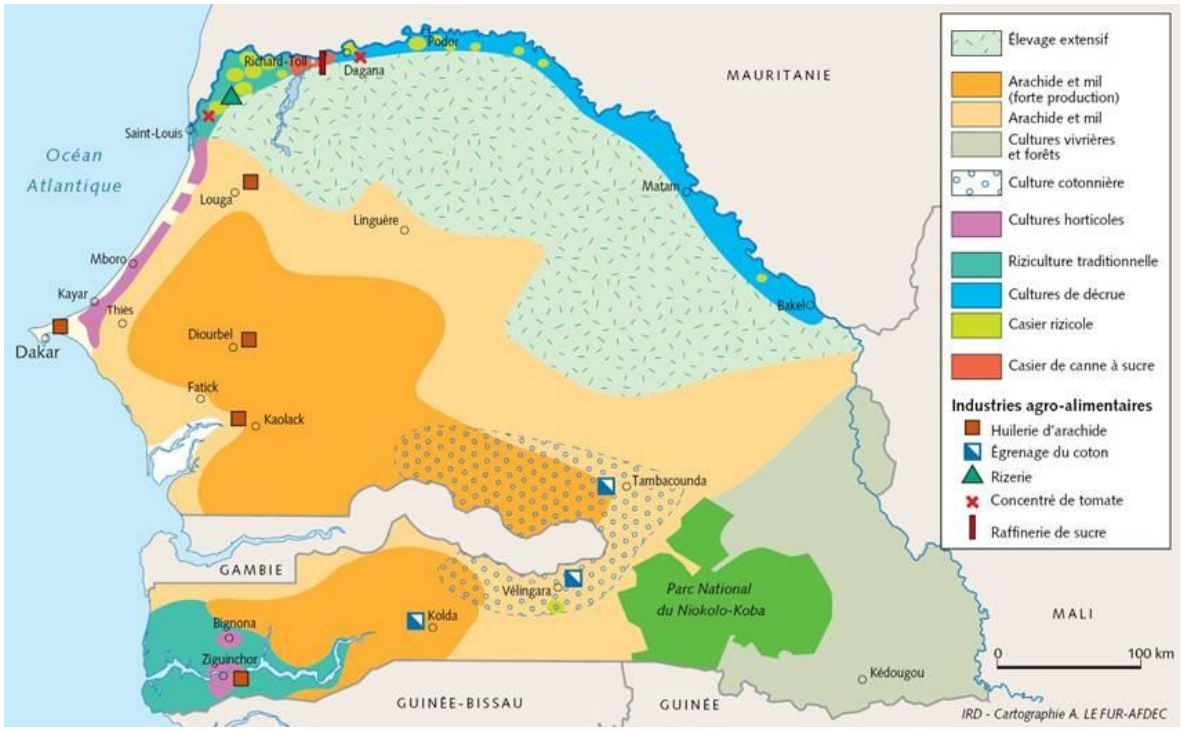
AGRICULTURAL LAND USE

In Senegal, the major millet-producing region is Kaolack. Rice is traditionally grown in Casamance. However, declining rainfall and the abandonment of rice fields due to the emergence of acidification and soil salinization led to a decline in rainfed rice growing in the lowland areas to the benefit of upland areas. There are also two quite distinct types of rice growing: irrigated rice farming in the Senegal River Valley and in the Anambé basin on the one hand, and the traditional or rainfed lowland or upland rice farming in the southern regions of Fatick, Zinguichor, Sédhiou, Kolda, Tambacounda and Kédougou on the other. Producers tend to become more and more involved in the processing and marketing of their production.50

In 2011, the estimated population of Senegal was 13.0 million (CIA, 2011). Senegal has a population growth rate of 2.5 percent; at this rate the population will double every 27 years. Between 1990 and 2010, the population of Senegal increased 64 percent. This population expansion will place increasing stress on limited natural resources. Analysis of crop statistics from the Food and Agriculture Organization of the United Nations (FAO, 2011) suggests that increases in crop yields have not kept pace with population growth. Between the 1960s and 2000s, the amount of farmland per person has declined by 300 percent from about 0.3 hectares per person to about 0.1 hectares person, while yields have only increased by about 70 percent. A continuation of these trends will be unfavorable for national food security. Projections for 2025 based on these trends suggest that Senegal will produce 30 percent less cereal crops per person.

50 http://www.jica.go.jp/english/our_work/thematic_issues/agricultural/pdf/senegal_en.pdf

Figure 9: Senegal Agricultural Land Use



Source: http://www.comap.ca/kmland/display.php?ID=222&DISPOP=VRCPR

FACTOR I: THE AVAILABILITY AND EFFECTIVENESS OF OTHER PESTICIDES OR NON-CHEMICAL CONTROL METHODS

Only a limited number of pesticides are going to be used by the IPs who plan to promote IPM and best agricultural practices for training in production of cereals, legumes, tubers, vegetables and fruit in Senegal. As noted, the "pests and control methods" tables presented in Annex A for each target crop serve as rough drafts for the crop- and pest-specific pest management plans to be developed by IPs.

In these tables, many non-pesticide remedies are recommended as control measures, some of which may already be practiced by the IPs. For some crop pests, only non-chemical controls are recommended. However, as established, effective pest management across the target crops, particularly at larger and more intensive production scales, is likely to require some chemical controls. As noted, pesticide use/support will be governed by crop- and pest-specific pest management plans. A major purpose of these plans is to assure a well-considered mix of non-chemical and chemical controls.

Per the Annex A tables, pesticides are not likely to play a critical role in control of use of improved crop management practices and crop varieties as well as biological, cultural, physical, mechanical, and other IPM control methods discussed in Factor C.

There are, in a number of cases, pesticides that are theoretically more effective against target pests, but are either not registered by US EPA, not available locally, or fail the toxicological/safety screens enumerated under the previous analysis factors.

FACTOR J: THE REQUESTING COUNTRY'S ABILITY TO REGULATE OR CONTROL THE DISTRIBUTION, STORAGE, USE AND DISPOSAL OF THE REQUESTED PESTICIDE

PESTICIDE REGISTRATION PROCESS

Pesticides in Senegal are registered through the regional CSP, a committee of experts managed by the *Institut du Sahel* (INSAH) in Bamako. INSAH is the science and policy body for agriculture within the CILSS. CILSS comprises nine countries in West Africa Burkina Faso, Cape Verde, Chad, Guinea Bissau, The Gambia, Mali, Mauritania, Niger, and Senegal working on common problems in agriculture, natural resources management, and climate science.

CSP's role is to accept requests and registration dossiers from manufacturers or importers. CSP reviews these dossiers for provisional and, where possible, full and final registration. Import authorizations must be sought at the country level, but a registration decision by the CSP is valid for imports to all CILSS countries. Senegalese law permits use of pesticides not registered in Senegal only for food commodities that are destined for export, as long as the pesticides comply with rules of the importing country.

The registration approval process can take two to four years and costs companies about $7,000-$18,000 per product. The FAO supports an ongoing project to harmonize national legislation on pesticide management in the nine CILSS countries. Additionally, the Joint Senegal—Gambia Initiative on Pesticide and Pest Control provides a framework for the joint monitoring of the countries' common borders for illegal entry of banned pesticides. This initiative also stipulates that Senegal perform residue analyses on pesticides for the two countries, while The Gambia is required to formulate analyses (United Nations Environment Programme (UNEP) 2010).

CSP also maintains a register of approvals and authorizations, and establishes a list of banned pesticides or severely restricted pesticides. It also performs an inventory of pesticides used or sold in the CILSS countries. CSP defines the methods of controlling the composition, quality, and product evaluation with respect to humans, animals, and the environment. Harmonized tests and field trials have been established, and regional laboratories for conducting various pesticide-related analyses have been identified (UNEP 2010). It is the responsibility of CSP to maintain a list of public institutions authorized to perform tests, and laboratories authorized to perform analyses, and to maintain links with national committees of Pesticide Management.51

Senegal also adheres to *Codex Alimentarius*, a guideline for pesticide residue standards and several specific national standards for the assessment of food safety. The sale or distribution of agrochemicals that are not approved by the relevant government services is banned.

RELEVANT INSTITUTIONS

Pesticides to be imported, produced and commercialized in Senegal for use in food production and processing must first be registered and accepted by the Ministry of Agriculture Directorate of Plant Protection La Direction de la Protection des Végétaux (DPV), or the Permanent Secretariat. DPV within the Ministry of Agriculture and Rural Equipment (MAER) is a central technical unit that works on pest control. DPV provides technical oversights for actions against pest attacks. It provides financial, material and technical resources made available by the state or private organizations that may provide equipment,

51 http://www.asti.cgiar.org/pdf/private-sector/Senegal-PS-Report.pdf

materials or services. 52 DPV maintains a list of approved and banned pesticides. All new pesticides, livestock breeds, and medications released in Senegal must be officially approved by the Ministry of Agriculture or the Ministry of Livestock.

SENCHIM and SPIA are Senegal's main fertilizer and pesticide companies that import and formulate pesticides. Most pesticides sold in Senegal are formulated and packaged locally. There are imported products from Europe and the US, but the demand for these products is relatively low due mainly to their cost, which includes the cost of transportation and the importation tax burden. The private sector plays a relatively important role in agricultural Research and Development (R&D) in Senegal compared with many other African countries.[53]Agricultural input manufacturers conduct some of their own research as well as outsource pesticide research to Institut sénégalais de recherches agricoles (ISRA). ISRA is a member of Sahelian Pesticide Committee and participated in testing new seeds and pesticides released into Senegalese markets.

Other agricultural education and research Institutions in Senegal include:54

- Cheikh Anta Diop University
- Gaston Berger University
- Assane Seck University
- University of Thies
- Advanced School for Applied Economics
- National Advanced School for Agriculture
- Institute for Advanced Rural and Agricultural Training
- Food Technology Institute
- Senegalese Institute for Agricultural Research
- National Water and Forestry Training Center
- Professional Horticulture Training Center
- National Animal Breeding Training Center
- Emile Badiane Agricultural Technical School
- National Agro-Food Research Fund

REGULATORY ENFORCEMENT

While Senegal's legislation governing pesticide import and registration is relatively strong, the level of enforcement varies. It has been reported by a number of implementers that borders are porous with illegal pesticides coming through borders with The Gambia and Mauritania. These pesticides are often

52 https://translate.google.com/translate?hl=en&sl=fr&u=http://dpvsenegal.com/&prev=search

53 http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/128709

54 http://www.oired.vt.edu/Senegal/welcome-era-senegal/partners/national-agro-food-research-fund/

counterfeit and come in re-packaged containers and do not have proper labels. Producers who purchase these products pay lower prices but the use of such products is risky. Farmers purchasing such products have no reliable information about the chemical they are using and receive no information about the product, its use, related risks and risk avoidance practices.

Senegal pesticide regulations require a sturdy vehicle and a permit from DPV for transportation of pesticides, however safety of pesticide transportation is usually not observed. Pesticides are required to be sold only by authorized dealers in authorized locations. However, there are many instances of pesticides being illegally sold house-to-house.

As reportedly occurs in many other developing countries, disposal of obsolete pesticides such as POP stocks of Aldrin and Dieldrin is a problem in Senegal. There is no recycle/collection location where unused and expired pesticides and containers are collected and safely disposed of. Hefty fines are levied for illegal possession of obsolete pesticide stocks.

In general, while Senegal has adequate legislation governing procedures for registration and importation of pesticides once the pesticide is imported, there is little control over how pesticides are transported; where and how they are sold; whether they are re-packaged; and how they are applied, monitored, stored, and disposed of. While pesticides are unlikely to be re-packaged in an authorized and registered shop, when sold through informal markets, pesticides may be removed from their original container. Farmers rarely store those pesticides under optimal conditions in terms of humidity and temperature. Dampness and high temperatures can reduce effectiveness of pesticides.

Re-entry or restricted entry interval (REI) and pre-harvest interval (PHI) statements are not usually observed. REI statement contains re-entry precautions and state a time interval during which entry into a pesticide treated site is not allowed. The statement indicates the length of time that must elapse after the pesticide application before individuals may enter the treated area without personal protective clothing and equipment. PHI statements indicate the time interval that must elapse after the pesticide application before the crop may be harvested. Harvesting prior to the PHI may result in dangerous and illegal pesticide residues on the crop.

INTERNATIONAL CONVENTIONS AND TREATIES

The following are the many Multilateral Environmental Agreements to which Senegal is a party:

- Basel Convention on the Trans boundary Movement of Hazardous Wastes and their Disposal
- Bamako Convention on the ban of Import into Africa and the Control of Trans boundary Movement and Management of Hazardous Wastes within Africa
- Common Regulation of CILSS on the registration of pesticides signed in 1990 and ratified in 2002
- Comprehensive Test Ban Treaty
- Convention on Biological Diversity
- Convention on Fishing and Conservation of Living Resources of the High Seas
- Convention on the International Trade in Endangered Species of Wild Flora and Fauna
- Convention on the Conservation of Migratory Species of Wild Animals
- The International Code of Conduct on the Distribution and Use of Pesticides of the United Nations

- FAO in 1985
- International Convention for the Regulation of Whaling
- International Convention for the Conservation of Atlantic Tunas
- International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage
- International Convention on Oil Pollution Preparedness, Response and Co-operation
- International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties
- International Plant Protection Convention
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
- Kyoto Protocol
- MARPOL 73/78 (International Convention for the Prevention of Pollution from Ships)
- Memorandum of Understanding concerning Conservation Measures for Marine Turtles of the Atlantic Coast of Africa
- Memorandum of Understanding on the Conservation of Migratory Sharks
- Montreal Protocol
- Ramsar Convention
- 1978 Convention on Ship Pollution
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
- Sahelian Pesticides Committee
- Statute of the International Renewable Energy Agency
- Stockholm Convention on Persistent Organic Pollutants signed in May 2001 and ratified in October 2003
- United Nations Framework Convention on Climate Change
- United Nations Convention to Combat Desertification
- United Nations Convention on the Law of the Sea
- The Vienna Convention for the Protection of the Ozone Layer (ratified in March 1985)

FACTOR K: THE PROVISIONS MADE FOR TRAINING OF USERS AND APPLICATORS

Several in-country training programs in safer use of pesticides exist, and in-country expertise in safer use is generally strong. Ceres Locustrix, DPV, CropLife, and Green Senegal have strong safer use training programs. These organizations can be a resource for training and technical assistance in IPM and when required in safe pesticide use for producers, agro-chemical shop owners, program staff, partners and other stakeholders.

A core strategy of the USAID-funded projects is to promote knowledge about pesticides use, risks, and safety among farmers as well as to strengthen the agricultural extensions and encourage farmers to turn for advice. While the pesticides put forward for approval by this PERSUAP are generally of relatively lower toxicity, the pesticide toxicology profiles presented in Annex B clearly show that use of pesticides presents some human health and environmental risks. These risks, combined with the overall extremely poor awareness of pesticide risks and safer use principles among beneficiary population (see Sections 4.5 and 4.6), mean that an aggressive program of pesticide safer use training is essential for the following groups:

- Project staff who will apply or handle pesticides, or serve as extension agents;
- Beneficiary farmers who will use/apply pesticides;
- Those being trained as extension agents by the projects;
- Beneficiary agro-input dealers.

Key training topics must include the following:

- Definition of pesticides.
- Pesticide risks and the understanding that pesticides are bio-poisons.
- Concepts of Active Ingredients vs. formulated products.
- Classes of pesticides and the concept that specific pesticides are effective only against a certain class of organism.
- Concept of proper application rates and pesticide resistance and techniques for avoiding misapplication.
- Survey of the core elements of Safe Pesticide Use: IPM, Safe Purchase, Transport, Storage, Mixing, Application, Reentry and PHIs, Clean-up and Disposal, including specific treatment of PPE.
- Pesticide first aid and spill response.
- Reading and interpreting pesticide labels -- particularly to understand PPE requirements and other precautions, dosage rates, and to identify AIs and expiration dates.
- Proper sprayer operation and maintenance.
- Record keeping and monitoring.

Each project will develop a training plan meetings its specific needs:

- The training plan must cover the categories of individuals enumerated above.
- Training curricula must cover all relevant key topics outlined above and discussed in more detail in Annex C.
- Training must reach all relevant individuals within 6 months of the effective date of this PERSUAP.
- Brief refresher training must be provided at least annually.
- Projects are encouraged to consider the training-of-trainers approach.

FACTOR L: THE PROVISIONS MADE FOR MONITORING THE USE AND EFFECTIVENESS OF THE PESTICIDES

The project must maintain records of all pesticide use, monitor pesticide effectiveness, and scout for resistance. Training in monitoring must be provided to farmers. Where literacy or language is a limiting factor, training should be developed to address this concern. Some products are considered low risk for resistance development, while others allow a limited number of applications per season because of the high risk of resistance development, and must alternate with pesticides from different chemical groups.

IPs will be required to report initially and every 6 months thereafter on compliance with the conditions established by this PERSUAP; the SUAP (Section 6) includes a tracking reporting form (Section 6.4) that dictates the content of such reporting.

As part of this reporting, IPs directly supporting farm-level pesticide use or extension will be required to report on instances observed of pesticide resistance. USAID monitoring and evaluation field visits will examine pesticide compliance.

SECTION 6: SAFER USE ACTION PLAN (SUAP)

6.1 INTRODUCTION

This **Safer Use Action Plan** is the definitive statement of IP pesticide compliance requirements and is synthesized from the PER analysis:

- Section 6.2, immediately below, delineates allowed pesticides and provides advisory and restrictions for their use.
- Section 6.3 summarizes the mandatory safer use conditions attendant to use/support of these pesticides.
- Section 6.4 defines these conditions in the attached **Mandatory Template,** entitled "Pesticide Safer Use Action Plan & Compliance Tracker," for assigning responsibilities and timelines for implementation of these requirements, and for tracking compliance.

MANDATORY TEMPLATE

Every Project Subject to this PERSUAP must **submit a completed SUAP template to its AOR/COR by the date specified on the attached tracker template and must provide an annual update.**

With respect to pesticides, the "Pesticide Safer Use Action Plan & Compliance Tracker" (Section 6.4) satisfies the requirement for an Environmental Mitigation and Monitoring Plan (EMMP). The project EMMP should simply incorporate the SUAP by reference.

6.2 ALLOWED PESTICIDES

Upon approval of this PERSUAP, pesticides containing the Active Ingredients (AIs) listed in **Table 8** below are permitted for procurement/use/support by USAID/Senegal agricultural activities. **Table 8** is also inluded in the Executive Summary, see **Table 1**. These pesticides have an identified use within an Integrated Pest Management (IPM) scheme; are registered by the US Environmental Protection Agency (EPA) and by the CILSS-CSP[55], and are chosen conservatively with respect to their environmental and human health risk profiles*[56].

Table 8 specifies AI- and product-specific risk-reducing conditions. Two of these restrictions are as follows:

- **No Acute Toxicity Class I Products.** While these AIs have been chosen conservatively with regard to their risk profiles, some products with these approved AIs may nonetheless be EPA Acute Toxicity class 1 or equivalent on the basis of their acute oral, dermal or inhalation toxicity. All products in which methanol (methyl alcohol used as a solvent) is present at 4 percent or more

[55] Senegal is a member of the Comité permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel (CILSS) – the Permanent Interstate Committee for Drought Control in the Sahel. Through its Comité Sahélien des Pesticides (CSP) – the Sahelian Pesticides Committee, CILSS addresses registration and regulation of pesticides of its members, including Senegal, Therefore, AIs approved under this PERSUAP are all CSP-CILSS registered.

[56] Human health and ecological toxicological summaries and U.S. Environmental Protection Agency (US EPA) registration status for each pesticide are presented in Table B-1 in Annex B.

are also Class I. Such products are marked with the skull and crossbones symbol and the word "POISON" or "DANGER" or equivalent.

Under this PERSUAP, such products may ONLY be used by professionally trained certified and registered pest control specialists and NEVER by smallholder farmers. **This restriction is set out prominently at the top of Table 8**.

- **Some Products Require Label Approval.** Similarly, some approved AIs are present in products designated as Restricted Use Pesticides (RUPs) by EPA.[57] Generally, AIs for which a significant percentage of US products are RUP have been rejected by this PERSUAP. However, a few such AIs are approved under this PERSUAP where they meet an important pest management need for which there is no reasonable alternative. For such AIs, the conditions in **Table 8** require IPs to submit the label of the proposed product together with the intended use to USAID for COR and MEO approval prior to procurement or use. To approve the use, the MEO must verify that the closest US-registered analogue to the product is not RUP.

Low-risk Active Ingredients not requiring approval under this PERSUAP. Note that some particularly low-risk AIs are exempt from regulation under the US Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and therefore may can be used by implementing partners without approval via this PERSUAP. These are listed at http://www.epa.gov/sites/production/files/2015-12/documents/minrisk-active-ingredients-tolerances-2015-12-15.pdf.

(A list of pesticides Inert Ingredients that are exempt from FIFRA is available at: http://www.epa.gov/sites/production/files/2015-01/documents/section25b_inerts.pdf.)

The below-listed pesticides (as AIs) are permitted for use/support in USAID/Senegal, SUBJECT to compliance with any conditions enumerated in these tables and those enumerated in the "Safer Use Action Plan and Compliance Tracker" that comprises Section 6.4. (A summary of these conditions is provided in Section 6.3.) Human health and ecological toxicological summaries and US EPA registration status for each are presented in Table B-1 in Annex B.

