International Water Management Institute (IWMI) &
Comité Inter-Etats de Lutte contre la Sécheresse au Sahel (CILSS)

Pesticide Evaluation Report and Safe Use Action Plan

(PERSUAP)

for

Improving food security in West Africa through revitalizing irrigation systems performance and productivity and promotion of agricultural water and small-scale irrigation WAIPRO

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Acronyms use in WAIPRO PERSUAP

ADS	Automated Directives System
AFR	Africa Bureau, AID
AI	Active Ingredient
BMP	Best Management Practice
BT	*Bacillus thuringiensis* (a bacteria that produces a toxin used as a pesticide)
BRC	British Retail Consortium
CA	Cooperative Agreements
CEQ	Council on Environmental Quality (US Government)
CFR	Code of Federal Regulations
CILSS	Comité Permanent Inter-Etats pour la Lutte contre la Sécheresse dans le Sahel
COP	Chief of Party
CP3	Cleaner Production and Pollution Prevention
DDT	Dichloro-Diphenyl-Trichloroethane
EA	Environmental Assessment
EC	Emulsifiable Concentrate (pesticide formulation)
EMMP	Environmental Mitigation & Monitoring Plan
EPA	US Environmental Protection Agency (also known as USEPA)
ETOA	Environmental Threats and Opportunities Analysis
EU	European Union
FAO	Food and Agriculture Organization (United Nations agency)
FDA	Food and Drug Administration (US)
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
GAP	Good Agriculture Practice
GBP	Good Business Practice
GDP	Gross Domestic Product
GMP	Good Manufacturing (Processing) Practice
GUP	General Use Pesticide
Ha	Hectares
HT	Highly Toxic
ICM	Integrated Crop Management
IFDC	International Fertilizer Development Center
IEE	Initial Environmental Examination
IGR	Insect Growth Regulator
IWMI	International Water Management Institute
IP	Implementing Partner
IPM	Integrated Pest Management
ISFM	Integrated Soil Fertility Management
IVM	Integrated Vector Management
IWM	Integrated Weed Management
M&E	Monitoring and Evaluation
MEO	Mission Environmental Officer
MOA	Ministry of Agriculture
MRL	Maximum/Minimum Residue Level/Limit
MSDS	Material Safety Data Sheet
MT	Moderately Toxic
NARS	National Agriculture Research Systems
NARES	National Agriculture Research and Extension Systems

NAT	Not Acutely Toxic
NEPA	National Environmental Policy Act (US)
PAN	Pesticide Action Network
PER	Pesticide Evaluation Report
PERSUAP	Pesticide Evaluation Report and Safe Use Action Plan
pH	log of Hydrogen concentration, measure of acidity
PHI	Pre-Harvest Interval
PIC	Prior Informed Consent (a treaty, relates to toxic pesticides)
POPs	Persistent Organic Pollutants (a treaty, relates to toxic persistent pesticides)
PMP	Pest Management Plan
PNT	Practically Non-Toxic
PPE	Personal Protection Equipment
R&D toxin	Reproductive and Developmental toxin
Reg 216	Regulation 216 (USAID Environmental Procedures)
REI	Re-Entry Interval (safety period after pesticide spraying)
RUP	Restricted Use Pesticide
S&C	Standards and Certification
SPS	Sanitary and Phytosanitary
ST	Slightly Toxic
SUAP	Safe Use Action Plan
UC	University of California
UN	United Nations
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USEPA	US Environmental Protection Agency (also known as EPA)
USG	United States Government
VHT	Very Highly Toxic
WAIPRO	West Africa Irrigation Promotion
WARDA	West Africa Rice Development Association
WHO	World Health Organization
WSP	Water Soluble Packet
WTO	World Trade Organization

TABLE OF CONTENTS

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EXECUTIVE SUMMARY

Risks to human health and environment are present for WAIPRO farmers, and it is these types of risk that drive the necessity for compliance and the use of best practices. Pesticide promotion, sale, discussion during training, or uses (such as those that will undoubtedly be used by WAIPRO beneficiaries) potentially increase these risks. The use of mitigation measures (such as those recommended in this PERSUAP) reduces these risks. It is the goal of this document to make recommendations for actions to mitigate these increased risks from pesticides. Before errors (such as human poisonings from pesticides) occur, it is the responsibility of the project implementers (WAIPRO, MOAs/NARS project implementing partners—IPs) to put these mitigation recommendations into action, as soon as possible, monitor them and report on their success at mitigation and risk reduction.