PESTICIDES APPROVED FOR AGRICULTURAL USE

The Active Ingredients listed below can be in products that are designated as RUPs as well as in products designated as General Use Pesticides (GUP).

RUPs are pesticides which are not available to the general public in the United States. The "Restricted Use" classification restricts a product to use by a certificated pesticide applicator or under the direct supervision of a certified applicator. This means that a license is required to purchase and apply the product. Certification programs are administered by the federal government, individual states, and by company policies that vary from state to state.[58] Restrictions can apply to the particular crop, formulations, concentrations or uses.

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[57] In the United States, the same AIs can be in products that are designated by EPA as Restricted Use Pesticides (RUP) as well as in products designated as General Use Pesticides (GUP). RUPs are pesticides which are not available to the general public in the United States. The "Restricted Use" classification restricts a product to use by a certificated pesticide applicator or under the direct supervision of a certified applicator. This means that a license is required to purchase and apply the product. Certification programs are administered by the federal government, individual states, and by company policies that vary from state to state (see http://www2.epa.gov/pesticide-worker-safety/restricted-use-products-rup-report). Products can be designated RUP because of human acute (immediate) and chronic (long-term) toxicity/health risk, physical hazards such as risks of fire or explosion, and eco-toxicity hazards such as potential risks of water pollution and risk to flora and fauna.. Restrictions can apply to the particular crop, formulations, concentrations or uses.

58 EPA Pesticide Worker Safety. (n.d.). Retrieved August 17, 2015, from http://www2.epa.gov/pesticide-worker-safety/restricted-use-products-rup-report

Products can be designated RUP because of human acute (immediate) and chronic (long-term) health risk; physical hazards, such as risks of fire or explosion; and eco-toxicity hazards, such as potential risks of water pollution and risk to flora and fauna. RUP pesticides are designated if their toxicity exceeds certain hazard criteria. The skull and crossbones symbol and the word "Poison" identify pesticide products that are determined to be in Toxicity Class I based on at least one of the following acute toxicity studies: acute oral, acute dermal, or acute inhalation. They are also required if methanol is present at 4 percent or more.

Only GUP products are approved for use by farmers. RUP products that contain AIs listed in the table below can be used only by professionally trained certified and registered pest control specialists. Class I products are not approved for use by farmers by this PERSUAP.

Farmers must be trained to use Class II and III products. The training must require farmers to interpret product labels to understand product health risks, physical hazards, eco-toxicity, and required safety measures. Training requirements are specified within this SUAP. For more complete information on impacts of these AIs on human health and environment, please see Annex B, Table B-1.

IMPORTANT NOTE: any product containing these Active Ingredients that is marked with **skull and crossbones** or the words **"danger" or "poison"** or equivalent may ONLY be used by professionally trained certified and registered pest control specialists and NEVER by smallholder farmers.

Where required by the Advisory column in the table below, IPs must submit pesticide product label to MEO/A/COR for review and approval. MEO/A/COR will review product label against USEPA guidance for restricted use pesticides provided at https://www.epa.gov/pesticide-worker-safety/restricted-use-products-rup-report

IPs must always review pesticide label's PPE requirements and environmental hazards statement and always keep pesticides away from water sources. Active Ingredients that have been identified as potential groundwater contaminants are identified in the Advisory column below.

TABLE 8. PESTICIDES (ACTIVE INGREDIENTS) **APPROVED** WITH CAUTIONARY ADVICE AND MANDATORY RESTRICTIONS (BASED ON INFORMATION PROVIDED IN ANNEX B)

HERBICIDES	ADVISORY
2,4-D acid, ester or salts	Possible carcinogen, suspected endocrine disruptor, potential groundwater contaminant Salt and acid forms can be extreme eye irritants Many products containing this AI are RUP—IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Acetochlor	Potential groundwater contaminant All products in combination with Atrazine are RUP. Few other products are also RUP. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Bensulfuron methyl	Potential groundwater contaminant.

TABLE 8. PESTICIDES (ACTIVE INGREDIENTS) **APPROVED** WITH CAUTIONARY ADVICE AND MANDATORY RESTRICTIONS (BASED ON INFORMATION PROVIDED IN ANNEX B)

Bispyribac sodium	Potential groundwater contaminant
Clethodim	Potential groundwater contaminant
Clomazone	Potential groundwater contaminant
Dicamba	Potential groundwater contaminant, potential developmental/reproductive toxin. Included in many RUP products. Check all ingredients for approval.
Diuron	Known water pollutant, use care around open water
Fluazifop-P-butyl	Potential developmental/reproductive toxin
Fluometuron	
Glyphosate and Glyphosate salts	Some Glyphosate products are classified as Acute Toxicity I due to potential for eye irritation and are RUP. Do not use products that have Danger sign. In 2015, Glyphosate was identified as a potential carcinogen by USEPA. Glyphosate-isopropyl ammonium products are RUP. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Nicosulfuron	Potential groundwater contaminant. When combined with Atrazine, this AI is RUP. Do not use.
Orthosulfamuron	Potential groundwater contaminant, possible carcinogen
Oxadiazon	Potential carcinogen and developmental/reproductive toxin
Pendimethalin	Possible carcinogen, suspected endocrine disruptor. Highly toxic to fish and aquatic invertebrate.
Penoxysulam/penoxsulam	Potential groundwater contaminant, possible carcinogen
Prometryn	Potential ground water contaminant
Propanil	Possible carcinogen, suspected endocrine disruptor. Moderately toxic to birds and aquatic organisms.
Tembotrione	Possible carcinogen
Terbutylazine	Also microbicide and algaecide
Tribenuron methyl	Possible carcinogen
Triclopyr	Slightly to moderately toxic to aquatic organisms

TABLE 8. PESTICIDES (ACTIVE INGREDIENTS) **APPROVED** WITH CAUTIONARY ADVICE AND MANDATORY RESTRICTIONS (BASED ON INFORMATION PROVIDED IN ANNEX B)

	RUP when combined with Picloram (potassium salt), do not use
FUNGICIDES	ADVISORY
Azoxystrobin	Potential groundwater contaminant RUP when combined with some ingredients. All product ingredients must be approved for use. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Difenoconazole	Possible carcinogen, suspected endocrine disruptor (used in treated seed)
Copper hydroxide	Microbicide, nematicide and fertilizer
Copper sulfate (pentahydrate)	Use only acute toxicity Class II or III products; not Class I
Iprodione	Highly toxic to crustaceans
Mancozeb	Potential groundwater contaminant, carcinogen and developmental/reproductive toxin
Mefenoxam/ Metalaxyl-M	Potential groundwater contaminant (used in treated seed)
Miclobutanil	Likely developmental/reproductive toxin, suspected endocrine disruptor
Tebuconazole	Potential ground water contaminant, possible carcinogen, suspected endocrine disruptor RUP in combination with Lambda-cyhalothrin, do not use
INSECTICIDES	ADVISORY
Abamectin (Avermectin)	Potential reproductive and developmental toxin, suspected endocrine disruptor. Many products are RUP. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Acetamiprid	Do not use during flowering to protect foraging honeybees When combined with Bifenthrin RUP, do not use
D-phenothrin	Highly toxic to fish and aquatic organisms, suspected endocrine disruptor
Azadirachtin (botanical neem extract) also nematicide	Suspected endocrine disruptor
Bacillus thuringiensis (Bt)	
Bacillus sphaericus	

TABLE 8. PESTICIDES (ACTIVE INGREDIENTS) **APPROVED** WITH CAUTIONARY ADVICE AND MANDATORY RESTRICTIONS (BASED ON INFORMATION PROVIDED IN ANNEX B)

Beta-cyfluthrin	Use only formulations of 10% or less AI, most formulations below 10% are GUP, and above 10% are RUP
Chlorantraniliprole	Potential groundwater contaminant When combined with Lambda-cyhalothrin RUP, do not use
Chlorothalonil	Do not use products with acute toxicity I for eye irritation. Potential groundwater contaminant, likely carcinogen,
Cyantraniliprole	
Cypermethrin Cypermethrin (alpha) Cypermethrin (beta)	Possible carcinogen, potential endocrine disruptor Many products are RUP. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use. Most Zeta-cypermethrin products are acute toxicity I, do not use
Deltamethrin	Highly toxic to some aquatic organisms Some products are RUP for some crops and applications. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Flubendiamide	Highly toxic to fish
Fludioxinil	Potential groundwater contaminant
Insecticidal soap	Recommended to use natural soaps and not to use detergents, dish soaps, or any products with degreasers, skin moisturizers, or synthetic chemicals.
Indoxacarb, S-isomer	High toxicity to bees and birds
Imiprothrin	Highly toxic to fish
Imidacloprid	Linked to honey-bee colony collapse disorder. Should not be used during flowering, only during vegetative growth and for seed treatment. Several products and AI combinations are RUP. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Lambda-cyhalothrin	High toxic to fish and other aquatic organisms, toxic to bees. Many products and AI combinations are RUP. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.

TABLE 8. PESTICIDES (ACTIVE INGREDIENTS) **APPROVED** WITH CAUTIONARY ADVICE AND MANDATORY RESTRICTIONS (BASED ON INFORMATION PROVIDED IN ANNEX B)

Lufenuron	
Malathion	Toxic to bees When combined with gamma-Cyhalothrin RUP, do not use
Novaluron	Insect Growth Regulator (IGR) When combined with Bifenthrin RUP, do not use
Permethrin	May NOT be used for crop and wide area applications such as nurseries. Such uses are RUP. Weak carcinogen, suspected endocrine disruptor, Highly toxic to fish and aquatic organisms. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Pyriproxyfen	Insect Growth Regulator (IGR)
Pirimiphos-methyl	May interfere with proper functioning of the nervous system
Spinosad	Slightly to moderately toxic to some aquatic organism Some products are RUP when combined with Bifenthrin, or Lamda-cyhalothrin do not use
Spirotetramate	
Tagetes oil	
Terbutryn	Possible groundwater contaminant, possible carcinogen, possible endocrine disruptor
Thiamethoxam	Potential ground water contaminant (used in treated seed) Some products and used are RUP. IPs must submit the product label with description of the proposed use to the COR for MEO approval prior to procurement or use.
Thyme oil	Exempt, not regulated
Trifloxysulfuron sodium	Potential groundwater contaminant
RODENTICIDE	ADVISORY
Brodifacoum	Use in bait traps only, Required to be enclosed in bait stations that are inaccessible to children and non-target animal species.
FUMIGANT	ADVISORY
Aluminum Phosphide	EPA Toxicity Class I. All products are marked DANGER. All warehouse pest control activities for protection of agricultural commodities must be performed only by trained and certified pest control specialists. Only products approved in Senegal for

TABLE 8. PESTICIDES (ACTIVE INGREDIENTS) **APPROVED** WITH CAUTIONARY ADVICE AND MANDATORY RESTRICTIONS (BASED ON INFORMATION PROVIDED IN ANNEX B)

	control of pests in warehouses and its surroundings can be used by the fumigators. In addition, Aluminum Phosphide fumigation must comply with the USAID Programmatic Environmental Assessment (PEA) for Phosphide Fumigation of Stored Agricultural Commodity (http://www.usaidgems.org/fumigationpea.htm); see Annex T-1 for guide to compliance requirements.

PESTICIDES REJECTED AND BANNED

Only pesticides specifically approved (i.e., appearing in the "lists of approved pesticides" above) under this PERSUAP are authorized for use under FtF in Senegal. For reference, the tables below document pesticides (as AIs) that were specifically considered and rejected for use by the analysis undertaken in this PERSUAP. Toxicological summaries and US EPA registration status for each are presented in Table B-1 in Annex B.

TABLE 9. PESTICIDES REJECTED

PESTICIDES REJECTED	REASON FOR REJECTION
Aclonifen	Not registered by USEPA
Alletrin, d-trans allethrin	Used mostly for control of mosquitos and flies in homes and gardens
Asulam	Used mostly for cane sugar
Bendiocarb	Acute toxicity
Bifenthrin	Most products are RUP
Bromadiolone	Anti-coagulant rodenticide, RUP, certified for use only indoors
Cartap	Not EPA registered
Chlorpyrifos-ethyl	Most products are RUP
Cycloxidim	Not registered by USEPA
Cypermethrin (zeta)	
Diflubenzuron	RUP, all products and uses
Dimefluthrin	Not registered by US EPA
Emamectin benzoate	Use mostly for ornamental trees, most products are RUP
Esbiothrin	Not registered by USEPA
Fenitrothion	Registered for use of ornamental crops only
Haloxyfop-R-mathyl	Not registered by USEPA
Hexazynone	Known groundwater contaminant, some products are acute toxicity I

TABLE 9. PESTICIDES REJECTED	
Isoxadifen-ethyl	Not registered by USEPA
Mepiquat chloride	Plant growth regulator used exclusively on cotton
Mesothrione,	Most products are RUP
Metolachlor, S-Metolachlor	Most products are RUP
Methomyl	All methomyl products, except the 1% bait formulations, are classified as restricted use pesticides.
Oxadiargyl	No US Federally registered products containing this chemical
Oxamyl	Oxamyl is a "restricted use" (RUP) chemical due to acute toxicity and toxicity to birds and mammals.
Pencycuron	No US Federally registered products containing this chemical
Pyribenzoxim	Not registered by USEPA
Profenofos	Restricted to use on cotton solely
Pretilachlor	Not registered by USEPA
Propaquizafop	Not registered by USEPA
Pyriproxyfen	Alleged (not substantiated) link to microcephaly
Teflubenzuron	Not registered by EPA
Transfluthrin	No US Federally registered products containing this chemical

TABLE 10. PERSISTENT ORGANIC POLLUTANTS (POPS) BANNED BY THE STOCKHOLM CONVENTION[59]

PESTICIDE	USE
Aldrin	Used mostly on corn and cotton
Chlordane	Used on agricultural crops, lawns, and gardens and as a fumigant for termite control
DDT	Malaria control
Dieldrin	Used mostly on corn and cotton
Dioxins (polychlorinated)	Byproduct of pesticides
Endrin	Pesticide used to control insects, rodents,

59 "What Is Pesticide Regulation?" Environmental Performance Index, Yale University. Web. 17 Aug. 2015. http://epi.yale.edu/files/pops_final.pdf .

TABLE 10. PERSISTENT ORGANIC POLLUTANTS (POPS) BANNED BY THE STOCKHOLM CONVENTION[59]

PESTICIDE	USE
	and birds
Furan (polychlorinated)	By product of pesticides
Heptachlor	Used in household and Agriculture
Hexachlorobenzene	Fungicide used on seeds
Mirex	Insecticide and flame retardant
Toxaphen	Insecticide used primarily on cotton

TABLE 11. ACTIVE INGREDIENTS (AIs) BANNED BY ROTTERDAM CONVENTION

HERBICIDES
2,4,5-T and its salts and esters
Alachlor
Dinitro-ortho-cresol (DNOC) and its salts
Dinoseb and its salts and ester
FUNGICIDES
Benomyl (certain formulations)
Binapacryl
Captafol
Thiram (certain formulations)
INSECTICIDE
Aldicarb
Aldrin
Carbofuran (certain formulations)
Chlordane
Chlordimeform
Chlorobenzilate
DDT
Dieldrin
1,2-dibromoethane (EDB)
Endosulfan
Hexachlorocyclohexane (mixed isomers, some are pesticides)
Heptachlor
Hexachlorobenzene
Lindane
Methamidophos (certain formulations)
Methyl parathion (certain formulations)
Monocrotophos

TABLE 11. ACTIVE INGREDIENTS (AIs) BANNED BY ROTTERDAM CONVENTION
Parathion
Pentachlorophenol and its salts and esters
Phosphamidon (certain formulations)
Toxaphene
RODENTICIDE
Fluoroacetamide

6.3 SUMMARY OF COMPLIANCE REQUIREMENTS

In summary, the mandatory mitigation measures and restrictions that apply to the above listed pesticides are as follows:

A. Only pesticides approved by this PERSUAP may be supported with USAID funds in USAID/Senegal activities. These pesticides are enumerated above. (Pesticide "SUPPORT" means procurement, use, recommending for use, or otherwise facilitating the use of a pesticide.) Where a pesticide product contains more than one ingredient, the product can only be used when all AIs are approved by this PERSUAP.

B. Pesticide support must be governed by a set of locally adapted, crop- and pest-specific IPM-based pest management plans and observe enumerated use restrictions. (The PERSUAP provides key information for IPs to develop these plans.)

C. Appropriate project staff and beneficiaries must be trained in safe pesticide use and pesticide first aid.

D. To the greatest degree practicable, projects must require the use and maintenance of appropriate PPE—as well as safe pesticide purchase, handling, storage and disposal practices.

E. Projects must be systematic in their pesticide-related record-keeping and monitoring.

These conditions are **additional** to those described in the lists of approved pesticides above. They have been synthesized from the PER analysis and are detailed in the **mandatory SUAP template** (see Section 6.4) for assigning responsibilities and timelines for implementation of these requirements, and for tracking compliance. Each project subject to this PERSUAP must submit a completed SUAP template to its AOR/COR and MEO 30 days before the implementation of the activity and must provide an annual update of the SUAP.

With respect to pesticides, the SUAP satisfies the requirement for an environmental mitigation and monitoring plan (EMMP). The project EMMP should simply incorporate the SUAP by reference.

The PER and the annexes provide substantial resources to support compliance with these requirements, as detailed in the table below.

TABLE 12. IPM/SAFER USE REQUIREMENTS AND RELEVANT RESOURCES

IPM/SAFER USE REQUIREMENT	KEY RESOURCES PROVIDED
Pesticide recommendations and use must be governed by a set of crop- and pest-specific IPM-based pest management plans. (IPs are responsible for developing these plans.)	ANNEX A: sets out crop-by-crop, pest-by-pest chemical and non-chemical management methods recommended by this PERSUAP. The pests and control methods table for each crop is intended to serve as a rough draft for a crop-specific pest management plan. ANNEX B: provides toxicology information for each approved active ingredient, including human acute toxicities and chronic health issues, water pollution potential, as well as potential eco-toxicities to important non-target organisms like fish, honeybee pollinators, birds and several aquatic organisms. This information is summarized in table B-1.
Appropriate project staff and beneficiaries must be trained in safe pesticide use and pesticide first aid.	ANNEX C: Mandatory Elements of Pesticide Safer Use Training provides significant discussion of safer use training elements.
To the greatest degree practicable, projects must require use and maintenance of appropriate PPE—as well as safe pesticide purchase, handling, and disposal practices.	
To address countrywide pesticide management constraints, policy level interventions will be required in some instances.	Annex D: Proposed policy measures for future agricultural projects.

6.4 PESTICIDE SAFER USE ACTION PLAN & COMPLIANCE TRACKER

2015 USAID/Senegal Programmatic PERSUAP

Must be submitted to AOR/COR by Date: and annually updated thereafter.

TABLE 13. PERSUAP COMPLIANCE TRACKER

BASIC INFORMATION		SUBMISSION DATES:	
Prime Contractor		Initial submission	
Project		Annual Update #1	
Pesticide Compliance Lead & Contact Information		Annual Update #2	
Summary of Pest Management Needs on Project		Annual Update #3	

Note: Pesticide "support" = use of USAID funds to: purchase pesticides; directly fund the application of pesticides; recommend pesticides for use; enable the application or purchase of pesticides via provision of application equipment, credit support, etc.

PESTICIDE SAFER USE ACTION PLAN & COMPLIANCE TRACKER: 2015 USAID/ PERSUAP

REQUIRED COMPLIANCE (MITIGATION) MEASURE	INITIAL COMPLIANCE STATUS (IF NOT KNOWN, SO INDICATE)	ACTIONS PLANNED TO ACHIEVE & MAINTAIN COMPLIANCE (W/ DEADLINES & RESPONSIBLE PARTY)	STATUS OF COMPLIANCE ACTIONS
SUPPORT ONLY THE PESTICIDES AUTHORIZED BY THE 2015 USAID/Senegal Programmatic PERSUAP			
Immediately			
Inventory Pesticides being supported and ensure NO SUPPORT for Class I chemicals.			
		(insert extra rows if needed)	
Ensure that Restricted Use Pesticides (RUPs), as classified by US EPA, can only be used by or under supervision of a certified pesticide applicator.			
Distribute copies of the list of allowed AIs with matching commercial product names and list of cancelled products to all project field extension staff & advice regarding the Date: deadline for compliance (below). Updated lists can be found in References and Resources.			
As soon as possible but not later than Date:			
Assure that USAID-funded pesticide support is limited to ONLY PESTICIDES APPROVED BY PERSUAP. Continue verification throughout life-of-project			

REQUIRED COMPLIANCE (MITIGATION) MEASURE	INITIAL COMPLIANCE STATUS (IF NOT KNOWN, SO INDICATE)	ACTIONS PLANNED TO ACHIEVE & MAINTAIN COMPLIANCE (W/ DEADLINES & RESPONSIBLE PARTY)	STATUS OF COMPLIANCE ACTIONS
Pesticide technical assistance and use must be governed by a set of locally adapted IPM-based pest management plans and observe enumerated use restrictions. For agricultural activities these will be crop-and-pest specific.			
By Date:			
Starting from the information in PERSUAP Annex A and drawing on PERSUAP Annex B, adopt/develop crop- and pest-specific IPM-based pest management plans (PMPs). For chemical controls, PMPs must include the use restrictions specified in the Annex B pesticide profiles. (E.g. no use near surface waters.)			
Translate PMPs into crop-specific field reference guides or posters for farmers to anticipate and manage pests.			
By Date:			
Provide first-time training to appropriate project staff, partners and beneficiaries in PMPs; Provide refresher training annually.			
From Date:			
Require and enforce PMP implementation in situations where the			

REQUIRED COMPLIANCE (MITIGATION) MEASURE	INITIAL COMPLIANCE STATUS (IF NOT KNOWN, SO INDICATE)	ACTIONS PLANNED TO ACHIEVE & MAINTAIN COMPLIANCE (W/ DEADLINES & RESPONSIBLE PARTY)	STATUS OF COMPLIANCE ACTIONS
project has direct control over pesticide use			
Require and enforce that field extension under direct project control be PMP-based.			
Where project control over extension or agricultural practice on the ground is less than complete, promote and support to PMPs to the greatest practicable extent.			
Ongoing over Life of Project (LOP)			
Modify PMPs over LOP based on ground-truthing/field experience.			

REQUIRED COMPLIANCE (MITIGATION) MEASURE	INITIAL COMPLIANCE STATUS (IF NOT KNOWN, SO INDICATE)	ACTIONS PLANNED TO ACHIEVE & MAINTAIN COMPLIANCE (W/ DEADLINES & RESPONSIBLE PARTY)	STATUS OF COMPLIANCE ACTIONS
For all target activities appropriate project staff & beneficiaries must be trained in safe pesticide use & pesticide first aid.			
Ensure availability of product label and MSDS. For all products that will be in use, the project personnel must obtain and review the product label and MSDS to ensure that pesticide users are aware of potential hazards and are undertaking all measures to minimize risks to human health and safety and to the environment.			
Ensure that for all beneficiaries that receive support for procurement and use of seed treated with pesticides, training in handling dressed seed is provided.			
Develop a Training Plan for Pesticide Safe Practices and IPM for project staff and beneficiaries, including at least annual refresher training.			
Develop or source curricula conforming to required training elements specified in Annex C.			
Implement training plan, providing first-time training to all relevant staff and beneficiaries within 6 months.			

REQUIRED COMPLIANCE (MITIGATION) MEASURE	INITIAL COMPLIANCE STATUS (IF NOT KNOWN, SO INDICATE)	ACTIONS PLANNED TO ACHIEVE & MAINTAIN COMPLIANCE (W/ DEADLINES & RESPONSIBLE PARTY)	STATUS OF COMPLIANCE ACTIONS
To the greatest degree practicable, all projects must require use & maintenance of appropriate PPE – as well as safe pesticide purchase, handling, storage and disposal practices.			
If carbonate or organophosphate-class pesticides are used extensively, follow procedures for baseline testing for cholinesterase inhibition, and establish a periodic cholinesterase monitoring schedule when necessary.			
Implement/observe core risk mitigation measures (PPE and other precautions) identified in the summary section of each extended pesticide profile. Where control is less complete, take all practicable measures to support and promote implementation of these measures.			
Whenever providing, supporting or recommending pesticides for use, assure that appropriate personal protective equipment is available and, to the degree possible, require its use.			
Whenever directly using, procuring or supplying pesticides, assure that quality application equipment is available and local capacity for application is available and maintained.			

REQUIRED COMPLIANCE (MITIGATION) MEASURE	INITIAL COMPLIANCE STATUS (IF NOT KNOWN, SO INDICATE)	ACTIONS PLANNED TO ACHIEVE & MAINTAIN COMPLIANCE (W/ DEADLINES & RESPONSIBLE PARTY)	STATUS OF COMPLIANCE ACTIONS
Projects must follow safety restrictions and precautions for all target activities			
People who are not wearing PPE should not enter pesticide treated areas during Restricted Entry Intervals (REI) to perform tasks that involve contact with pesticide treated surfaces. Each pesticide label specifies a REI usually ranging from 12 to 72 hours.			
Warning signs should be posted to warn people in advance about pesticide application and REI.			
Products that are suspected to have potential to cause harm to unborn child will not be handled and applied by pregnant women. Pregnant women should not enter treated areas during application and REI.			
Pre-harvest interval (PHI) is the time required between the last application of pesticides and the safe harvesting of edible crops for immediate consumption. Farmers will be trained about the importance of adhering to the PHI stated on the label to ensure no chemical residues are found on harvested crops.			
Projects must be systematic in their pesticide related record-keeping and monitoring.			
Pesticide efficacy in demonstration must be evaluated			

REQUIRED COMPLIANCE (MITIGATION) MEASURE	INITIAL COMPLIANCE STATUS (IF NOT KNOWN, SO INDICATE)	ACTIONS PLANNED TO ACHIEVE & MAINTAIN COMPLIANCE (W/ DEADLINES & RESPONSIBLE PARTY)	STATUS OF COMPLIANCE ACTIONS
Any evidence of pesticide resistance development must be tracked and reported.			
Flow-down requirements			
Prime contractors must write pesticide compliance requirements as set out above into each grant or sub-contract that will involve support for pesticide use.			
Pesticide registration status in Senegal and US EPA must be updated yearly.			

REFERENCES AND RESOURCES

US EPA chemical search:

http://iaspub.epa.gov/apex/pesticides/f?p=CHEMICALSEARCH:1:0

Inert ingredients search

http://iaspub.epa.gov/apex/pesticides/f?p=INERTFINDER:1:0::NO:1::

Inert Ingredients Eligible for FIFRA 25(b) Pesticide Products

http://www.epa.gov/sites/production/files/2015-01/documents/section25b_inerts.pdf

US EPA product label search:

http://iaspub.epa.gov/apex/pesticides/f?p=PPLS:1

US product search:

http://ppis.ceris.purdue.edu/

National Pesticide Information Center:

http://npic.orst.edu/npicfact.htm

WHO Recommended Classification

http://www.inchem.org/documents/pds/pdsother/class_2009.pdf

Pesticides approved in EU:

http://sitem.herts.ac.uk/aeru/ppdb/en/atoz.htm

http://sitem.herts.ac.uk/aeru/bpdb/atoz.htm

Restricted Use Pesticides (RUP):

http://www2.epa.gov/sites/production/files/2015-08/documents/rupreport-sec3-update_0.pdf

http://www.agri.ohio.gov/apps/Restricted_Products_Rpt/default.aspx

http://www.ag.ndsu.nodak.edu/aginfo/pesticid/pdf/ec2500.pdf

http://ipcm.wisc.edu/pat/download/download/RUP-2013.pdf

https://s3.amazonaws.com/publicworks-takomapark/public/safe-grow/us-environmental-protection-agency-restricted-use-products.pdf

http://edis.ifas.ufl.edu/pi073

http://web.aces.uiuc.edu/vista/pdf_pubs/iapm99/ch22.pdf

http://www.simsfarm.com/images/E0162301/minstorage.pdf

Pesticides and Cancer

http://pesticide.umd.edu/products/leaflet_series/leaflets/PIL33.pdf

WHO recommended classification of pesticides by hazard:

http://www.who.int/ipcs/publications/pesticides_hazard_2009.pdf?ua=1

Pesticide adjuvants

http://psep.cce.cornell.edu/facts-slides-self/facts/gen-peapp-adjuvants.aspx

Codex alimentarius (pesticide residues in food and feed):

http://www.codexalimentarius.net/pestres/data/pesticides/search.html

NFPA Hazard Rating Information for Common Chemicals:

http://safety.nmsu.edu/programs/chem_safety/NFPA-ratingJ-R.htm

http://www.ehs.neu.edu/laboratory_safety/general_information/nfpa_hazard_rating/

Guidelines for Training

http://pesticidestewardship.org/Pages/default.aspx

http://www.croplifeafrica.org/

Pesticide Applicator Core Training Manual

http://www.stewartfarm.org/phragmites/pdf/coremanual.pdf

IPM

www.infonet-biovision.org

www.ipm.ucdavis.edu/GENERAL/whatisipm.html

www.birc.org/products.pdf

www.ipm,ncsu.edu/agchem/1-toc.pdf

http://ipm.tamu.edu/about/glossary/economic-thresholds/

http://www.ipm.ucdavis.edu/

https://www.daf.qld.gov.au/plants/fruit-and-vegetables/a-z-list-of-horticultural-insect-pests

http://www.organic-africa.net/fileadmin/documents-africamanual/training-manual/chapter-09/Africa_Manual_M09-8.pdf

IPM insect and disease control

http://www.caes.uga.edu/extension/habersham/anr/documents/Organic.pdf

Pesticide regulations

http://epi.yale.edu/files/pops_final.pdf

http://www.usaid.gov/our_work/environment/compliance/22cfr216

Senegal Country Development Cooperation Strategy 2012-2016

https://www.usaid.gov/sites/default/files/documents/1860/SenegalCDCS.pdf

Plant protection equipment

http://agricoop.nic.in/dacdivision/machinery1/chap4.pdf

Effects of Modern Agriculture

http://mjcetenvsci.blogspot.co.il/2013/10/effects-of-modern-agriculture.html

Pesticide ecological and health risks in West African agriculture

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3928896/

Hazardous pesticides and health impacts in Africa

http://www.pan-uk.org/attachments/101_Hazardous_pesticides_and_health_impacts_in_Africa.pdf

Insect Damage, Postharvest Operations

http://www.fao.org/3/a-av013e.pdf

Trade-offs between rice yield, weed competition and water use in the Senegal River Valley

http://www.africaricecenter.org/workshop/ARC/2.3%20Krupnik%20ed2.pdf

LSUAG Center

http://www.lsuagcenter.com/en/crops_livestock/crops/

Insect pests of rice

http://books.irri.org/9712200280_content.pdf

Insects as pests

http://www.cals.ncsu.edu/course/ent425/text18/pestintro.html

Local Development, Institutions And Climate Change
In Senegal http://siteresources.worldbank.org/EXTSOCIALDEVELOPMENT/Resources/244362-1232059926563/5747581-1239131985528/5999762-1242914244952/Senegal_Report_Final_EN.pdf

Potential groundwater contamination from intentional and nonintentional storm water infiltration

https://books.google.com/books?id=kIzoGxF9GvUC&pg=PA5&lpg=PA5&dq=fungicides+potential+groundwater+pollutants&source=bl&ots=mcyfhV5R2v&sig=vARUKmI3kXUbKpElLwErHGp-Ytk&hl=en&sa=X&ved=0CCsQ6AEwAWoVChMI3Ljf-6TyyAIVhTUmCh0G_ANN#v=onepage&q=fungicides%20potential%20groundwater%20pollutants&f=false

An introduction to insecticides

http://ipmworld.umn.edu/ware-intro-insecticides

Fungal diseases of pearl millet

http://www.tifton.uga.edu/fat/fungaldiseasesPM.htm

Pest monitoring

http://pesticidestewardship.org/ipm/Pages/Monitoring.aspx

Recognition and Management of Pesticide Poisoning

http://npic.orst.edu/RMPP/rmpp_main2a.pdf

Organic Africa Net

http://www.organic-africa.net/fileadmin/documents-africamanual/training-manual/chapter-09/Africa_Manual_M09-22-low-res.pdf

ANNEX A: PESTS & DISEASES OF TARGET CROPS & AVAILABLE & RECOMMENDED CONTROL METHODS

This annex details the primary pests of all target crops on a crop-by-crop basis, available non-chemical control methods, and recommended chemical controls, where these are necessary. As such, this Annex contains both information compiled as INPUT to the PER analysis (pests of target crops), and OUTPUTS of that analysis (available non-chemical controls, recommended chemical controls.)

The pest-control method matrices provided for each target crop are intended to serve as the basis for the crop and pest-specific IPM Management Plans required by the SUAP. This Annex is generated mostly from desk research. USAID/Senegal agriculture sector target crops including rice, pearl millet and maize are profiled in this Annex.

PEARL MILLET

Pennisetum glaucum

Family: Poaceae

In Senegal Pearl millet (*Pennisetum glaucum*) [60] is grown primarily in the semi-arid regions by smallholder farmers. It is the most drought resistant crop, vital to subsistent rural communities where soil fertility is poor and rain is scarce and unpredictable. Besides agronomic advantages, millet is rich in nutrients such as iron, phosphorus, calcium, iron, potassium, and B-complex vitamins. Millet stores fairly well. Millet is the most cultivated food produced in Senegal with a strong demand for domestic consumption and export in the Diaspora market.[61]

Pearl millet is attacked by about 100 species of insects. Of these, the most regular pests in Senegal are **stem borers** *(Acigona ignefusalis* Hmps. and *Sesamia* spp.) and **earhead caterpillars** (*Masalia* spp., *Raghuva* spp.). Sporadic pests such as hairy caterpillars (*Amsacta moloneyi* Druce), **armyworms** *(Spodoptera* spp. and *Mythimna* spp.) and **grasshoppers** (Acrididae) may cause severe losses to crops during prolonged droughts early in the season. A **grain midge** *(Geromyia penniseti*) attacks late millets and can cause a considerable loss in yield.[62]

60 http://agridr.in/tnauEAgri/eagri50/ENTO331/lecture03/index.html

61 https://www.usaid.gov/sites/default/files/documents/1860/SenegalCDCS.pdf

62 http://www.tandfonline.com/doi/abs/10.1080/09670878409370867?journalCode=ttpm19

TABLE 14. PEARL MILLET INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Weeds and Grasses Annual and perennial broadleaf weeds Annual or perennial grasses	Reduction in crop yield as weeds compete with crops for water, nutrients and light Increased cost of cultivation Reduced quality of produce Transmitting pests and disease Weeds block drainage and reduce irrigation efficiency63	• Land preparation to provide weed free environment for small millet seed • Small millet seeds should be sown less deep than seeds such as maize • Making sure all equipment used to plant millet is free of weed seeds. • Help prevent weed seed from entering fields by controlling weeds along ditchbanks, roadsides, and field margins • Narrow row spacing, adapted variety selection, and crop rotations, all practices that will provide a competitive edge for the millet crop. • Hand weeding • Soil applied and foliage applied herbicides.64	Chemical weed control options are limited for millet production. Use Glyphosate products
Parasitic weed **Striga** *(Striga spp.)*	*Striga* will parasitize millet plants and prevent root development and nutrient uptake. Severe attack produces leaf wilting and chlorosis. Infected plants may be stunted and die before seed set.	• In Striga affected fields, do not grow pearl millet continuously and follow crop rotation with legumes	Dicamba provides early protection to the crop by killing the seedlings before full development Post emergence use 2, 4-D products

63 http://oer.nios.ac.in/wiki/index.php/Damages_caused_by_Weeds

64 http://lubbock.tamu.edu/files/2011/10/Millet-Production.pdf

TABLE 14. PEARL MILLET INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Millet head miner (*Heliocheilus albipunctella*) **Millet earhead caterpillar also known as Millet spike worm** *(Rhaguva albipunctella)*	Fly period of the adult moth coincides with the peak of millet panicle emergence and flowering. Caterpillars eat and finish the larval development inside panicles. During this period, the seed head also grows and develops, passing from emergence through flowering to grain-filling and maturity.	• Plough deeply to expose residual larval populations and pupae to natural enemies and desiccation. • Conserve natural enemies. • Augmentation (rearing and releases) of an effective parasitic wasp (*Habrobracon hebetor*) • A two-week delay in planting of short cycle millet varieties (75 days to maturity) to desynchronize the peak flight period of the susceptible phenological stage of the crop has been reported to be effective against this pest.	The synthetic insecticides containing deltamethrin or lambda-cyhalothrin may be used as well as imediacloprid or dimethoate products
Head-bugs *Eurystylus oldi and other spp.*	Damage on panicle starts as soon as it emerges from the boot leaf, the nymphs and adults suck the sap from the developing grain and occasionally on tender parts of the panicle	• Use resistant cultivars Use common cultural practices such as • Timely sowing • Field sanitation, rogueing • Destroy the alternate host plants • Soil test based application of manures and fertilizers. • Adoption of crop rotation. • Avoid high plant populations • Adopt ecological engineering by growing the attractant, repellent, and trap crops around the field bunds.	Neem extract Azaderachtin
Stem borers (Several species of stem borers	The damage starts from the seedling stage and continues until	• Post-harvest plowing and disposal of dead stalks to get rid of larva and pupae in millet stubbles	Use natural extracts of neem and chili peppers.

TABLE 14. PEARL MILLET INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
attack millet including the millet stemborer (*Coniesta ignefusalis*), the maize stalkborer (*Busseola fusca*), the spotted stalkborer (Chilo partellus), and the pink stalkborer (*Sesamia calamitis*).	maturity. Early-sown millet is attacked by first-generation larvae (caterpillars), which damage young plants and cause dead-hearts. Seedlings of late-sown millet are exposed to larger populations of second or third-generation larvae which produce extensive tunnels in the stems that may kill the plant. On older plants, stem tunneling may cause lodging and panicle damage due to disruption of the vascular system, which prevents grain formation.	• Deep ploughing and soil solarisation to expose pupae and propagules of soil borne pathogens • Cutting stems and laying on soil, or 5 cm below soil post-harvest[65] • Timely sowing should be done. Field sanitation, rogueing (removing plants with undesirable characteristics from agricultural fields) Destroy the alternate host plants • Soil test based application of manures and fertilizers. • Adoption of crop rotation. • Sowing of healthy, disease free and certified seeds • Uproot and burn infected plants early enough to avoid spread of the disease. • Avoid high plant populations • Growing attractant, repellent, and trap crops around the field bunds • Before rainfall apply aqueous neem extracts or neem powder applied before rainfall • Harvest before development of third generation larvae • Use water-based pheromone trap for adults • Plant resistant varieties	Neem can be effective against stem borers if used early in the season before the larvae bore into the stem of the plant Can use Azadirachtin products
The shoot fly	Females lay single cigar-shaped	• Conserve natural enemies. Parasitic wasps and several	

65 Youm, O. *Coniesta ingefusialis (Hampson) The millet Stem Borer: A Handbook of Information. (*Andhara Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics, 1999) http://pdf.usaid.gov/pdf_docs/Pnaby140.pdf

TABLE 14. PEARL MILLET INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
(Atherigona soccata**)**	eggs on the undersides of leaves at the 1- to 7-leaf stage. The eggs hatch after only a day or two of incubation, and the larvae cut the growing point of the leaf, resulting in wilting and drying. These leaves, known as 'deadhearts', are easily plucked. When a "dead heart" is plucked, it releases unpleasant odor. Larvae also bore into the heart of the young shoot of seedlings killing the growing points.	species of spiders are important predators on eggs. • Collect and destroy crop residues after harvest to reduce carry-over from one season to the other. • Use shoot-fly resistant varieties, if availableIntercropping with leguminous crops reduces damage	Can use Azadirachtin, Malathion spray @ 125 ml/ha at the four leaf stage of the crop.
Grasshoppers (Several species of grasshoppers attack millets Short-horned grasshoppers include *Zonocerus* spp, *Oedaleus senegalensis, Kraussaria angulifera, Hieroglyphus daganensis, Diabolocantatops axillaris* among others)	Grasshoppers defoliate and eat the panicles. They are not of economic importance when present in low numbers. However, invasion by a swarm of grasshoppers may result in serious grain losses. Locusts are the swarming phase of certain species of short-horned grasshoppers in the family Acrididae. Under suitable conditions of drought followed by rapid vegetation growth, they	• Conserve natural enemies. Important natural enemies include ants, larvae of blister beetles, parasitic flies, assassin bugs, predatory wasps, birds, lizards, snakes, frogs, and fungi. Robber flies are also major predator of grasshoppers. • Domesticated poultry and wild birds are good for keeping grasshopper populations in check. However, enclose the birds in wire fencing along the perimeter to avoid damage to the crop. • Ensure the ground is covered with crops, grass or mulch. This is reported to reduce grasshopper numbers since they prefer laying eggs on bare soil. • Dig or cultivate the land before planting to expose the	Can use products containing lambda-cyhalothrin or deltamethrin.