The purpose of this document is to conduct a Pesticide Evaluation Report (PER) and Safe Use and Action Plan (SUAP) in compliance with USAID's environmental regulations (Title 22 of the Code of Federal Regulations (CFR), part 216, or Regulation 216) on pesticide use on USAID-funded projects. The report begins with sections that evaluate background and risks. The Pesticide Evaluation Report (PER) section addresses the 12 informational factors (a through l) required in the Agency's Pesticide Procedures, under 22 CFR 216.3 (b)(1)(i). The Safe Use Action Plan (SUAP) puts the conclusions and recommendations reached in the PER into a plan of action, including assignment of responsibility to appropriate parties connected with the pesticide risk mitigation program, a timetable and a budget—for the project implementer to fill and implement.

This 45-page long PERSUAP study (with an additional 41 pages of useful Annexes and References), including findings from a field trip to a sample potential WAIPRO site identifies risks and fills some information and knowledge gaps where pests, Integrated Pest Management (IPM) and pesticides are concerned. It also helps ensure (along with WAIPRO implementation of recommended mitigation/monitoring/reporting measures, and AID audits) compliance.

PERSUAP FINDINGS THAT INDICATE RISKS FROM PESTICIDES

A field visit to a proposed WAIPRO site in Burkina Faso found WAIPRO staff and cooperating farmers who will require inputs either through their local farm input stores which sell pesticides, fertilizers and farm tools, or through the MOA or both.

For this study, it was assumed that in order for WAIPRO and Implementing Partner staff using WAIPRO resources to properly, safely and correctly provide advice to cooperating farmers and demonstration farms, at minimum, they should understand:

- Primary crop pests impacting each WAIPRO-supported crop
- IPM tools and tactics used by the target farmers to prevent primary crop pests
- Pesticides used by target farmers for each primary crop pest
- Local/regional pesticide registration information
- Pesticide risk issues like relative toxicity and internationally restricted/banned pesticides
- PPE (Personal Protection Equipment) needed for specific pesticide uses

Beneficiary farmers interviewed for this study do not understand all of these issues sufficiently to mitigate risk significantly. Further, banned, not EPA registered, restricted and highly toxic pesticides are found across the Sahel. For instance on recent trips to the Sahel, banned pesticides containing dieldrin, endosulfan and heptachlor as well as restricted pesticides containing HCH, lindane and monocrotophos were found available to and purchased by local farmers. Although not found being used currently for agriculture, DDT is available in several countries for malaria control; in other parts of Africa where it is used, there are issues with it being diverted illegally to the agriculture sector.

The pesticide active ingredient endosulfan is currently being targeted for international ban by the international environmental community due to deaths of farmers in Benin and India from unprotected and unsafe use on, among other crops, tomatoes. In fact, endosulfan, along with fumigant aluminum phosphide, is one of the most frequently reported causes of unintentional poisoning, particularly in Asia, Latin America, and West Africa. For these reasons and others, certain specific measures and actions are recommended.

Further, scarce quantities of PPE were found available in pesticide shops across the region, and farmers visited had no PPE. Common Best Management Practices (BMPs) for use of chemicals would dictate that WAIPRO field staff recognize and correct these PPE deficiencies with their beneficiary farmers. Training is also significantly lacking. Beyond recommending and procuring PPE, WAIPRO Implementing Partners, demonstration farmers and their beneficiaries will need to be trained in pesticide safe use best practices.

THE PERSUAP STUDY FOCUS ON IPM, PMPs AND PESTICIDES

The practice of IPM – the use of which is considered to be a policy of USAID – is fully supported and promoted in Section 2.6 of this PERSUAP as well as in the required PER Section 3.3 Factor C analysis. Moreover, Annex 1 of this PERSUAP presents off-the-shelf IPM and Good Agriculture Practices (GAPs) researched and extended to farmers in other African countries, the USA and other developed countries for the very same or similar crop-pest combinations as those found at WAIPRO implementation locations. These IPM tactics (which include pesticides registered and used in the USA for the same crop-pest combinations) are presented for project field managers and beneficiaries to test and adopt, as is practical and wanted.

Further, the crop-pest-GAP/IPM/pesticide information in Annex 1 is meant to provide WAIPRO implementing partners and beneficiary farmers with a solid starting point for developing their own locally-adapted Pest Management Plans (PMPs) for each crop. A guide for making detailed PMPs is provided in Annex 2, and it is expected that the implementing partners will work with farmers and farm managers to prepare PMPs and crop management posters to assist in the prediction and prevention of damage caused by specific pests and crop constraints.

Annex 3 provides an updated adaptation of an outline of important IPM program elements developed by FAO and implemented successfully in Indonesia in the 1980s. These same 10 elements are offered to project field managers to consider for planning purposes in developing and implementing IPM strategies.