TABLE 14. PEARL MILLET INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	become swarms causing great economic damage.	eggs to predators and to the weather. • Whenever necessary spray biopesticides • Neem extracts act as antifeedant (grasshoppers stop feeding when exposed to neem products) and affect development of grasshoppers • IITA (the International Institute of Tropical Agriculture) researchers and partners have developed an environmental friendly biopesticide "Green Muscle" for control of grasshoppers and locusts (www.iita.org).	
Ergot *(Claviceps spp.)*	Cream to pink sticky "honeydew" droplets ooze out of infected florets on panicles. Within 10 to 15 days, the droplets dry and harden, and dark brown to black sclerotia (fungal fruiting bodies) develop in place of seeds on the panicle. Sclerotia are larger than seed and irregularly shaped, and generally get mixed with the grain during threshing. The sclerotia falling on the soil or planted with the seed germinate when the plants are flowering.	•Plant resistant varieties, where available. •Remove affected panicles. •Avoid planting seeds from infected panicles. •Plough deep. •Rotate with non-cereals preferably with pulses. •Practice good field sanitation	No chemical methods

TABLE 14. PEARL MILLET INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	They produce spores that are wind-borne to the flowers, where they invade the young kernels and replace the kernels with fungal growth. The fungal growth bears millions of tiny spores in a sticky, sweet, honeydew mass. These spores are carried by insects or splashed by rain to infect other kernels.		
Downy mildew *(Sclerospora graminicola, Plasmopara penniseti)*	Pale, chlorotic, broad streaks extending from base to tip of leaves. At the advancement of disease, the leaf streaks turn brown and the leaves become shredded longitudinally. In severe infection, the downy fungal growth can be seen on the upper as well as lower surface of the leaves. The rapid growth of fungal pathogen is favored by rainy and humid environment. The infected plants fail to form ear but if formed, they are malformed to green leafy structures. The complete ear can be transformed	• Use tolerant varieties available in country • Plant in a row of 15 inches to 24 inches. Seed may be placed about 6 inches apart within the row. • The seed should be planted shallow, about half inch deep at the rate of 2 Kg/acre • Maintain good fertility levels, apply adequate organic manure .	Use mefenoxam treated seed Broadcast application for some pathogens

TABLE 14. PEARL MILLET INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	into leafy structure. The fungal pathogen transformed all floral parts such as glumes, palea, stamens and pistils into green linear leafy structures of variable lengths. As the disease advances, the malformed floral structures of ears become brown and dry.		
Kernel smut *(Ustilago crameri* and *Sporisorium neglectum)*	Immature, green sori larger than the seed develop on panicles during grain filling stage. A single sorus develops per floret. As grain matures, sori change in color from bright green to dark brown. Sori are filled with dark teliospores.	• Plant resistant varieties, if available. • Rotate with non-cereals. • Plough deep • Practice good field sanitation	Chemical control measures are neither economical nor feasible at the farmers' level.
Birds	Birds peck away at the exposed seed on the grain head and in large enough numbers can eat the entire crop	• keeping pearl millet fields away from tree lines or woods if possible • Family labor at the time of grain filling stay in field to scare off birds • Use effigies and scarecrows in the field	

TABLE 14. PEARL MILLET INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
		• Destroy nesting sites within the vicinity • Reflecting tape in the field • Bird repellant	

RICE

Oryza sativa

Family: Poaceae

Source: IRRI.org

Rice is critical to the Senegalese diet. Rice is grown under a variety of conditions in Senegal including irrigated and rain-fed upland and lowland. Women are dominant rain-fed lowland farmers, while men are dominant irrigated rice farmers. The rain-fed farms per farmer are generally smaller (from few hundred to thousand square meters). In the Valley of Senegal River in the north, rice is grown under irrigated conditions. In the south rice is grown under diverse ecologies. Irrigated rice areas are responsible for about 70% of entire production and practice double-cropping. In rain-fed lowland areas rice is grown as a mono-crop or mixed with other food crops.66

The lowland areas particularly are targeted for intensification of the growing demand for rice because they provide potential for expansion, diversification and intensification of rice production. However, this intensification is accompanied by an increase in the use of fertilizers, pesticides, and high-yielding varieties. The yield potential of rice cultivated in the intensified systems is continually challenged by chronic pest infestations and by pest outbreaks. 67

Pest species distribution and abundance vary among rice ecosystems within a given location. For example, some species are primarily upland rice feeders while others are more numerous and damaging under lowland conditions. Some species may be abundant in all rice-growing environments. Rice-feeding insects are dynamic and their relative importance changes with time due to changes in rice production practices, climate, yield, and varieties—and, in many cases, due to undetermined factors. The infestation of the rice crop by different species is related to the growth stage of the plants.

Most common rice-feeding species that can be found in Senegal include stem borers, caseworm, African rice gall midge, hispid beetle, l grain-sucking bugs and termites. In the irrigated Sahel region of Senegal, mites, whiteflies, and stem borers are the most important arthropod pests. Six species of stem-borer attack rice. Common diseases include Rice yellow mottle virus68, sheath blight, rice blast, bacterial blight

66 http://www.fao.org/docrep/005/y4347e/y4347e1k.htm

67 http://cdn.intechopen.com/pdfs-wm/21186.pdf

68 Rice-Feeding Insects And Selected Natural Enemies In West-Africa; Biology, Ecology, Identification; E.A Heinrich and Alberto T. Barrion; IRRI, 2004. http://ag.udel.edu/delpha/2022.pdf

and other diseases69. Besides, insects other invertebrates like nematodes, mites, snails as well as birds and rats may feed on rice.

69 https://www.plantvillage.com/en/topics/rice/infos/diseases_and_pests_description_uses_propagation

TABLE 15. RICE INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Weeds and Grasses Wild rice, *Oryza barthi* and *O. longistaminata*, are among the most important weeds in West Africa and Sahel Common weeds include grasses, grass-like and broadleaf weeds	Decrease yields by direct competition for sunlight, nutrients, and water Increase production costs e.g., higher labour or input costs Reduce grain quality and price, for example, weed seeds in grain can cause the buyer price to be reduced.	• Plowing destroys weeds and remaining stubble from the previous crop. Weeds should be allowed to grow before the next cultivation. In addition, a level field helps retain a constant water level that controls weeds. • When used as mulches, crop residues can help conserve soil moisture, improve soil fertility, and control weeds, especially in direct seeded systems. • Weed control is critical after planting until the canopy closes. Control methods vary depending on the rice ecosystem and planting method: for transplanted, wet seeded and dry seeded rice • Direct control of weeds can be done through (1) manual weeding by hand and (2) mechanical weeding using implements such as push weeder and inter-row cultivation weeders.70 • Chemical weed control options	Pendimethalin (pre-emergence) Propanil (post emergence) Bensulfuron methyl
African gall midge (*Orseolia oryzivora*)	Gall midges can cause serious damage from the seedling stage to panicle initiation. Attacked tillers do not produce panicles. Galled plants may tiller profusely to compensate for loss of growing points. A serious attack results in	• Destroy alternative host plants such as rice ratoon crop, volunteers and wild red rice or longstamen rice (*Oryza longistaminata*). • Destroy stubble after harvest • Plant resistant and early maturing varieties. • Avoid close spacing since it provides a suitable micro-environment for the survival of this pest.	In general, insecticide treatment for rice gall midge is ineffective.

70 http://www.knowledgebank.irri.org/step-by-step-production/growth/weed-management

TABLE 15. RICE INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	stunted plant growth and poor yields. Gall midges do not attack rice plants that have matured beyond tillering stage. These midges spent some generations on wild grasses and then move to attack young rice plants. They are pests during the rainy season, and are most serious on rain-fed lowland and irrigated rice.	• Conserve natural enemies. Parasitic wasps (*Aprostocetus procerae* and *Platygaster diplosisae*) are very important in the natural control of the African rice gall midge. These wasps provided an important check to pest populations, especially late in the season. However, the wasp populations usually build up too late to prevent heavy gall midge infestation. • Habitat manipulation such as dry-season cultivation to encourage *Paspalum* grass (*Paspalum scrobiculatum*) abundance early in the wet season is suggested as a way of improving the natural biological control of the rice gall midge.	
Rice-sucking bugs, stink bugs (*Aspavia* spp, *Nezera viridula*)**,** and **Alydid bugs (***Mirperus spp.and Riptortus spp.)*	Both nymphs and adult bugs feed sucking rice grains in the milky stage. When grains have ripened the bugs feed on panicle stalks and pedicels. *Riptortus* bugs also feed on hard dough rice grains. Bug feeding causes pecky rice that is partially or wholly stained due to infections with bacteria and fungi. The glumes change color first to light brown, then darker and may turn grey in severe cases. Damage grains are	• If necessary spray plant extracts. A number of plants (lantana, garlic, oleander, African marigold, blackjack, goat weed, wormseed, among others) are reported as effective against various species of bugs (Elwell and Maas, 1995).	Can use Imidocloprid products

TABLE 15. RICE INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	shriveled and unfilled. Severity of the damage depends on the stage of grain development and on the number of punctures in the grain.		
Stemborers **Striped borer** (*Chilo partellus*, *Chilo zacconius, Chilo orichalcocilielus*) **White rice borer** (*Maliarpha separatella*) **Yellow borer** (*Scirpophaga* sp.) **Pink stemborer** (*Sesamia calamistis*).	The caterpillars bore into the stem of rice plants. Caterpillars of the yellow borer bore into the stem below the growing point, destroying tillers. The white borer and the pink stemborer attack rice at full tillering stage preventing grains from filling up and ripening. This damage results in empty panicles known as "whiteheads". The striped borer feed on rice plants at all stages. Young caterpillars cause "dead hearts".	• Practice field sanitation. Burn or feed debris to livestock after harvest. • Plough and flood after harvest. These practices destroy diapausing stemborer caterpillars. • Use natural extracts of neem and chili peppers. • Practice early and synchronized planting. Synchronized planting over a large area allows the most susceptible stage of rice to escape from stemborer damage. • Practice proper water management. • Conserve natural enemies. Wasps that parasitize eggs and caterpillars, and predators such as ants, dragonflies, assassin bugs, carabid beetles and spiders are important natural enemies of stemborers. • Plant resistant varieties	Chemical control of stem borers is generally not recommended as stem borers are quite difficult to control with insecticides Can use available permethrin products

TABLE 15. RICE INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Stalk-eyed shoot flies (*Diopsis* spp.)	The whitish maggots that hatch from the eggs penetrate into the growing zone (heart) of the plant. As a result of maggot feeding the central whorl does not open, but dries-up and dies, producing what is commonly known as "dead heart".	• Practise early and synchronised planting. • Proper plant spacing. There are indications that damage increase with an increases in plant density (Heinrich and Barrion, 2004). • Apply calcium silicate to strengthen stem tissues. • Avoid panicle harvesting (leaving tall stems) and destroy stubbles after harvest. • Water management: keep basis of stems always under water. • Conserve natural enemies. Spiders are the main natural enemies of these flies. • The cultivars "WAB 1159-2-12-11-6-9-1-2" has been reported in Uganda to trap Diopsis thoracica larvae with their highly hairy leaves (WARDA).	Use cypermethrin, deltamethrin or lambda cyhalothrin products Insecticide use may not be economical; yield loss only occurs when damage reaches more than 50%, which rarely occurs

TABLE 15. RICE INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Termites (*Microtermes* spp., *Ancistrotermes* spp., *Trinervitermes* spp., *Macrotermes* spp., and *Odontotermes* spp.).	Termites may cause serious damage during dry periods. They may also occur in lowland areas in light texture soils. They generally attack plants in their later growth stage by hollowing out their root system and filling it with soil resulting in the lodging of the rice plants. The attacked plants are then predisposed to further damage by ground-dwelling pests such as rodents, ants, and secondary infection by fungi and bacteria. Damaged plants can easily be pulled up by hand because the roots are severed.	• Plant resistant varieties whenever available. " • Use neem with detergent. • The application of red palm oil mixed with pawpaw is an indigenous control practice.	Imidacloprid is one of non-repellents slow-acting materials that allow foragers to carry the product back to the nest and effectively control the entire colony
The case worm (*Nymphula depunctalis - Parapoynx stagnalis*)	The case worm is a common pest on wetland rice. The caterpillar attacks the food plant only in the vegetative stage, during the first 4 weeks after transplanting. The caterpillars climb onto a leaf and begin feeding by scrapping the leaf surface causing linear grazing of leaves giving the leaf tissue a	• Practice field sanitation (burning debris or feeding of debris to livestock after harvest). • Practice early and synchronized planting. • Proper plant density. • Practice proper water management. Ensure good drainage for 3 days, since larvae cannot survive without water. • Hand pick and destroy rolled leaves in the nursery	Insecticides are not commonly used

TABLE 15. RICE INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	ladder-like appearance. Later caterpillars cut a piece of rice leaf, roll it up into a case and seal the edges with silk material leaving the interior end open. The cut near the tip of a leaf is characteristic.		
Hispid beetles (*Trichispa* spp., *Dicladispa viridicyanea, Dactylispa bayoni*)	The beetles cause severe defoliation and act as vectors of the Rice Yellow Mottle Virus. Hispid beetles attack the crop in the early growth stages. Larval feeding occurs during the tillering stage. The first attack in a field is highly localized, but the infested area spreads rapidly. Feeding by adults on the leaves causes characteristic narrow white streaks or feeding scars that run along the long axis of the leaf. Mining by grubs within the leaf shows as irregular pale brown blister-like patches. Feeding results in loss of chlorophyll and the plants wither	• Use close proper spacing. • Keep bunds and surroundings free of grass weeds. • Destroy stubbles and avoid ratooning. • Ensure balanced nutrition. Avoid excessive nitrogen application.	Use of lambda-cyhalothrin

TABLE 15. RICE INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	and die. The most serious damage occurs in nurseries, which may be completely destroyed. Severe infestations sporadically occur on transplanted rice and can kill the plant. When the plants survive, they usually recuperate and produce some grain. However, damaged plants often mature late. They are generally most abundant during the rainy season.		
Rice Yellow Mottle Virus (RYMV)	Stunting of rice plants Reduced tillers Yellowing and mottling of leaves Infected plants easily attacked by other diseases	• Use resistant/tolerant varieties NERICA 4 and 6, NARIC 1 and 2 • Rouging infected plants only when infestation is low • Do not ratoon crop to avoid disease carryover • Vector control	Can use synthetic insecticides containing pyrethroids like lambda-cyhalothrin or deltamethrin to control the flea beetle vector. A preventive seed treatment with thiamethoxam
Rice blast –Leaf and Neck blast *Pyricularia oryzae*	Most destructive Removes photosynthetic tissue from leaves, stems and gains	• Resistant varieties like Gold • Avoid excess nitrogen fertilizer • Fungicides not economic to use	Use application of synthetic fungicides containing azoxystrobin, mefenoxam, mancozeb, chlorothalonil, or

TABLE 15. RICE INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Magnaporthe grisea	Reduces yield by up to 50% or more		difenoconozole.
Sheath Blight *Thanatephorus cucumeris* *Rhizoctonia solani*	Reduced photosynthetic areas Leaves die Yield reduction by 20-25%	• No variety has a high level of resistance • Do not apply excessive nitrogen • Fungicides not economical and not recommended	Use available fungicides such as iprodione, azoxystrobin
Brown spot *Cochliobolus miyabeanus*	Reduced photosynthetic area Reduced grain weight and quality	• Provide adequate fertilizer • Resistant varieties • Hot water treatment of seed	Seed treatment with mancozeb.
Leaf scald *Metasphaeria albescens*	Reduced photosynthetic area Lowers filled grain ratio and grain quality	• Avoid excess nitrogen fertilizer	Use mancozeb products
Sheath rot *Acrocylindrium oryzae* Associated with insect injured plants and viral	Loss of photosynthetic area on the uppermost leaf sheaths enclosing panicle Panicle remains in sheath	No control known	None available

TABLE 15. RICE INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
infection	Lowers filled grain ratio and grain quality		
Bacterial panicle blight *Burkholderia glumea* Seed transmitted disease	Spikelet lose green color and become white then brown Lowers grain quality and weight	• No resistant variety • Use of fungicides not economical • Use certified disease free seed	No chemical control agents are labeled to control bacterial panicle blight.
False smut *Claviceps virens* also *Ustilago*	Infects a few single grains in a panicle	• Leave out infected panicles during harvest • Dress seed with fungicide when appropriate	Fungicides are generally not used for most smuts.
Birds *Qealea spp* *Ploceus spp* Starlings	Swarm into crop at Milky and grain filling stage and remove grains	• Family labor at the time of grain filling stay in field to scare off birds • Use effigies and scarecrows in the field • Trap cropping with maize or • Sorghum • Destroy nesting sites within the vicinity • Reflecting tape in the field	

TABLE 15. RICE INTEGRATED PEST MANAGEMENT PLAN

TYPE OF PESTS	DAMAGE DONE	AVAILABLE IPM CONTROL MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
		• Bird repellant • Resistant variety with awns (NERICA 10)	
Rats	Cut tillers and feed on grains	• Clear bushes around the fields • Destroy burrows • Preserve predators of rats e.g. mongooses, owls etc. • If mole rats, plant *Tephrosia vogelii* around the field • Use traps set carefully in the field	Use bait boxes with blocks of rodenticides containing brodifacoum.

MAIZE

Zea mays

Family: Poaceae (Graminae)

Source: myagro.org

Demand for maize in Senegal is large and growing. Current maize production is not enough to supply the flour milling industry and the poultry and livestock feed industry.71 Maize is a versatile crop, cultivated across a range of agro-ecological zones. With its large number of varieties differing in period to maturity, maize has a wide range of tolerance to temperature conditions. It is essentially a crop of warm regions where moisture is adequate. The crop requires an average daily temperature of at least 20°C for adequate growth and development. Optimum temperature for good yields is around 30°C. The time of flowering is influenced by photoperiod and temperature. Maize is considered to be a quantitative short-day plant (short days can induce premature flowering).

Maize is especially sensitive to moisture stress around the time of tussling and cob formation. It also needs optimum moisture conditions at the time of planting. In the tropics it does best with 600 - 900 mm of rain during the growing season. Maize can be grown on many soil types, but performs best on well-drained, well-aerated, deep soils containing adequate organic matter and well supplied with available nutrients. The high yield of maize is a heavy drain on soil nutrients. Maize is often used as a pioneer crop, because of the high physical and chemical demands it makes to the soil. Maize can be grown on soils with a pH from 5 - 8, but 5.5 - 7 is optimal. It belongs to the group of crops that is considered to be sensitive to salinity. Since a young crop leaves much of the ground uncovered, soil erosion and water losses can be severe and attention should be paid to adequate soil and water conservation measures.

Weeds remain a pivotal constraint. Delayed weed removal is the primary cause of maize yield loss in smallholder agriculture. Herbicides can save labor and time to increase the net benefits to farmers. However, very few farmers use herbicides because they have low capital, inadequate knowledge systems and poor access to credit. The parasitic weeds Striga spp. known as witch weeds, are important pests of maize, particularly in drier areas. The weeds grow on the roots of maize affecting development of maize plants. A single weed plant produces many thousands of tiny seeds that survive in the soil for long periods. A heavy infestation can cause complete yield loss. Striga infestation is associated with increased cropping intensity and declining soil fertility.

Maize is constantly threatened by the potential outbreak of multiple foliar diseases. Maize and rice share some common stem borer species. Stemborers are major pests of maize in all African countries south of

71 https://www.usaid.gov/sites/default/files/documents/1860/SenegalCDCS.pdf

the Sahara. Damage caused by stemborers is one of the main causes of low maize yields. Female stemborer moths lay eggs on maize leaves. The newly emerged larvae enter into the whorls of young maize plants and feed actively on the tender leaves. In older plants the larvae bore into the stem and start tunneling. Plants thus affected have stunted and poor growth, reduced yield, and are more susceptible to wind lodging and secondary infections.

The most common storage pests of maize are the Angoumois grain moth (Sitotroga cerealella), the larger grain borer (Prostephanus truncatus), grain weevils (Sitophilus spp.) and rodents (mostly mice). They can be managed by a combination of measures: Early harvest of the maize to prevent or reduce infestation of the maize cobs in the field; Growing suitable varieties where the husk covers all of the grains. Proper drying of the maize grain is an important procedure in storage pest prevention. For maize to be stored safely, it must be dried quickly after harvest. For minimizing re-infestation of the new harvest, residual pockets of infestation need to be cleaned out all at the end of the storage season. It is important to access all dark corners, sealing off all potential entry points and clearing the surrounding spots where rodents are likely to hide. Periodic inspection and removal of all infested maize cobs or grain is necessary to repel and kill maize weevils. Plant extracts, for example, crushed ripe, dry chili pepper pods mixed with wood ashes can repel and kill maize weevils.

Use of natural enemies, for example, the predatory beetle Teretrius nigrensis has been used in many African countries in an attempt to control the larger grain borer. Bt-maize is genetically engineered to resist stem borer. It has been created by adding the genes from the soil bacterium Bacillus thuringiensis to the maize seeds. Bt-maize produces a toxin that kills the African white stem borer (Maliarpha separatella (Ragonot). Apart from being expensive, farmers are not allowed to save or exchange Bt-maize seed. Stem borers quickly develop resistance to Bt-maize and pollen could transmit the Bt-gene to local maize varieties.72

Maize is a high risk food for aflatoxin contamination. Aflatoxin is a naturally occurring toxin produced by the fungus *Aspergillus flavus*. In more advanced stages, the fungus can be recognized by a gray-green or yellow-green mold growing on corn kernels in the field or in storage. Plant stress due to drought, heat or insect damage during fungus growth usually increases aflatoxin levels. Aflatoxin contamination will reduce feeding value and hinder sales. Because it is extremely poisonous to warm-blooded animals even at relatively low levels, grain handling facilities often check for the presence of the toxin before purchasing maize. International Institute of Tropical Agriculture (IITA) aflatoxin working group has an ongoing research in Senegal on commercial production of Aflasafe, a nontoxic biocontrol technology that reduces harmful aflatoxin development in cereals.

72 http://www.agriguide.org/agriguide/files/etic_agriguide_en_20120830.pdf

TABLE 16. MAIZE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGMENET AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Striga (Purple witch weed, Striga spp)	Tap the roots of maize plant and draw water and nutrients Stunting of plants and yield loss	Weeding regularly but is labor intensive Rotate maize with trap crop Intercrop maize with "Striga chaser" Celosia Inter crop with legumes like cowpea and pigeon pea – can cause suicidal germination of Striga seed Intercrop with Desmodium to reduce seed bank of Striga in the soil (push and pull) Use resistant varieties Boost plant health through manure/fertilizes application	2,4-D
Grass and broad leaf weeds	Compete for water and nutrients	Post-emergent controls Thorough land preparation Hand hoe Weeding Post-emergent spray if previous crop was weedy	Pendimethalin
Perennial weeds	Compete for water and nutrients	Pre-plant or pre-emergence spray Herbicide post- emergence weed control	Glyphosate (most effective if applied from time of flowering when

TABLE 16. MAIZE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGMENET AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
			the plant's energy system shifts to developing roots)
Borers Spotted Stem Borer Maize Stalk Borer (aka African Stalk Borer) Pink Stem Borer African sugarcane borer	Young plants have pinholes in straight lines across the newest leaves. Borers tunnel stalks to inhibit nutrient and water flow. Their feeding causes ears to break off	Conserve natural enemies. Parasitic wasps and predatory ants are important in natural control of stemborers. Destroy crop residues to kill pupae left in old stems and stubble and prevent carry-over populations. This helps in limiting initial establishment of stemborers on the following season's crops. Intercrop maize with crops that are non-hosts for stemborers (e.g. cassava and grain legumes) Intercrop maize with a repellent plant such as Desmodium and plant an attractive trap plant, such as Napier grass, as a border crop around this intercrop to protect maize from stemborers. This technology is known as "push-pull". Use neem products. Simple neem products are reported to be effective for control of stemborers.	Apply imidacloprid or thiamethoxam to seed or growing plant, or apply acetamiprid to the plant (but only when plants are in vegetative state, not when flowering due to risk to pollinators and honeybee colony collapse disorder). Use Bt or spinosad (both extracts from soil microbes) between the egg stage and leaf-feeding stage (before they bore into the stem). Can use synthetic insecticides containing lambda-cyhalothrin

TABLE 16. MAIZE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGMENET AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Termites *(Microtermes* spp., *Macrotermes* spp., *Allodontermes* spp., and *Odontotermes* spp)	Attack roots and stems of young seedlings and mature plants,	Deep plowing Dig out queen and destroy Grinding fish bones and placing dry meal underground to attract ants that reduce termites Use of dressed seed Use bio-pesticides Intercropping with legumes	Can spray imidacloprid (but only when plants are in vegetative state, not when flowering due to risk to pollinators and honeybee colony collapse disorder).
African bollworm (*Helicoverpa armigera*) aka Earworm and Cornworm	Attack mainly the developing cobs, although they may occasionally feed in the leaf whorl or on tender tassels. Eggs are laid on the silks. Caterpillars invade the cobs and feed on developing grain. Development of secondary infections is common. Local outbreaks of this pest are sometimes severe.	Conserve natural enemies. Parasitic wasps, ants and predatory bugs are important in natural control of the African bollworm. Monitor the crop regularly. Use bio-pesticides. Plant extracts (e.g. neem, garlic, chilli,) and Bt are reportedly effective against the African bollworms. However, timing of application is very important. Spraying when caterpillars are inside the cob would be ineffective. Handpick and destroy pod borers. This helps when their numbers are low and in small fields.	Can use products containing Bt, Azadirachtin
Cutworms (*Agrotis spp.*	Sever seedlings,	Early planting	Apply products containing beta-cyfluthrin,

TABLE 16. MAIZE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGMENET AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
and other species)	defoliate and reduce photosynthetic surface area	Deep plowing to expose worms Conserve natural enemies Apply insecticide poisoned bait when larvae first seen in economic numbers	flubendiamide
Grasshoppers and locusts	Grasshoppers and locust attack maize from the mid-whorl stage to maturity, and may consume every part of the plants. Attacks vary in severity from location to location.	Conserve natural enemies. Avoid destroying larvae of blister beetles, since they feed on eggs of grasshoppers. Other natural enemies include ants, parasitic flies, assassin bugs, predatory wasps, birds, lizards, snakes, frogs, and fungi. Robber flies are a major predator of grasshoppers. Domesticated poultry (e.g. chickens, turkeys, guinea fowl, geese, and ducks) and wild birds are good for keeping grasshopper populations in check. However, birds may damage the plants too. To avoid this enclose the birds in wire fencing along the perimeter so that they can prey on visiting grasshoppers while staying out of the crop. Ensure the ground is covered with crops, grass or mulch. This is reported to reduce grasshopper numbers since they prefer laying eggs on bare soil. Catch grasshoppers by hand or with a butterfly net.. Catching them in the early morning is easier, as they are less active in the mornings. Dig or cultivate the land before planting to expose the eggs to	Can use insecticides containing lambda-cyhalothrin or deltamethrin.

TABLE 16. MAIZE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGMENET AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
		predators and to the sun. Whenever necessary spray biopesticides. Neem extracts act as antifeedant (grasshoppers stop feeding when exposed to neem products) and affect development of grasshoppers.	
Maize lethal necrosis (MLN) **Maize chlorotic mottle virus** (MCMV) and other potyvirus	Infection rates and damage can be very high, seriously affecting yields and sometimes causing complete loss of the crop. MLN is mainly spread by a vector, transmitting the disease from plant to plant and field to field. The most common vectors are maize thrips, rootworms, leaf beetles and aphids. Hot spots appear to be places where maize is being grown continuously	MLN does not occur on crops other than maize; so avoid growing maize after maize. Diversify your farm enterprise by planting different crops each season. Do not plant a new maize crop near an infected field. Wind-blown insect vectors can transmit the disease from the infected field to the new crop Plant maize at the onset of the main rainy season, rather than during the short rain season; this creates a break between maize crops and interrupts the disease cycle Weed fields regularly to eliminate alternate hosts for insect vectors. Use maize varieties that are resistant to MLN Immediately remove diseased plants from your fields. You can feed the leaves to livestock Do not allow humans or animals to eat infected ears or grains, which may contain secondary fungal infections and harmful mycotoxins. Burn infected ears and grains.	
Maize streak virus (MSV)	White to yellowish streaking on the leaves.	Use of tolerant, resistant varieties if available.	Pesticides such as imidacloprid and

TABLE 16. MAIZE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGMENET AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	The streaks are very narrow, more or less broken and run parallel along the leaves. The virus is transmitted by leafhoppers (*Cicadulina mbila* and *C. bipunctella zeae*). Maize streak virus is a serious constraint to maize production in sub-Saharan Africa. The reduction in yields depends on the time of infection. Plants infected at early stage usually do not produce any cobs.	Plant early in the season. Eradicate grass weeds. Eradicate control vectors such as leafhoppers	thiamethoxam can be used but have been found not to be economical for control of disease
Angoumois grain moth (*Sitotroga cerealella*)	The larvae of the Angoumois grain moth penetrate and feed inside maize grain. This insect may also infest the crop in the field prior to harvest. The moths are small yellowish or straw-colored. The larvae are whitish. The larvae	Practice good warehousing hygiene. Ensure proper monitoring and record keeping. All residual pockets of infestation should be cleaned out at the end of the storage season. This is important to minimize re-infestation of the new crop. Store old and new lots separately. Do not leave maize in the field after drying, this increases the chances of infestation. Whenever possible separate stores from fields. The grain moths are good flyers and adults from infested stores often infest	Standard fumigation with Aluminum Phosphide and insecticide treatments with perimiphos-methyl

TABLE 16. MAIZE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGMENET AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	prepare a round exit hole for the moth, leaving the outer seed wall only partially cut as a flap over the hole, resembling a trap door. The adult pushes its way out through this "window" leaving the trap door hinged to the grain. Infested grains can be recognized by the presence of these small windows.	growing maize in the field. Keep the temperature and humidity as low as possible. There are indications that storing grain in a dry place can reduce infestation. Prevent pest entry by sealing the store (windows, doors, ventilation facilities) with insect-proof gauze. Hermetic storage at low humidity gives good levels of control. Periodically inspect and remove any infested maize.	
Lesser grain borer (*Rhizopertha dominica*), and **Larger grain borer** (*Prostephanus truncatus*).	Both the adults and the larvae (grubs) of these beetles feed in the grains. Adults come from infested cobs in the field or from an infested maize store and lay eggs in the grains. They attack maize both in the field and after harvest. Attacked maize grains lose all their contents and are not fit to eat. These pests become a serious problem	Maize is often left in the field until the moisture content of the grain has fallen to 15-20%, though this can lead to attack by grain borers in the covered cobs. Practice good warehousing hygiene. Ensure proper monitoring and record keeping. All residual pockets of infestation should be cleaned out at the end of the storage season. This is important to minimize re-infestation. Store old and new lots separately. Do not leave maize in the field after drying, this increases the chances of infestation. Whenever possible separate stores from fields. The grain moths	Fumigation with Aluminum Phosphide

TABLE 16. MAIZE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGMENET AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	in short time if no control measures are applied.	are good flyers and adults from infested stores often infest growing maize in the field. Keep the temperature and humidity as low as possible. There are indications that storing grain in a dry place can reduce infestation. Prevent pest entry by sealing the store (windows, doors, ventilation facilities) with insect-proof gauze. Hermetic storage at low humidity gives good levels of control. Periodically inspect and remove any infested maize.	
Maize weevil (*Sitophilus zeamais*)	Both adults and larvae feed on internally on maize grains and an infestation can start in the field (when the cob is still on the plant) but most damage occurs in storage.	Because the maize weevil larvae develop inside the grain it is difficult to detect the pest by visual inspection unless its numbers are very high The severity of a maize weevil infestation can be reduced by good store hygiene: cleaning the store between harvests, removing and burning infested residues, fumigating the store to eliminate residual infestations and the selection of only uninfested material for storage. Harvesting the maize as soon as possible after it has reached maturity will reduce the chances of attack by maize weevil and other storage pests. The use of resistant cultivars may also reduce the severity of an infestation. The removal of adult insects from the grain by sieving can reduce populations but this is very labor-intensive. The addition of inert dusts such as ash and clay to the grain can reduce insect numbers by causing the insects to die from desiccation.	If needed, can use synthetic insecticide powders or dusts containing pirimiphos-methyl and permethrin.

TABLE 16. MAIZE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGMENET AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
		Various parasitoids (Anisopteromalus calandrae, Cephalonomia tarsalis, Lariophagus distinguendus and Theocolax elegans) could be effective if introduced early in the storage period. The fungus Beauveria bassiana can be used as a biological insecticide to control maize weevil in stored maize. The bacterium Bacillus thuringiensis can be used on adults73. Black pepper, bay leaves and cloves are reported to deter some weevil spp.	

73 http://keys.lucidcentral.org/keys/v3/eafrinet/maize_pests/key/maize_pests/Media/Html/Sitophilus_zeamais_Motschulsky_1855_-_Maize_Weevil.htm

HORTICULTURE: LEGUMES, TUBERS, GREEN LEAFY VEGETABLES, VEGETABLES, AND FRUIT

Source: PAN-UK.org

About two decades ago, 80-85 percent of Senegal horticultural produce originated from small and medium producers. Since then their role has been declining as large-scale commercial producers have entered the market, including for export. Some of these companies run integrated operations growing, packaging and shipping their produce, while others work with outgrowers or buy from independent smallholders.

While export has grown in Senegal, production is concentrating in fewer and fewer hands. While the export sector may be thriving, the livelihoods of smallholders that are unable to meet stricter EU regulations are in jeopardy. Exporters will not buy produce from smallholders unless they can ensure quality and food safety compliance through training and close supervision.[74]

The majority of horticulture production is still grown for local domestic markets by smallholders. The horticulture sector represents an important source of livelihood for many farmers, farm workers and their families.

Horticultural produce grown in Senegal includes vegetables such as tomatoes, okra, and onions, green leafy vegetables, pulses such as beans and groundnuts, tubers including potatoes and cassava, and fruit such as mango.

Horticultural crops are often attacked by pests that affect the harvested part of the plant, and thus have low tolerances for injury resulting in frequent applications of pesticides. At the same time, these are the crops that contribute both to the family diet as well as being distributed in local markets and can be consumed unwashed and uncooked. Practices that minimize insecticide use to prevent pesticide residues at harvest, but to also slow the development of pesticide resistance is of particular importance in these crops.

Movement of insect pests is a global issue. When an invasive pest attacks a restricted host, the impact may be severe, but nevertheless restricted to that crop or plant species. However, if an invasive pest is highly polyphagous (can feed on various types of food/crops), its establishment can cause economic loss over a much wider span of the agro-ecosystem; this impact can continue over years. [75]

[74] http://www.pan-uk.org/archive/Projects/Fairness/PN71/pn71p12.pdf

[75] http://www.reeis.usda.gov/web/crisprojectpages/0229483-ecologically-selective-pest-management-in-high-value-horticultural-crops-in-national-and-international-settings.html

LIVESTOCK

Demand for livestock products, including poultry, is expanding in West Africa as a result of population growth and increased urbanization.

Poultry production in Senegal generally falls under two categories: traditional farmyard poultry keeping by smallholders and semi-industrial commercial systems. Most rural Senegalese households raise some type of poultry as a source of protein and supplemental income. Indigenous chicken varieties are widespread, with some Guinea fowl raised in the eastern regions and ducks raised in southern areas. Poultry's short production cycle and ease of transport and sale relative to other livestock make the sector particularly important to the poorest segments of the population and to females.[76] Sheep and goats are very important livestock species, particularly for the poorer rural communities.

[76] http://evans.uw.edu/sites/default/files/public/Evans%20UW_Request%2086_Poultry%20Market%20Analysis%20Senegal_5-24-2010.pdf

TABLE 17. HORTICULTURE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
		Legumes – cowpeas and beans	
Aphids *Aphis craccivora (cowpea aphids)*	The aphids attacks all growing stages and parts of the plant: flowering, seedling and vegetative growing , points including the leaves and the plant as a whole. Congregating on lower leaf surfaces and on terminal buds, aphids extract plant sap. Leaves curl and pucker and seedling plants may become stunted and die. Infested plants may develop yellow foliage, may become dwarfed and malformed, and lose vigor. A dark sooty mold often grows on the honeydew-coated surfaces of aphid-infested plants.	Use insect resistant varieties Check plants regularly for aphids—at least twice a week when plants are growing rapidly Prune out infested crop and dispose of safely. Protect natural enemies such as lady beetles, lacewings, bigeyed bugs, damsel bugs, and syrphid flies where available, prevent symbiotic ants Wash off aphids with a strong stream of water with insecticidal soap and garlic oil if plants are strong Don't over-fertilize, use slow release fertilizers Grow plant under natural cover until they are strong enough	Cypermethrin, Malathion, Permethrin, Azaderachtin Insecticidal Soap, Diatomaceous Earth, Neem Oil
Aphids *Aphis fabae (bean aphids)*	Removes sap from the leaves, pods, seeds and other aerial plant parts causing damage to the plant resulting in yield reductions. Distortion, stunting of leaflets, lesions; abnormal colors; premature defoliation; sooty mold	• Use of improved varieties • Choosing suitable growing location • Avoid using fresh manure that can attract pests • To avoid water stress, early planting and weeding • Remove any plants with sign of virus from the field • Use of natural enemies is also recommended. Bean aphids are attacked by a variety of common aphid predators and parasites. Lady beetles, green lacewing larvae, and syrphid fly larvae are frequently found associated with bean aphid colonies. Bean	Imidaclopid Dimethoate

TABLE 17. HORTICULTURE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
		aphid is attacked by a parasitic wasp, Lysiphlebus testaceipes.	
Bruchid weevils *Callosobruchus maculatus (Fabricius)*	Damage in fields as well as dry seed in storage Producing tunneling injuries	Solarization (sun drying and heating) can be used to control infestations without affecting seed germination Treating seed at intake is effective in minimizing bruchid damage in storage Thorough pre-harvest cleaning of storage, transport and harvesting equipment is critical for the management of bruchids.	Lambda-Cyhalothrin+ Thiamethoxam Fumigation in storage with Aluminum Phosphide by professional fumigators
Maruca pod borer *Maruca vitrata* Pod borers	Maruca pod borer is a post flowering pest that feeds on every part of the cowpea plant	Cowpea cultivars resistant to stem damage have been identified. Removing leguminous weeds, Trap cropping with Crotalaria spp., a genus of herbaceous plants and woody shrubs in the Family Fabaceae commonly known as rattlepods Intercropping with sorghum, maize, pearl millet or finger millet, mung beans reduced pod damage in main crop. Pheromone traps were found effective in some locations but not others	Neem Seed kernel extract (NSKE), Neem Oil, and Bacillus thuringiensis (Bt) Indoxacarb Spinosad
Thrips *Megalurothrips sjostedti*	Premature dropping of flowers	Field inspection during active growth Use resistant varieties Planting site sanitation Field inspection during active growth Removal of infested residues after harvest Selection of pest free seeds after threshing for storage, dry seed inspection	Cypermethrin

TABLE 17. HORTICULTURE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Mosaic virus	Transmitted by various beetles with biting mouthparts	Use of resistant cultivars offers the best means of disease control. Cowpea lines with resistance to multiple viruses including CPMV have been developed at the International Institute of Tropical Agriculture (IITA).	Because of the small plots used for cowpea growing and the extreme prevalence of the beetle vector, the use of insecticides for vector control is not practicable.
Leaf spot *Mycosphaerella spp.*	On infected leaves (especially those more mature) brown or rust-coloured lesions that vary from circular to angular, are 2-10 mm, and may coalesce. Lesions may have a grey centre with a slightly reddish border. Conidia develop at the centre on short conidiophores. Severely affected leaves become chlorotic. Lesions may dry and portions may fall out, giving the leaf a shot-hole appearance. Lesions and blemishes may occur on branches, stems and pods.	Use of resistant varieties	Copper-based bactericides will reduce epiphytic populations of bacterial pathogens on bean foliage These compounds, however, cannot eradicate the pathogens once the plants are infected
Fusarium	Dry root rot caused by the fungus directly affects only the roots of the plants; however, the parts above ground are stunted and may turn yellow, wilt, and die before the plants mature.	Pathogen is not seed-borne, but is a soil organism, therefore correct disposal of the bean straw and long rotations are recommended (at least 3 years) Avoid injury to the root system including with herbicides Remove crop debris immediately after harvest Beans should be planted only on well-drained, well-fertilized soil Plant beans on raised beds	No cost-effective chemicals for *Fusarium* control Seed treatment by Mancozeb only partial control

TABLE 17. HORTICULTURE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
		Avoiding stress caused by excess water, prolonged drought, soil compaction Avoid dense plant population	
Anthracnose	Seedlings grown from infected seeds often have dark brown to black sunken lesions on the cotyledons and stems	Using anthracnose-free and certified seed Since the fungus is disseminated in the presence of water, fields should not be entered for cultivation or pesticide applications when the plants are wet. Avoiding unnecessary movement in infested fields will minimize the spread of the disease. Two-year crop rotation Plow debris deep into the soil	No seed treatment, Foliar fungicides are not considered economical Chlorothalonil has been recommended by some research. Research also suggests management of Anthracnose in Common Bean by Foliar Sprays of Potassium Silicate (KSi), and/or Sodium Molybdate (NaMo), and Azoxystrobin can be effective. (APS Journal; January 2014, Volume 98, Number 1 Pages 84-89)
Cutworm Larval noctuid moth *Loxagrotis albicosta* and others	Cutworms are the larvae (caterpillars) of several species of night-flying moths. The larvae are called cutworms because they cut down young plants as they feed on stems at or below the soil surface.	Regular inspections, control is more effective when the larvae are small Remove weeds and plant residue to help reduce egg-laying sites and seedling weeds that nourish small cutworms Till before planting which helps expose and kill overwintering larvae. Tilling also removes plant residue, which helps to discourage egg laying. Avoid using fresh manure, use compost instead	Chlorantraniliprole/ Rynaxypyr

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PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Nematodes	Nematode injury can involve both aboveground and below ground plant parts. Foliar symptoms of nematode infestation of roots generally involve stunting, premature wilting, and slow recovery to improved soil moisture conditions, leaf chlorosis (yellowing) and other symptoms characteristic of nutrient deficiency. Root damage can cause infected plants to form a tight mat of short roots swollen appearance	Plant resistant varieties Crop rotation with plants that are poor host for nematodes, sorghum is often recommended as a cover crop to decrease population levels of root-knot nematodes Nematode management is primarily a pre-planting activity Planting equipment and tools should be properly cleaned, and in extreme cases could only be used for the same field Only soil and planting material free of nematodes should be used, because once nematodes are introduced into a field they cannot be eradicated After harvest infected plants should be destroyed to prevent the build-up of nematodes on these crop residues and therefore in the soil	Soil fumigants are not approved by this PERSUAP
		Tubers – sweet potatoes	
Weevils	Female weevils excavate cavities and create egg-laying punctures. The eggs are laid below the surface of the roots and are covered with dark color. Hatched larvae are tunneling inside tubers. Mining of sweet potato tubers by larvae is the principal cause of sweet potato damage. The tuber becomes	Intercropping with maize, yam, cowpea, other crops Crop rotation Elimination of crop residues Deter infestation by preventing soil cracking, irrigating frequently or hilling a small area around the sweet potato Mulching materials such as rice straw and plastic film reduce the infestation of sweet potato weevils by spreading them over the planting site Reridging at tuber formation stage	Bacillus thuringiensis B. bassiana + M. brunneumi *B. bassiana* + *M. anisopliae* in more humid locations Azadirachtin Beta-cyfluthrin on weevil adults

TABLE 17. HORTICULTURE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	spongy in appearance, riddled with cavities, and dark in color	Practice proper field sanitation Using entomopathogenic nematodes and fungi Pheromone traps and use of natural enemies where available	
Write grub (larvae of Scarab beetles)	White grub larvae gouge out broad, shallow areas on the root	Avoid planting in fields that follow pasture	None Approved
Stemborers *Omphisa anastomosalis*	Larvae boring into the main stem and sometimes penetrates storage roots	Use treated planting materials Crop rotation Hilling-up to cover the holes that provide the adults with an exit from the stem Earwigs and ants may attack the larvae developing within sweet potato vines. Undetermined hymenopteran species (family Encyrtidae) have been observed attacking this pest Use resistant varieties where available	Use of insecticides, is difficult and costly because the insect remains largely concealed throughout its life Lambda-cyhalothrin+ Thiamethoxam
Viruses in tubers	Specific virus diseases can rarely be diagnosed on the basis of visible symptoms alone. Symptoms may include mild to moderate growth reduction, mild chlorosis or mottling, pale spots or veins and leaf deformities	Selection and use of virus free planting material Viruses can be removed by heat treatment and meristem culture Remove the infected plants and burn them Follow crop rotation. Control vectors with insecticides as appropriate	None

TABLE 17. HORTICULTURE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
		Green Leafy Vegetables	
Caterpillars on Moringa oleifera	Larvae feed on leaflets in a thin silken web on the lower surface	Set traps to collect adult moths Hand-picking larvae in early stages Arrangements for attracting birds	Insecticidal soap Cyfluthrin Deltamethrin Permethrin Lambda cyhalothrin Malathion
Nematodes Roselle (Hibiscus)	Root knot nematodes usually cause distinctive swellings, called galls, on the roots of affected plants.	The most reliable practices are preventive, including sanitation and choice of plant varieties Soil solarization Certain marigolds, Tagetes species, suppress root knot and lesion nematodes Use resistant varieties if available	None available for smallholders
Weevil in Amaranth (Palmer's Pigweed)	Stem-boring weevils such as the pigweed weevil (Hypolixus haerens) are the most damaging causing plants to wither; stems bending and collapsing	Uproot and destroy attacked plants to reduce number of weevils and prevent damage to healthy plants	Beta-cyfluthrin
Red spider mite Jute mallow	Causes the leaves to turn yellow and also reduces the size and number of leaves	Good drainage essential for plant survival and growth Proper land preparation and weed control Pest damage is usually less severe in plantings that are well-fertilized and rotated with other crops	Pyrethrum+ garlic extracts Abamectin
Cotton bollworms *Heliothis armigera,*	The newly emerged larvae feed on the leaf and foliage of the	Proper fertilization and weeding Control of vectors	Azaderachtin

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PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Diparopsis castanea and Earias biplaga In Baobab	plants. Cotton bollworms tunnel into the fruits of the baobab. They suck the sap of the leaves and young foliage. The immature fruit drops.		
Caterpillars In Baobab	Feeds on leaves. Caterpillar sucks the sap of the leaflets, mature and tender shoots, leaf petiole bases and young foliage. The immature fruit drops. Chlorotic leaves and defoliation can be observed	The affected parts should be removed. The caterpillars can be removed by hand and crushed. Consider use of Caterpillar Parasites (Trichogramma species) that control over 200 species of Caterpillars	Insecticidal soap Cyfluthrin Deltamethrin Permethrin Lambda cyhalothrin Malathion
		Vegetables	
Caterpillar of the **Spiny Bolworm** in okra	The larvae/caterpillars bore into terminal shoots of young plants, causing death of the tip and development of side shoots. When pod production starts, the caterpillars move to the flower buds, small pods and eventually mature pods. Damaged flower buds and young pods are shed, leading to yield reduction.	Okra should be rotated with maize, peas, onions, potatoes, fodder grass or small grains Scout the crop regularly. Early detection of eggs and/or caterpillars before they bore into the pods is important. Conserve of natural enemies. Hand pick and destroy eggs and caterpillars, and damaged tips and pods (in small plots). Regulate fertilization. Avoid high doses of nitrogen. Destroy old crops and crop debris after harvesting.	Use biopesticides (e.g Bt, neem-based pesticides). Good spray coverage and targeting small caterpillars before they bore into the pods is very important.

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PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Blister beetle aka Flower beetles (*Mylabris spp. and Coryna spp.)*in okra	Adult beetles feed on flowers reducing pod set. They also feed on foliage biting off irregular patches on leaves. Larvae of these beetles do not feed on plants but on eggs of grasshoppers and locusts. Therefore, they are beneficial and should not be destroyed.	Monitor crop regularly. Hand pick adults regularly. This helps to maintain their numbers low in small plots. However, do not destroy all of them, but keep numbers in check. Care should be taken when handling these beetles, since when disturbed they release a liquid that could burn the skin. To avoid this, wear thick gloves to protect your hands. Provide alternative habitats by keeping flowering plants at the borders of the field.	Spray repellents such as extracts of strong smelling plants (eucalyptus, lantana, onion, garlic etc.). Recommended mixes vary from 20 to100 g dried aromatic leaves per liter of water. Dried leaves are immersed in boiling water and left to steep till the tea is cold. Then sieved and sprayed onto affected plants. Repellents are reported to keep most beetles away (Elwell and Maas, 1995). Perimeter application of lambda-cyhalothrin.
Okra leaf curl disease	Viral disease affecting okra. On lower surface of leaves we will see a small pin head enations. This enation become warty and rough in structure at later stage. Reduce in leaf size. The stem, lateral branches and leaf petioles become twisted along enation. Leaves appear thick and leathery. In severely infected plants the emerging leaves shows bold enations and curling. And produce few deformed fruits.	Remove the infected plant and burn them to avoid further spread of disease Use yellow sticky traps to monitor whiteflies population Control white fly population	Use Acetamiprid to control white flies when plants are not flowering

TABLE 17. HORTICULTURE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	Disease transmitted by white fly		
Onion thirps *Thrips tabaci, Frankliniella occidentalis*)	Feed on young leaves in the inner neck of plants and cause reduced bulb size Onion thrips can vector plant viruses	Avoid planting onions adjacent to grain and fields with weeds that can host thirps. Plant younger fields upwind, relative to prevailing winds, from older fields. This applies to fields planted with transplants as well. Adult thrips in more mature fields will tend to fly downwind to infest less mature fields. Fertilize onions with adequate, but not excessive amounts of nitrogen. Straw or other mulch placed on the plant bed has been shown to reduce thrips populations and improve onion growth. Use trap crops that attract thirps, such as carrots that are not as damaged by them or flowers that attract thirps. Overhead sprinkler irrigation has been shown to reduce thrips populations on onion plants. Remove or destroy volunteer onion plants and debris. Onion plant matter left on the soil can survive and spread the following year. Use onion varieties can tolerate effects of thrips feeding with only mild yield loss	Pyrethrins + diatomaceous earth Azadirachtin Spinosad Insecticidal soaps Cypermethrin Permethrin
Onion fly (*Delia antique*)	The larvae or maggots feed on onions	Control soil moisture. ☐ Floating row covers exclude onion fly. ☐ During the growing season, minimize damage to bulbs caused by insects and diseases. ☐ Provide for quick drying following topping, especially if	Malathion, if needed.

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PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
		temperatures are high. ☐ Rotate 3 to 4 years out of onions, garlic, and leeks. ☐ Control other soil insects and foliage diseases that cause wounds entered by onion fly larvae. ☐ Harvest only after onion tops are well matured, cure onions properly before storage and store onions at cool temperatures since infection is favored by warm conditions. ☐ Sanitation: Clean up all cull and volunteer onions out of fields before planting. ☐ Use fall plowing to destroy pupae.	
Armyworm, *Spodoptera exigua*	Profuse silk webbing may give infested plants a shiny appearance	Good soil preparation	Use of biological insecticides as *B. Thuringensis/BT*.
Onion stem nematode (*Ditylenchus dipsaci*)	Nematode penetrates the germinating clove and destroys tissue as it moves through seeking food. Nematodes sucking the cell contents and salivary secretions cause the cells to collapse	There are currently no resistant cultivars available. ☐ Use certified clean propagation material. ☐ Treat bulbs with hot water to eradicate nematodes from garlic cloves. ☐ Rotate or alternate alliums with nonhost crops such as carrots and lettuce for several years. ☐ Sanitation: Avoid infesting new fields by cleaning machinery and equipment with water, and preventing movement of infested soil.	
Downy mildew (*Peronospora destructor*)	Appearance of pale green spotsas on the upper leaf surface. These areas soon become yellow and angular to irregular in shape,	Plastic mulch covering to avoid plant contact with soil and minimize weeds that enhance microclimate conditions favorable to disease dispersion. ☐ Heat treatment of bulbs at 35 to 40 °C for 4 to 8h reduces the	Bulb dipping with a synthetic fungicide containing metalaxyl. ☐ Use synthetic pesticide as soil drench and spray applications containing of thiophannate

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PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	bounded by the leaf veins. As the disease progresses, the lesions may remain yellow or become brown and necrotic.	disease significantly. ☐ Eliminate crop residues, plant during dry season, avoid irrigation during heat of the day. ☐ Use crop rotation. ☐ Use certified seed and good drainage.	methyl, metalaxyl + mancozeb followed by copper oxychloride.
Tomato fruit borers *Larvae of several types of moth*	The larvae of the moth damage fruit as they feed on flesh and seed	Hand picking of larvae Trenching the field Damaged fruits and crop residue should be burn to avoid carryover of pest Don't over-irrigate, high moisture in field increases infection Use light traps Use African Marigold (*Tagitus Erecta*) as a trap crop Use pheromone traps Deep ploughing after picking Establish bird perches in the field	Cypermethrin 5% Neem extract (Azaderachtin)
Root knot nematodes *Meloidogyne* spp.	Cause galls on roots up to 1 inch in diameter. These galls interfere with the flow of water and nutrients to the plant; infected plants appear less vigorous than healthy plants, may be yellowed, are prone to wilt in hot weather, and respond poorly to fertilizer. Damage areas usually appear as irregular patches and are frequently associated with lighter-	Because root knot nematodes feed and multiply on many weed species, weed control is an important aspect of their management. Use varieties resistant to nematodes, rotate with resistant varieties Soil solarization Soil fumigation can be done only by certified professionals	Not available for this PERSUAP

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PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	textured soils.		
White flies in tomatoes *Bemisia tabaci* *Trialeurodes vaporariorum* *Trialeurodes abutilonia*	Whiteflies are found mostly on the undersides of leaves. Whitefly cause damage to leaves by feeding, which causes leaves to yellow and curl, and by the production of honeydew, which causes leaves to appear shiny or blackened (from sooty mold growing on the honeydew).	Identify the damaging species as not all whiteflies species cause damage in tomatoes. Conserve natural enemies. Several wasps, including species in the Encarsia and Eretmocerus genera, parasitize whiteflies. Plant tomatoes at least one-half mile upwind from key whitefly hosts Destroy and remove all crop residues as soon as possible Control weeds in non-crop areas including head rows (headland areas) and fallow fields. Routinely check field margins that are infected first for whiteflies	Growing stage: Insecticidal soap Azaderachtin Rosemary oil + peppermint oil At planting and transplanting stage Imidacloprid Acetamiprid
Diamond back moth in crucifers (cabbage and turnip) *Plutella xylostella*	This moth attacks only plants in the family Cruciferae. Plant damage is caused by larval feeding.	Use natural enemies. A parasitoid wasp helps control diamondback moth larvae, especially if Bt is the main pesticide used. An egg parasitoid (Trichogramma sp.) and fungal pathogens also aid in control. Utilize pheromone traps to monitor adult populations destroying crop residues Plant several rows of collards around the perimeter of the fields as a trap crop	*Bacillus thuringiensis* products

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PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Turnip Mosaic Virus (TuMV)	TuMV is transmitted **by aphids** notably green peach aphid (*Myzus pericae)* and cabbage aphid (*Brevicoryne brassicae*) and is readily transmitted mechanically. Causes lumpy or warty growths	Locate seedbeds away from weedy fields. Weeds and volunteer plants should be eliminated from seedbed areas and preferably from production fields. It may be helpful to discard plants from outside rows in seedbeds. When transplanting seedlings, wash your hands frequently and thoroughly with soap and water. Field equipment should be used in new fields first and then in older fields. Do not transplant a healthy plant into the soil from which a diseased plant was removed. Roots from diseased plants will remain in the soil and provide the virus source for the new transplant. Field sanitation, particularly, weed control is very important since the virus can infect many weed species.	*Those needed for control of aphids*
Fusarium wilt in tomatoes *Fusarium oxysporum* f. sp. *lycopersici*	Plants infected with Fusarium become yellow and wilt. Sometimes only one branch or one side of the plant is affected, creating a yellow flag effect. Infected plants usually die. A dark brown vascular discoloration extends far up the stem. Symptoms often first appear during fruit sizing.	Use resistant varieties Long distance spread is by seed, transplants, and soil on farm machinery. Use healthy seed and wash off equipment that may have come in contact with infected soils. Rotation out of tomatoes for several years reduces inoculum level, although Fusarium is long-lived Soil fumigation requires professional application	none

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PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Early blight in tomatoes *Alternaria solani*	Plants infected with early blight develop small black or brown spots on leaves, stems, and fruit.	Destroy infected plants Proper crop rotation is important to ensure infected plant debris decomposes	Chlorothalonil Mancozeb
Tobacco mosaic virus (TMV) in tomatoes	The symptoms in tomato vary greatly in intensity depending upon the variety, virus strain, time of infection, light intensity, and temperature The most characteristic symptom of the disease on leaves is a light- and dark-green mosaic pattern	Select resistant varieties	
Squash bug *Anasa tristis* in Cucurnbita (squash, pumpkin, zucchini)	Feed on plant foliage resulting in plant wilt	The best method for control is prevention through sanitation Remove old plants after harvest Using a trellis for vining types of squash can make them less vulnerable to squash bug infestation Some squash varieties, including Butternut, Royal Acorn, and Sweet Cheese, are more resistant to squash bugs Use of natural enemies such as the parasitic tachinid fly *Trichopoda pennipes*	Insecticidal soap and oils Azaderachtin
Aphids in cucurnbita	Feeding on plants and transmission of viruses	Planting nasturtiums in garden beds before growing zucchini and pumpkins Clearing land of broadleaf weeds, which are viral host plants, can decrease the risk of disease spread by aphids. Severely infested plants should be removed and destroyed to keep the aphid population from spreading.	Insecticidal soaps and oils Petroleum-based horticultural oils or plant-derived oils such as neem or canola oil Imidacloprid

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PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
		Forceful spray of water or water-soap solution	
Yellow squash beetle *Epilachna borealis*	Damage plants by feeding on the plant's juices and occasionally the fruit. Damage is first seen by a yellowing or darkening of the leaves, followed by wilting	Spray a stream of water around the bottom of the squash plants to flush out the adult squash bugs from the bottom of the plant. Clear all debris from the field and around	Azaderachtin Malathion Pyrethrum powder
Powdery mildew in cucurnbita	Several fungi can cause powdery mildew	Use resistant plant varieties Grow plants in sunny locations Provide good air circulation by pruning excess foliage Don't over-fertilize with nitrogen because lush foliage and shade encourage the disease.	Chlorothalonil Mineral oil Copper Sulphur Azoxystrobin
Zucchini Yellow Mosaic Virus (ZYMV)	Aphid-borne virus tnat affects all cucurbits Yellowing and eventually "shoestring" symptoms in the leaves. The fruits are stunted, twisted and deformed by raised protuberance	sourcing clean seed can help prevent the disease control the aphid vectors inoculation with a non-virulent strain of the virus (ZYMV-WK) to prevent infection with the virulent strain Select resistant varieties such as yellow crookneck squash	See aphids control above
White flies in zucchini *Trialeurodes vaporariorum* *Aleyrodes spiraeoides* *Bemisia tabaci*	Desiccation of plants occurs with moderate-to-heavy populations and the production of honeydew gives rise to sooty mold	Use natural predators Control weeds in neighboring areas prior to planting Destroy old crops	Imidacloprid Thiamethoxam

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PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Carrot fly *Chamaepsila rosae*	Crop damage is caused by the larvae feeding on the outer layers of the carrot root	As female carrot flies are very low flying, prevention is to erect a barrier around the crop at least 60 cm high. Because the carrot fly is attracted to host plants by odor, masking the smell of the host plant by planting odoriferous companion crops such as onions, chives, and garlic can successfully deter attack. Some plants such as Rosemary, Sage, and Marigold can be used to deter the carrot fly. Commercially available beneficial nematodes (*Steinernema* spp.) can be applied to the soil surrounding the carrot crop, where they will infect the damaging carrot root fly larvae. Use varieties resistant to carrot fly	Lambda-cyhalothrin
Leaf blight in carrots *Alternaria dauci*	dark brown to black irregularly shaped lesions on leaf blades and petioles The pathogen also causes damping-off of carrot seedlings.	Planting *Alternaria*-indexed seed or treating seed in a hot water bath is very important. Turn under carrot residue by tillage or plowing to hasten decomposition of debris, because the pathogen only survives in soil in infected carrot residue. Practice 2-year rotations: avoid continuous carrot culture. Do not plant new fields near existing fields with blight symptoms. Differences in susceptibility exist among cultivars. If possible, the use of furrow irrigation may aid in disease reduction.	Azoxystrobin Chlorothalonil Iprodione
Broad Mites *Polyphagotarsonemus latus* in bell and hot peppers	Found on the underneath undeveloped, growing foliage. Feed on the plant, destroying its tissue and causing leaves to thicken and narrow. When feeding heavily, these tiny, white mites can also kill flowers and	Use natural enemies identified locally Cultural manipulation of crops such as early or delayed sowing, cropping pattern, spacing, irrigation and fertilizer application can be used to 'minimize the impact or severity of mite damage on chilli	Insecticidal oils or soaps

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PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	russet fruit.		
Whiteflies in bell and hot peppers *Bemisia tabaci* *Trialeurodes vaporariorum*	Whiteflies damage peppers by sucking large quantities of sap and covering plants with sticky honeydew. Black sooty mold grows over the honeydew, lowering the photosynthetic capacity of the plant and making the fruit unattractive. Feeding by high populations may result in stunting, poor growth, defoliation, and reduced yields.	monitoring is important in detecting and preventing the development of populations Use of natural enemies. Several wasps, including species in the Encarsia and Eretmocerus genera, parasitize whiteflies. Maximize the distance and time interval between host crops. When possible, plant peppers at least one-half mile upwind from key whitefly hosts Maintain good by destroying and removing all crop residues as soon as possible Control weeds in noncrop areas including head rows and fallow fields	Insecticidal soaps and oil sprays Imidacloprid Acetamiprid
Bacterial wilt *Ralstonia solanacearum* in bell and hot peppers	This is a soil borne disease. Wilting of leaves, sometimes only few branches of the plant The wilted leaves maintain their green color and do not fall as disease progresses	Bacterial wilt is very difficult to control after it is established in the field Seedlings must be free from infection by R. solanacearum. It is mandatory that commercial seedling producers use irrigation water not contaminated with the pathogen. Fields should not be over-irrigated, because excess soil moisture favors disease build-up. Crop rotation with non-susceptible crops reduces soilborne populations of the bacterium such as soybean. Shifting planting dates to cooler periods of the year can help escape the disease. Soil amendments with inorganic and organic mixtures reduce wilt	None

TABLE 17. HORTICULTURE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
		incidence in some locations. Control root-knot nematodes and root-feeding insects since they may help the disease to establish and spread Remove wilted plants, root debris, and volunteer hosts and burn them to reduce spread of the disease from plant to plant. Clean farm equipment after working in an infested field. Disinfest tools when used in an infested field. Wash with water or bleach or sterilize by flame. Wash the soles of shoes after working in an infested area. Work in the infested portion of a field after working in the non-infested areas. Solarize soil	
Bacterial spot in peppers *Xanthomonas campestris pv. Vesicatoria*	Leaf spots on affected leaves are at first small, yellow-green lesions with a water-soaked border. These spots may coalesce, giving a blighted appearance. Eventually these spots turn brown and dry up, leaving holes in the leaves. A tattered appearance of the leaves often results. Fruit spots are raised, scabby areas. Fungi may enter these spots and cause secondary fruit rots.	Use only inspected, healthy transplants Avoid working around plants when the foliage is wet Do not plant peppers in the same spot in successive years Control weed that can host bacteria Applications of a fixed-copper fungicide can slow the spread of the disease but will not eradicate existing infections Remove infected plant debris or plow under deeply. Use resistant cultivars Use treated seed or treat seed by dipping in a solution containing 1 quart of bleach, 4 quarts water, and 1/2 tsp. surfactant for 1 minute. Use 1 gallon of solution per pound of seed and agitate the solution constantly. Wash seed in running water for 5 minutes after treatment and dry thoroughly.	Copper

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PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
Fruit and shoot borer *Leucinodes orbonalis* in egg plant	Larvae feed inside eggplant fruit, making the fruit unmarketable and unfit for human consumption	Destroy eggplant stubble from previous year Use healthy, pest-free seedlings Remove and destroy infested shoots Use pheromone lures to trap male moth Protect natural enemies Use resistant varieties of plants In small plantings, physically remove eggs and larvae	*Bacillus thuringiensis* (Bt)
Whiteflies *Bemisia argentifolii* *Bemisia tabaci* in eggplant	Whiteflies damage eggplants by sucking enormous quantities of sap and covering plants with sticky honeydew. Black sooty mold grows over the honeydew, lowering the photosynthetic capacity of the plant and making the fruit unattractive. Currently, no virus problems associated with whiteflies have been reported on eggplant.	monitoring is important in detecting and preventing the development of populations in any given year	sprays of insecticidal soaps and oils Imidacloprid Acetamiprid Pyriproxyfen Azaderachtin
Spider mites *Genus: Tetranychus*	Cellular damage resulting in leaf drop and sunburning of fruit resulting in reduced yields. Webspinning spider mites more damaging in small quantities	Inspect leaves for damage such as stippling and webbing Minimize dusty and dry conditions by regular spraying Excessive nitrogen can cause population increases Pesticide used to control other pests can use increase population of	Insecticidal soaps and oils (not to be applied at temperature above 32 degrees Celsius) Neem oil (Azaderachtin)

TABLE 17. HORTICULTURE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
		spider mites	Sulfur dust (not to be applied at temperature above 32 degrees Celsius)
Blights in eggplant *Alternaria solani* Phomopsis vexans Phytophthora nicotianae and other Phytophthora spp.) Sclerotium rolfsii)	Eggplant are related to tomatoes and peppers, so they're susceptible to many tomato diseases as well as some of their own.	Amend soil regularly with compost and apply organic mulches continually to enrich your soil. Look for resistant varieties Control aphids and leafhoppers, which can spread diseases as they feed. Control weeds and moisture	
Wilts in eggplant *Verticillium dahliae*,	Wilting leaves and plants, and eventually plants die. Fruits are few, small, and of poor quality. Wilts are caused by various fungi that live in the soil or on crop residues.	Control via crop rotation, a high level of soil organic matter, and good drainage. Do not leave crop remains on the field or add them to the compost pile; this encourages future infections. use of both black plastic mulch and ammonium sulfate fertilizers improved yields Grow eggplant as grafts onto *Verticillium*-resistant tomato root stock.	None
Anthracnose *Colletotrichum coccodes* in eggplant	Appears on fruits as dark circular, sunken spots with black spores. It's a seed- and soil-borne fungus that can also be transmitted by infected plant debris	Use disease-free seed Do not cultivate when plants are wet, Use drip rather than overhead irrigation Destroy all plant refuse by burning or deep plowing. Rotate crops.	Copper products Chlorothalonil Difenoconazole

TABLE 17. HORTICULTURE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
		FRUIT	
Fruit flies in Mango *Ceratitis cosyra* *C. rosa and C. capitata*	Female fruit flies puncture the fruit skin and lay eggs that develop into maggots (larvae) in the flesh of the fruit after hatching. The larvae feed on the fruit and cause it to drop prematurely and destroy the pulp of the fruit. Generally the fruit falls to the ground as, or just before, the maggots pupate. In fruit for export, fruit flies cause indirect losses resulting from quarantine restrictions that are imposed by importing countries to prevent introduction of fruit flies. Nearly all fruit fly species are quarantine pests. Fruit flies attack soft, fleshy fruit of a wide variety of fruit and vegetables.	Continuous monitoring of fruit flies to determine when they arrive in the orchard and to decide when treatment is needed. Orchard sanitation is important as poorly managed or abandoned orchards can result in buildup of fruit fly populations Several natural enemies can contribute to the suppression of fruit flies. Some flowering crops can attract the native enemies populations and provide good habitats for them. Biopesticides such as a spray pyrethrum solution is effective in controlling fruit flies. Other plant extracts like neem, garlic, chilli and tephrosia can also be used. Bagging prevents fruit flies from laying eggs on the fruit, but this practice requires a lot of labor. Setting vinegar traps	Spinosad, Azadirachtin (neem)
Mango seed weevil *Sternochetus mangiferae*	The larva, which is the damaging stage of the pest, enters the fruit by burrowing through the flesh	Continuous monitoring to ensure timely intervention is important, for instance, a weevil attack can be detected by monitoring for egg-laying marks on young fruit. Regular fruit	Malathion

TABLE 17. HORTICULTURE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	into the seeds, where it feeds until pupation, destroying the seed.	scouting is important to detect adult activity during fruit growth. Ensuring good orchard sanitation by collecting and destroying all scattered mango seeds and fallen fruit. All collected fruit and seeds should be buried deeply (about 50 cm deep). Ensuring orchard quarantine by restricting movement of fruit from old orchards or areas known to have mango seed weevils to areas where young orchards, free of seed weevil, have been established. Applying sticky bands at the upper end of tree trunks when the trees start flowering to reduce migration of weevils to branches for egg laying.	
Papaya mealy bug *Paracoccus marginatus*	The bug feeds on the sap of plants by inserting its stylets into the epidermis of the leaf, as well as into the fruit and stem. In doing so, it injects a toxic substance into the leaves. The result is chlorosis, plant stunting, leaf deformation, early leaf and fruit drop, a heavy buildup of honeydew, and death.	Natural enemies of the papaya mealybug include the commercially available mealybug destroyer (Cryptolaemus montrouzieri), lady beetles, lacewings, and hover flies, all which are generalist predators that have a potential impact on mealybug populations. In addition to predators, several parasitoids may attack papaya mealybug.	Acephate Dimethoate Malathion White mineral oils
Nematodes in papaya *Rotylenchulus reniformis, Meloidogyne* spp., *Helicotylenchus dihysteria, Quinisulcius acutus,* and *Criconemella* spp.	Formation of galls on host root system is the primary symptom. Roots branch profusely starting from the gall tissue causing a 'beard root' symptom. Infected roots become knobby	Grow or procure healthy seedlings Burn diseased plants Till the soil after each period of rain. This will not stop nematode eggs from hatching but, without food plants, the young worms will die. Practice Solarisation that involves covering raised and moist beds with clear plastic for 2–4 months during the hottest months of the	Azaderachtin

TABLE 17. HORTICULTURE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	and knotty. In severely infected plants the root system is reduced and the rootlets are almost completely absent. The roots are seriously hampered in their function of uptake and transport of water and nutrients Plants wilt during the hot part of day, especially under dry conditions and are often stunted Nematode infection predisposes plants to fungal and bacterial root pathogens	year. The increased soil temperature helps to kill many soil borne pests and pathogens including root knot nematode. Nematodes in these moist beds will hatch out from eggs, move around for roots and will die of starvation.	
Viruses Papaya ringspot virus **Papaya mosaic virus** (PapMV) Papaya lethal yellowing virus	The first signs are irregular mottling of young leaves, then yellowing with transparent areas, leaf distortion, and rings on the fruit. If affected plants are not removed, the condition spreads. Fruits borne 2 or 3 months after the first symptoms will have a disagreeable, bitter flavor	Planting in areas where there is no virus, rogueing, cross protection, and resistance Plant variety resistant to virus	None
Fruit fly in Crab apple *Drosophila suzukii* *Rhagoletis pomonella*	Some fruit fly species are much more likely to cause significant damage to ripening fruit, while others simply take advantage of	Finding and eliminating sources where possible Light traps and other natural traps	Malathion Permethrin

TABLE 17. HORTICULTURE INTEGRATED PEST MANAGEMENT PLAN

PEST	DAMAGE DONE	INTEGRATED PEST MANAGEMENT AND PRODUCTION MEASURES	RECOMMENDED PESTICIDES, WHEN NEEDED
	overripe fruit.		
Powdery mildew in Crab apple	Powdery mildew disease is a fungal infection. first appears as irregularly shaped, powdery spots on the leaves. As the disease progresses, the white powder may continue to cover entire leaves and new growth. Shoots may fail to develop or grow in a malformed, twisted manner while existing leaves yellow, turn brown and drop. Crab apple fruits may have areas of discoloration or a russet hue and have rough patches.	Prune away heavily affected plant parts and destroy them to avoid spreading infection Wash away the infection by gently applying water to the tree, but only during the morning. This gives the leaves time to dry before the evening. Standing water on leaves may encourage the development of other fungal infections	Apply horticultural oil when temperatures remain under 90 F (32.2 C)
Fruit bats in soursop	When the fruit ripens on the tree, bats or birds may eat it	Ultrasonic bat repellent devices such as Transonic Pro Heavy Duty Repeller - Bat Control Netting	None
		Livestock	
Mites and lice in chickens	Infestation can reduce egg laying	Early detection. Keeping the coops and bedding fresh and clean, scrub coops with soap and water, inspect the flock	Orange peel extracts d-Limonene product such as Orange Guard Dusting with Diatomaceous Earth

Keds (ticks), lice, sheep nose bot flies, wool maggots (fleece worms), and sheep scab (mange) and flies in sheep and goats	Symptoms of these pests vary from minor itching and irritation to extreme annoyance and fatigue, malnutrition, and even death. Pests also can transmit dis eases and cause secondary infections.	In addition to routine shearing, clipping, and cleaning, other cultural controls include practices such as appropriate manure management and stall sanitation. Chemical controls include various sprays, dips, pour ons, and dusts. Flies are often targeted with sprays and baits/traps	Permethrin Malathion Deltamethrin Cyfluthrin Lambda-cyhalothrin

ANNEX B: PESTICIDE PROFILES: TOXICOLOGY

B.1 ORIENTATION: PESTICIDE TOXICITY AND RISK

Pesticides of necessity are poisons, but the *toxicity* of different compounds varies greatly, as do the risks of using them in particular circumstances.

Toxicity is the quality of being poisonous or harmful to animals or plants. A highly toxic substance causes severe symptoms of poisoning with small doses. A substance with a low toxicity generally requires large doses to produce mild symptoms. (Even common substances like coffee or salt become poisons if large amounts are consumed.) Doses can be received (absorbed) via oral ingestion, through dermal contact, or through inhalation. These different dose channels typically have different toxicities.

Toxicity can be either acute or chronic. **Acute toxicity** is the ability of a substance to cause harmful effects which develop rapidly following absorption, i.e., a few hours or a day. **Chronic toxicity** is the ability of a substance to cause adverse health effects resulting from long-term exposure to a substance. There is a great range in the toxicity of pesticides to humans.

The relative **risk of harm** from a pesticide is dependent upon the toxicity of the pesticide, the dose received and the length of time exposed. Dose can be influenced by the amount of pesticide used, concentration of the pesticide and how the pesticide and application equipment are handled.

For example, a pesticide can be highly toxic as a concentrate, but pose little risk to the user if:

- Used in a very dilute formulation,
- Used in a formulation not readily absorbed through the skin or inhaled, or
- Used by experienced applicators who are equipped to handle the pesticide safely.

In contrast, a pesticide may have a relatively low toxicity but present a high risk because it is used in the concentrated form which may be readily absorbed or inhaled.

Formulated pesticide products (which often include inert ingredients) are given an overall acute toxicity rating by US EPA which is shown on the label on the pesticide container:

Category I: Extremely toxic Category II: Highly toxic
Category III: Moderately toxic Category IV: Slightly toxic, Relatively non-toxic

The WHO toxicity classification system is similar (classes I-III), but assigns toxicity classes to Pesticide Active Ingredients, not formulated products. As such, it is less precise.

B.2 SUMMARY TOXICOLOGY PROFILES OF PESTICIDES ASSESSED BY THIS PERSUAP

The following table summarizes the toxicological profiles of all AIs examined by this PERSUAP, as well as their US EPA registration status.

TABLE 18. US EPA REGISTRATION STATUS & TOXICOLOGICAL PROFILE OF ANALYZED PESTICIDES

Active Ingredient	Chemical class	Human Health Issues				Ground-water contaminant?	Ecotoxicology								
		Acute Toxicity Class/Categ.			Chronic Toxicity										
		RUP?	WHO	EPA			Fish	Bees	Birds	Amphibians	Earth-worms	Mollusks	Crustaceans	Aquatic insects	Plankton
HERBICIDES															
2,4-D acid, ester, salts	chlorophenoxy acid and ester and its salts	Some	NL	NL	PC	Potential	NAT	ST		NAT	NAT	NAT	NAT	NAT	NAT
Acetochlor	Chloroacetanilide	Most	III	II,III	PC, ED	Potential	MT	MT	ST		MT				MT
Bensulfuron methyl	Sulfonyl Urea	No	U	II,III	NL	Potential	T	MT	ST		MT		ST		NAT
Bispyribac sodium	Unclassified	No	U	III	NL	Potential	MT	ST	NAT		MT		MT		
Clethodim	Cyclohexenone	No	U	II,III	NL	Potential	MT	MT	MT		MT		MT		
Clomazone	Izoxazolidinone	No	II	II,III	NL	Potential	MT	MT	NAT		MT		MT		HT
Diuron	Urea	No	U	III	LC, RD, RD	Known/Likely	ST			ST		ST	ST	MT	ST
Fluazifop-P-butyl	Propionic acid	No	III	III	NL	No data	ST	MT	PNT					ST	
Fluomethuron	Urea	No	U	III	PC	Potential	ST					ST			MT
Glyphosate and glyphosate salts	Phosphonoglycine	Some	III	II,III	PC	Potential	ST-MT	ST	NAT	ST	NAT		NAT-ST	NAT-ST	ST

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Active Ingredient	Chemical class	Human Health Issues				Ground-water contaminant?	Ecotoxicology								
		Acute Toxicity Class/Categ.			Chronic Toxicity										
		RUP?	WHO	EPA			Fish	Bees	Birds	Amphibians	Earth-worms	Mollusks	Crustaceans	Aquatic insects	Plankton
Nicosulfuron	Sulfonyl Urea	No	U	II,III	NL	Potential	MT	MT	MT		MT		MT		
Orthosulfamuron	Pyrimadinylsulfonylurea	No	NL	III	PC	Potential	NAT	NAT	MT		MT		NAT		
Oxadiazon	Oxidiazole	No	U	II,III		No data	MT	MT	ST	MT	MT		ST		HT
Pendimethalin	Dinitoaniline	No	III	III	None	No data	MT	T	ST				MT	MT	
Penoxysulam/penoxsulam	Triazolopyrimidine	No	U	III	PC	Potential	MT	MT	MT		NAT		NAT		
Prometryn	Triazine	No	U	III	ED, RD	Potential	MT	NAT	PNT	ST	NAT		NAT	ST	ST
Propanil	Analide	No	III	II,III	NL	Potential	MT	NAT		ST					
Tembotrione	Triketone	No	III		PC	No data	LT	NAT	LT		LT		MT		
Terbutylazine	Triazine	No	U	III	NL	No data	MT	MT	MT		MT		MT		HT
Tribenuron methyl	Sulfonylurea	No	U	III	NL	No data	LT	MT	LT		LT				

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Active Ingredient	Chemical class	Human Health Issues				Ground-water contaminant?	Ecotoxicology								
		Acute Toxicity Class/Categ.			Chronic Toxicity										
		RUP?	WHO	EPA			Fish	Bees	Birds	Amphibians	Earth-worms	Mollusks	Crustaceans	Aquatic insects	Plankton
Triclopyr	Chloropyridin	No	III	I, II, III	NL	No data	MT			NAT				ST	
Trifloxysulfuron sodium	Sulfonylurea	No	NL	-	NL	Potential	LT	MT	MT		MT				
FUNGICIDES															
Azoxystrobin	Strobin	No	U	III	NL	Potential	MT	MT	MT		MT		MT		VHT
Difenoconazole	Azole	No	III	III	NL	No data	MT	MT	ST		MT		MT		HT
Chlorothalonil	Chloronitrile	No	U	II	PC, RD	Potential	HT	MT	LT						
Copper hydroxide	Inorganic	No	II	III	NL	No data	HT		MT	HT					
Copper sulfate (pentahydrate)	Inorganic	No	II	I,II,III											
Iprodione	Dicarboximid	No	U	III	LC, ED	Potential	MT	NAT	ST				HT		
Mancozeb	Dithiocarbamate	No	U	III	PC, ED, RD	No data	MT	MT	ST	HT					NAT
Myclobutanil	Azole	No	III	III	ED, RD	No data	MT	ST	MT		MT		MT		HT
Mefenoxam/ Metalaxyl-M	Phenylamide	No	NL	-	NL	Potential	MT	LT	MT					MT	ST

TABLE 18. US EPA REGISTRATION STATUS & TOXICOLOGICAL PROFILE OF ANALYZED PESTICIDES

Active Ingredient	Chemical class	Human Health Issues				Ground-water contaminant?	Ecotoxicology								
		Acute Toxicity Class/Categ.			Chronic Toxicity										
		RUP?	WHO	EPA			Fish	Bees	Birds	Amphibians	Earth-worms	Mollusks	Crustaceans	Aquatic insects	Plankton
Tebuconazole	Triazole	No	II	II,III	PC, RD, ED	Potential									
Terbutryn	Triazine	No	III	III	ED	Potential	MT	LT	LT		MT			MT	
INSECTICIDES															
Abamectin	Microbial Extract	Some	NL	II, III	ED, RD	No data	ST	HT	PNT		MT		HT	VHT	VHT
Acetamiprid	Neonicotinoid	No	NL	III	NL	Potential	NAT	MT	HT				NAT		
Azadirachtin Also fungicide, acaricide	Plant derived	No	NL	IV	NL	No data	MT	MT	MT	MT	MT	ST	VHT	MT-HT	HT
Bacillus thuringiensis	Micro-organism derived	No	III	III	NL	No data									
Bacillus sphaericus	Micro-organism derived	No	U	III	NL	No data									
d-phenothrin/ fenothrin	Synthetic pyrethroid	No	U	III	ED	No data	VHT		ST				HT	VHT	VHT
Beta-cyfluthrin	Synthetic pyrethroid	Some	II	II,III	ED	No data	VHT	HT	PNT			ST		VHT	VHT

TABLE 18. US EPA REGISTRATION STATUS & TOXICOLOGICAL PROFILE OF ANALYZED PESTICIDES

Active Ingredient	Chemical class	Human Health Issues				Ground-water contaminant?	Ecotoxicology								
		Acute Toxicity Class/Categ.			Chronic Toxicity										
		RUP?	WHO	EPA			Fish	Bees	Birds	Amphibians	Earth-worms	Mollusks	Crustaceans	Aquatic insects	Plankton
Chlorantraniliprole/ rynaxypyr	Anthranilic diamide	No	NL	III	NL	No data	NAT	MT	MT		MT		HT		
Cyantraniliprole	Anthranilic diamide	No	U	IV	NL	No data	MT	HT	NAT		MT		HT		
Cypermethrin Alpha Beta	Synthetic pyrethroid	Some	II	II	PC, ED	No data	HT	HT	LT		MT	MT	HT	VHT	VHT
Deltamethrin	Synthetic pyrethroid	For cotton	II	I,II,III	ED	No data	HT	MT		VHT		NAT		VHT	VHT
Flubendiamide	benzen dicarboxamide	No	NL	III	NL	No data	HT	NAT	MT		MT		HT		
Fludioxinil	Phenylpyrrole	No	U	III	NL	Potential	MT	MT	MT		MT		MT		
Insecticidal soap	Salts of fatty acids	No			NL	No data									
Indoxacarb, S-isomer	Oxadiazine	No	O	III	NL	No data	MT	HT	HT		NAT		MT		
Imiprothrin	Synthetic pyrethroid	No	U	-	RD	No data	HT	HT	LT	HT					

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Active Ingredient	Chemical class	Human Health Issues				Ground-water contaminant?	Ecotoxicology								
		Acute Toxicity Class/Categ.			Chronic Toxicity										
		RUP?	WHO	EPA			Fish	Bees	Birds	Amphibians	Earth-worms	Mollusks	Crustaceans	Aquatic insects	Plankton
Imidacloprid	Neonicotinoid	No	II	II,III	NL	Potential	NAT		MT					VHT	
Lambda-cyhalothrine	Synthetic pyrethroid	Some	II	II,III	ED	No data	VHT	HT	PNT		VHT	VHT	VHT	VHT	
Lufenuron	Benzoylurea	No	NL	-	NL	No data	MT	LT	MT		MT			HT	
Malathion	Organophosphate	No	III	II	PC, ED	Potential	MT	HT	MT	HT	ST	VHT	MT	VHT	HT
Novaluron	Insect Growth Regulator	No	NL	II,III	NL	No data	MT	MT	MT		MT		HT		
Permethrin	Pyrethroid	Some	II	II,III	PC, ED	No data	HT	HT	LT	MT	LT	ST	HT	HT	HT
Pirimiphos-methyl	Organophosphate	No	II,III	I,II,III	NL	No data	MT	HT	MT		MT			VHT	VHT
Pyriproxyfen	Insect Growth Regulator	No	U	III	NL	No data	MT	MT	MT		MT		MT	HT	
Spinosad	Microbial	No	U	III	NL	No data	MT	HT	PNT		ST			HT	MT
Spirotetramate	Keto-enol	No	NL	II,III	NL	No data		MT	MT		MT		MT		

TABLE 18. US EPA REGISTRATION STATUS & TOXICOLOGICAL PROFILE OF ANALYZED PESTICIDES

Active Ingredient	Chemical class	Human Health Issues				Ground-water contaminant?	Ecotoxicology								
		Acute Toxicity Class/Categ.			Chronic Toxicity										
		RUP?	WHO	EPA			Fish	Bees	Birds	Amphibians	Earth-worms	Mollusks	Crustaceans	Aquatic insects	Plankton
Tagetes (Marigold) oil	Botanical	No			NL	No data									
Thiamethoxam	Neonicotinoid	Some	NL	III	PC	No data	PNT	HT	PNT		PNT	PNT	PNT	PNT	
Thyme oil	Botanical	No		III	NL	No data	ST								
RODENTICIDE															
Brodifacoum	Coumarin	No	Ia	III	none	No data	MT					MT			
FUMIGANT															
Aluminum Phosphide	Inorganic	Yes			RD		HT		HT					MT	

Key to abbreviations

WHO Acute Toxicity:

Class O = Obsolete Pesticide; Class Ia = Extremely Hazardous, Class Ib = Highly Hazardous; Class II = Moderately Hazardous; Class III = Slightly Hazardous, Class U = Unlikely to Present Acute Hazard in Normal Use

EPA Acute Toxicity:

Category I = Extremely Toxic, II = Highly Toxic, III = Moderately Toxic, IV = Slightly Toxic

Chronic Toxicity:

KC = Known/Likely Carcinogen; PC = Possible Carcinogen; ED = Potential Endocrine Disruptor; RD = Potential Reproductive or Developmental Toxin; P = Potential Parkinson's disease Risk Factor77

Ecotoxicity:

VHT = Very Highly Toxic; HT = Highly Toxic; MT = Moderately Toxic; ST = Slightly Toxic; PNT = Practically Not Toxic; NAT = Not Acutely Toxic

77 Neurological toxins

ANNEX C:
MANDATORY ELEMENTS OF PESTICIDE SAFER USE TRAINING

Pesticide safe use training must address the following minimum elements

- Definition of pesticides.
- Pesticide risks and the understanding that pesticides are bio-poisons.
- Concepts of AIs vs. formulated products.
- Classes of pesticides and the concept that specific pesticides are effective against only certain classes of organisms.
- Concept of proper application rates and the concept of pesticide resistance and techniques for preventing resistance.
- Concept that pesticides have specific organisms against which they are effective.
- Survey of the core elements of safe pesticide use: IPM, safe purchase, transport, storage, mixing, application, re-entry and pre-harvest intervals, and clean-up and disposal, including specific treatment of PPE.
- Pesticide first aid and spill response.
- Interpretation of pesticide labels, particularly to understand PPE requirements and other precautions, dosage rates, and to identify AIs and expiration dates.

The following sections provide specific content notes on some of these topics.

C.1 INTEGRATED PEST MANAGEMENT

IPM IS AN INTEGRAL PART OF SAFE PESTICIDE USE

and supporting the use of pesticides only within an IPM framework is a core requirement of this PERSUAP. Therefore, pesticide safer use training must build an understanding of IPM fundamentals.

The heart of IPM is an understanding of the relationship between pest injury, damage, yield loss, and economic loss. IPM was developed within the discipline of economic entomology. Farmers who are not trained in IPM may spray a crop upon seeing a single insect in a field or a few brown spots of a disease on a leaf. Pesticides are expensive and should only be used as a last resort and only when economically justified.

THRESHOLD DETERMINATION

Extension workers and farmers first need to understand the relationship between increasing injury levels and crop yield of each pest which is known as the damage function. A small amount of injury in fact can cause yield gain called overcompensation. In most cases, significant yield loss does not occur until a certain pest density occurs in the field because the crop can compensate for this level of damage. Then there is normally a linear decline in yield with increasing pest density. From this relationship, the economic injury level, economic threshold, or action threshold can be defined in the case of insect pests.

Other methods to assess the threat of weeds and crop diseases will need to be developed based on field experience. Certain guidelines can be developed based on experience in neighboring countries.

IPM INVOLVES SEVERAL TIERS OF INTEGRATION

First there is the integration between control methods which must be harmonious. A non-harmonious example is the negative effect of pesticides on biocontrol agents. Biocontrol, which is the action of natural enemies against the pest, is free to the farmer so it behooves him not to upset this delicate balance unless absolutely necessary. The next tier of integration occurs between the different pest control disciplines. When one sprays an insecticide, herbivorous insects feeding on weeds are killed. Some fungicides also kill insect pests. Removing weeds forces army worms to feed on the crop. The third tier is integration with the cropping system and farming system. Crops that are well nourished can tolerate more damage. Many crop husbandry practices also affect pests, either positively or negatively. Application of nitrogen fertilizer is an example. On the one hand it can stimulate plant diseases, but on the other nitrogen fertilizer can provide strength of the crop to tolerate insect pest damage.

Pests do not occur in isolation, thus the crop has to deal with multiple pests as well as multiple stresses. A crop that is weak from zinc deficiency or water stress cannot tolerate as much pest damage as a healthier crop. In fact some sucking insect pests explode in abundance on a drought-stressed crop, further exacerbating the problem. The relationship between multiple pests and multiple stresses can be additive (1 + 1 = 2), antagonistic (1 + 1 = 1), or synergistic (1 + 1 = 3). This can occur in terms of yield loss from adding more pests or stresses, or can occur in terms of yield gain when one or more stresses are removed due to an effective curative control effort.

THE IPM TRAINING WILL PROVIDE EXAMPLES OF THE DIFFERENT PEST CONTROL METHODS

beginning with preventative ones, which start with quarantine and cultural crop husbandry methods based on good agronomic practices, which increase the crop's tolerance for pest injury. Many of these methods fall under the rubric of cultural control. Host plant resistance is another good example of prevention. Other pest control methods can be physical (e.g., a fence to keep out animals), mechanical (e.g., using nets), or biological (e.g., parasitoids, predators, pathogens). Biological methods include natural control and man-induced methods, such as purchasing and releasing natural enemies or using selective pesticides. As a last resort there is chemical control.

Farmers will need to be trained to recognize pests in the field and to be able to assess their densities as well as know several methods of control for each. Training manuals with high-quality, color photos will be essential in the training process. Government-approved, recommended practices need to be published and updated annually in guides given to extension officers.

USING PPE AND CLOTHING NEEDS TO BE UNDERSTOOD FOR EACH LEVEL OF TOXICITY

This information is summarized below as well as other information on the risks and hazards of transport, storage, and disposal of pesticides. Safety practices need to be learned such as that pesticides should not be stored in the home where children can find them.

C.2 UNDERSTANDING PESTICIDE RISKS

Many times, non-chemical controls can be used to deal with pests. When deciding to use a pesticide, it is important to understand the risks associated with a specific product or treatment. No matter the treatment method, there is always a degree of risk associated with using a pesticide. Understanding the risk from specific pesticides can help determine whether or not a given pesticide is appropriate, or help choose between two different products.

Many people believe that some pesticides are "safe," while others are "dangerous." Actually, all chemicals, including all pesticides, have the potential to be hazardous. Even products that are considered low in toxicity, natural, or organic can be hazardous if someone or something comes in contact with enough of the substance.

The toxicity of a pesticide, its formulation, and how much a person touches, ingests, inhales, or gets in contact with skin and eyes are all important considerations. The likelihood of experiencing some health effect as a result of using a product is referred to as the pesticide risk. The pesticide risk depends on which pesticide is used, how much is applied, frequency of application, and who or what has contact with the pesticide. The length of time the exposure occurred and how much of the substance actually gets on or in the body are important details in understanding the risk.78

Occupational exposure often occurs in cases of agricultural workers in fields, people living close to agricultural fields, and people working in the pesticide industry and working in structural pest control. Exposure of the general population occurs primarily through eating food and drinking water contaminated with pesticide residues. Water, soil, and air becomes contaminated from pesticides leaching into the ground, running off into rivers with rain water, or drifting as spray from pesticide applications.

Ecological risk is risk posed by a pesticide to the wildlife and the environment. US EPA looks at ecological risks, including:

- **Wildlife and aquatic organisms:** How the pesticide affects various animal species.
- **Plant protection:** How the pesticide affects various plant species.
- **Non-target insect:** How the pesticide affects insects other than the ones the pesticide is intended to kill
- **Environmental fate:** What happens to the pesticide in soil, water, and air after being released into the environment?
- **Residue chemistry:** How much pesticide is present in the environment over time after application.
- **Spray drift:** How much the pesticide drifts off-site when sprayed from the air? Helps determine exposure of non-target organisms.

An adjuvant is any material that is added to a pesticide solution to enhance or modify the performance of the solution. Most pesticides are not flammable, but the solvents or dilutents of liquid emulsion concentrates or oil solutions—xylene, kerosene, or other organic solvents—can be flammable and under some conditions explosive. Adjuvant can be inert but it can also significantly increase pesticide toxicity.

C.3 UNDERSTANDING PESTICIDE LABEL AND MATERIAL SAFETY DATA SHEET

The label of a pesticide container must have all the information about risks as well as information needed for safe and effective use. Additional important details about risks of pesticide products and instructions about safer use can be found in the manufacturer's MSDS. Labels and MSDS for some pesticides are available online at http://www.cdms.net and http://www.greenbook.net.

78 http://npic.orst.edu/factsheets/WhatsMyRisk.pdf

The label on a pesticide container has three main functions:

- To tell the user what pest the product can be used on.
- To tell the user how to handle, use, and store the pesticide safely.
- To tell the user how and when to apply the pesticide for the best effect.

By law, pesticide labels must contain:

- The name of the product.
- Level of toxicity.
- Active ingredients.
- Other ingredients-co-formulants.
- The pests which the product will control.
- The rate of application of the product (how much of it to use).
- The time and method of application.
- Directions for handling the product safely.
- First aid procedures in case of an accident.
- Any special instructions or warnings about its use, transport, storage, or disposal.
- The net contents (weight when packed) of the container.

The pesticide pictogram will provide information about risks and safety measures required including PPE.

All programs must review the MSDS and provide training on reading and understanding the pesticide label prior to using pesticides.

C.4 PESTICIDE SAFETY AND USE OF PROTECTIVE CLOTHING AND EQUIPMENT

Training must address the types of personal protective equipment (PPE), when they should be worn and why.

TABLE 19. HANDLER PPE FOR WORKER PROTECTION STANDARD PRODUCTS

ROUTE OF EXPOSURE	TOXICITY CLASSIFICATION BY ROUTE OF EXPOSURE OF END-USE PRODUCT			
	I DANGER	II WARNING	III CAUTION	IV CAUTION
Dermal Toxicity or Skin Irritation Potential[1]/	Coveralls worn over long-sleeved shirt and long pants	Coveralls worn over long-sleeved shirt and long pants	Long-sleeved shirt and long pants	Long-sleeved shirt and long pants
	Socks	Socks	Socks	Socks
	Chemical-resistant footwear	Chemical-resistant footwear	Rubber boots or shoes	Rubber boots or shoes
	Chemical-resistant Gloves[2]	Chemical-resistant Gloves[2]	Chemical-resistant Gloves[2]	No minimum[4]
Inhalation Toxicity	Respiratory protection device[3]	Respiratory protection device[3]	No minimum[4]	No minimum[4]
Eye Irritation Potential	Goggles[5]	Goggles[5]	No minimum[4]	No minimum[4]

[1] If dermal t[1]/Toxicity and skin irritation toxicity categories are different, PPE shall be determined by the more severe toxicity classification of the two. If dermal toxicity or skin irritation is category I or II, refer to the pesticide label/MSDS to determine if additional PPE is required.
[2] Refer to the pesticide label/MSDS to determine the specific type of chemical-resistant glove.
[3] Refer to the pesticide label/MSDS to determine the specific type of respiratory protection.
[4] Although no minimum PPE is required for these toxicity categories and routes of exposure, some specific products may require PPE. Read pesticide label/MSDS.
[5] "Protective eyewear" is used instead of "goggles" and/or "face shield" and/or "shielded safety glasses" and similar terms to describe eye protection. Eye glasses and sunglasses are not sufficient eye protection.

Note: Where necessary, farmers can make their own PPE. For example a plastic or water repellent apron from the waist to ankle length, can be fashioned from a large piece of plastic purchased in the local market (important if walking through the spray path).

Source: CropLife

C.5 PROPER SPRAY TECHNIQUE: PROTECTING AGAINST PESTICIDE SPRAY DRIFT

Many farmers apply pesticides with a knapsack sprayer, which means that delivery of pesticides is either in front of the person spraying or to the side, not to the back as is the case with tractor-drawn sprayers. Inevitably pesticide drift will be carried by the wind and potentially settle on sensitive ecosystems such as national parks if they are nearby. Herbicides pose the greatest risk for environmental damage, especially when their drift lands on a neighbors crops and kills or severely damages them.

The potential for drift to travel long distances has been shown with highly residual chlorinated hydrocarbon pesticides, such as DDT, which have moved through the atmosphere and been found in measurable quantities at both poles on earth. Pesticides that can be transported to the earth's distant poles are bound tightly to dust particles carried high into the atmosphere and transported by jet streams. Their presence only represents a very small percentage of the drift. Spray drift is a mostly local phenomenon, whereby spray droplets move to areas near the field.

There are a number of ways in which pesticide drift can be minimized:

Increase spray droplet size. Fog-sized droplets can travel three miles (4.8 km) while coarse droplets typically travel less than 10 feet (3 meters). To increase droplet size, the farmer can reduce spray pressure (e.g., 30 to 50 pounds per square inch [2-3.5 kg/cm^2] with 5 to 20 gallons [19 to 76 liters] of water per acre [.4 ha]), increase nozzle orifice size, use special drift reduction nozzles, and purchase additives that increase spray viscosity.

Distance between nozzle and target. Reduce the distance between the nozzle and the target crop.

Temperature and relative humidity. As pesticides vaporize under high temperature, low relative humidity and/or high temperature will cause more rapid evaporation of spray droplets between the spray nozzle and the target. Evaporation also reduces droplet size, which in turn increases the potential drift of spray droplets. It is best not to spray in the heat of the day to avoid drift problems.

Avoid spraying when the wind speed > 10 mph (16 km/h). As drift occurs as droplets suspended in the air, it is best to minimize applications during windy days. If spraying has to be done, however, the farmer should spray away from sensitive areas. Local terrain can influence wind patterns, thus every applicator should be familiar with local wind patterns and how they affect spray drift.

Do not spray when the air is completely calm or when a temperature inversion exists. When the air is completely still, small spray droplets become suspended in the warm air near the soil surface and will be readily carried aloft and away from susceptible plants by vertical air movement. Temperature inversion occurs when air near the soil surface is cooler than the higher air. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud and impact plants two miles or more downwind. This cloud can move in unpredictable directions due to the light, variable winds common during inversions.

Application height. Making applications at the lowest height reduces exposure of droplets to evaporation and wind.

C.6 PESTICIDE TRANSPORT AND STORAGE

Where IPs or beneficiary groups will be transporting pesticides, training must address the fundamentals of safe transport of pesticides. (Some of the largest accidents involving pesticides have occurred during transportation.) Drivers should be trained on how to deal with and contain spills, and not to transport pesticides with food. Many of the agro-dealers are small and ship their stock individually in relatively small quantities. Agro-dealers should be sensitized about minimizing potential risks during transportation.

Minimum elements of safe transport are:

- Keep pesticides away from passengers, livestock and foodstuffs;
- Do not carry pesticides in driver's compartment;
- Containers must be in good condition;
- Do not transport packages with any leakage; and,
- Transport under cover and protected from rain, and direct sunlight.

Storing pesticides properly protects human and animal health, safeguards wells and surface waters, and prevents unauthorized access to hazardous chemicals. The pesticide label is the best guide to storage requirements for every product. The MSDS provides additional information on normal appearance and odor as well as flash point, fire control recommendations, boiling point, and solubility

Preventative measures are required in pesticide warehouses in order to reduce cases of pilferage, exposure through leakages, theft, and expiration of pesticides. Where IPs or beneficiaries, including agro-dealers, will be maintaining pesticide stores, training must address these practices, as per the best management practices for pesticide storage highlighted in FAO storage manual and summarized below:

- All primary pesticide storage facilities will be double-padlocked and guarded on a 24-hour basis.
- All the storage facilities will be located away from water sources, domestic wells, markets, schools, hospitals, etc. Wastewater from pesticide storage facilities must not be drained directly into public drains but should be pretreated on site.
- Soap and clean water will be available at all times in all the facilities.
- A trained storekeeper will be hired to manage each facility.
- Pesticides will be stacked as specified in the FAO Storage and Stock Control Manual.
- Inventory management will include recording expiration dates of all pesticides and maintaining a "first-in first-out" stocking system.
- All the warehouses will have at least two exit access routes in case of a fire outbreak.
- A non-water-based fire extinguisher will be available in the storage facilities, and all workers will be trained on how to use this device, and how to respond to fire (see below).
- Warning notices will be placed outside of the store in the local language(s) with a skull and crossbones sign to caution against unauthorized entry.

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Further, if IP-run pesticide stores exist in an area with fire or emergency services, local first responders must receive training on how to deal with pesticide fires. The smoke from such a fire is highly hazardous and effluent from water spray can do great harm to the environment. If fire fighters use water to put out a fire in a pesticide storage shed, the runoff will be highly toxic.

C.7 FIRST AID

It is important to provide training on recognition of the symptoms of a pesticide poisoning so the victim will receive timely treatment. Contact information of the closest medical facility must be known and available if someone can be possibly poisoned with a pesticide. Quick action could save the victim's life. Farmers must be trained to make sure to take the label and if possible the MSDS on the chemical to the hospital. This will enable the medical professionals to treat the victim properly and promptly.

Training must include the basic elements of pesticide first aid, as per the table below. Wherever possible, personnel at local health facilities should participate in/receive such training.

General	Read the first aid instructions on the pesticide label, if possible, and follow them. Do not become exposed to poisoning yourself while you are trying to help. Take the pesticide container (or the label) to the physician.
Poison on skin	Act quickly. Remove contaminated clothing and drench skin with water. Cleanse skin and hair thoroughly with detergent and water. Dry victim and wrap in blanket.
Chemical burn on skin	Wash with large quantities of running water. Remove contaminated clothing. Cover burned area immediately with loose, clean, soft cloth. Do not apply ointments, greases, powders, or other drugs in first aid treatment of burns.
Poison in eye	Wash eye quickly but gently. Hold eyelid open and wash with gentle stream of clean running water. Wash for 15 minutes or more. Do not use chemicals or drugs in the wash water; they may increase the extent of injury.
Inhaled poison	Carry victim to fresh air immediately. Open all doors and windows so no one else will be poisoned. Loosen tight clothing. Apply artificial respiration if breathing has stopped or if the victim's skin is blue. If victim is in an enclosed area, do not enter without proper protective clothing and equipment. If proper protection is not available, call for emergency equipment from your fire department (if available).
Poison in mouth or swallowed	Rinse mouth with plenty of water. Give victim large amounts (up to 1 quart) of milk or water to drink. Induce vomiting only if instructions to do so are on the label.
Procedure for inducing vomiting	Position victim face down or kneeling forward. Do not allow victim to lie on his back, because the vomit could enter the lungs and do additional damage. Put finger or the blunt end of a spoon at the back of victim's throat or give syrup of ipecac. Collect some of the vomit for the physician if you do not know what the poison is. Do not use salt solutions to induce vomiting.
When not to induce vomiting	If the victim is unconscious or is having convulsions. If the victim has swallowed a corrosive poison. A corrosive poison is a strong acid or alkali. It will burn the throat and mouth as severely coming up as it did going down. It may get into the lungs and burn there also. If the victim has swallowed an emulsifiable concentrate or oil solution. Emulsifiable concentrates and oil solutions may cause severe damage to the lungs if inhaled during vomiting.

C.8 PROPER PESTICIDE CONTAINER DISPOSAL

Once pesticides have been used, the empty containers need to be properly disposed of. Training must address proper disposal. This table gives a summary of the best practices for doing so.

TABLE 20. PROPER METHODS TO DISPOSE OF PESTICIDES AND THEIR EMPTY CONTAINERS

CONTAINER TYPE	DISPOSAL STATEMENTS
Metal Containers (non-aerosol)	Triple rinse. Then offer for recycling or reconditioning, or puncture and bury.
Paper and Plastic Bags	Completely empty bag into application equipment. Then bury empty bag.
Glass Containers	Triple rinse. Then bury.
Plastic Containers	Triple rinse. Then offer for recycling or reconditioning, or puncture and bury.

C.9 MONITORING AND DATA RECORD KEEPING

Senegal small-scale farmers do not keep records of information on crops grown, production, pest attack, pesticides used, whether the pesticides worked well or not, pest resistance development and pre-harvest intervals to reduce pesticide residues. Certified large-scale commercial and estate farms, on the other hand, generally keep detailed records. Projects must conduct training programs on monitoring and data record-keeping techniques for pest control and pesticide needs and/or effectiveness.

An example of monitoring and record keeping chart is included below. Suggestions for development of simple charts for monitoring and record keeping can be found at http://www.hobbyfarms.com/crops-and-gardening/crop-record-keeping-charts.aspx.

TABLE 21. EXAMPLE OF MONITORING AND RECORD KEEPING CHART

Crop	Plot Location	Plot Size	Planted Date	Pests Observed	Infestation Severity	Management Technique	Date/Time Of Application	Notes (Rate Of Application, Weather, Etc.)	Harvested Date	Results