This PERSUAP focuses strongly on GAP and IPM tools including commercialized natural pesticides containing Active Ingredients (AIs) extracted from plants, microbes, marine organisms, spices and minerals (see Annexes 4 and 5) as well as cultural practices and synthetic pesticides used in the USA, some of which are available in West Africa and CILSS countries, or could be made available in the future.

Annex 6 shows important differences between EPA's and WHO's systems for classifying acute human health risk, followed by Annex 7 which compiles all of the AIs in pesticides (natural and synthetic) registered, imported to and found in Burkina and Niger. Project decision-makers—especially those who interface at the field level with beneficiary demonstration farmers—are encouraged to look at the label of potential pesticide choices to determine the AIs contained in them and then use this Annex as a quick reference guide to attributes of and issues with each chemical. These attributes include pesticide class (to manage resistance by rotating chemicals from different classes), EPA registration and Restricted Use Pesticide (RUP) status (to comply with Regulation 216) and acute toxicity (judged by this document to be safe, or not, for small-holder farmers—most Class I chemicals are not considered safe for smallholder farmers to use). Annex 7 also presents chronic human health issues, water pollution potential, and potential toxicities to important non-target organisms like fish, honeybee pollinators, birds and several aquatic organisms.

Further, Annex 7 contains basic pieces of human safety and environmental data needed for the various analyses required throughout the PER; ergo it is referred to throughout this document. And it provides data used to produce the project-critical information contained in Annexes 8 and 9. Thus, this PERSUAP provides useful tools for evaluating and choosing among IPM options, including natural and synthetic pesticides, while adhering to 22 CFR 216, as well as aiming at the market-driven best practices found in Standards and Certification (S&C) systems—the highest international standards available.

Annex 8 contains the names of pesticide AIs in pesticides that cannot be mentioned or promoted during WAIPRO training and not used on WAIPRO demonstration farms. WAIPRO staff will need to produce a list of the names of commercial products containing these AIs and keep it on hand at project offices, for training and for use in the field with beneficiary farmers, to advise them what is not permissible with USAID support.

Annex 9 contains a short list of Restricted Use Pesticide (RUP) AIs commonly encountered in pesticide products found in West Africa (and some of which are natural plant-extracted chemicals). For these, this PERSUAP requests an exception for use, with conditions and arguments justifying this request found in Section 3.1, and invoking language for exceptions found in 22 CFR 216.3b, Pesticide Procedures, Part 1, subparts (ii and iii) to permit their use. None of these are highly acutely toxic to humans. Finally, Annex 10 to this report synthesizes training topics that should be covered by WAIPRO and Annex 11 provides a monitoring format.

Thus, this PERSUAP provides useful tools for evaluating and choosing among IPM options (including pesticides) while adhering to 22 CFR 216, as well as many of the rapidly-evolving international and market-driven best practices found throughout Standards and Certifications (S&C) systems like Organic, Fair Trade, GlobalGAP and others. Below are the key best management practices and recommendations synthesized from the PER, and found in the SUAP.

PERSUAP RECOMMENDATIONS FOR MITIGATING RISKS

Immediate Actions Required for Safety	
Perform IPM and Safe Pesticide Use training & certification (to ensure that training sticks) for all WAIPRO implementers and beneficiary farmers (see Annex 10)	Obtain recommended PPE for all project implementers and beneficiary farmers who will use pesticides
WAIPRO ensure that implementers and beneficiary farmers do not use pesticides containing the following chemical Active Ingredients: aluminum phosphide, endosulfan, dieldrin, heptachlor, HCH, lindane and monocrotophos	WAIPRO use lists of pesticides registered under CILSS to match pesticide commercial product names with each of the Active Ingredients found in Annexes 8 and 9; make lists for each Annex and distribute these lists to each WAIPRO implementer
Ensure that each WAIPRO implementer has a copy of the list of pesticides registered for use in CILSS countries as well as copies of Annexes 1 and 7, and understands their use, especially if audited	WAIPRO ensure that each implementer has a copy of the Material Safety Data Sheets (MSDS) for all of the pesticide products used by beneficiary farmers on WAIPRO-sponsored crops and demo farms

Actions Required by December 2010	
WAIPRO with NARS make provisional PMPs for each WAIPRO crop (use Annexes 1, 2 and 3 as well as local farmer knowledge) so managers and farmers have a tool to predict, prevent and manage pests throughout the season	WAIPRO's training coordinator receive row-crops RUP training and certification on-line or at a US state extension service that focuses on tropical/subtropical crops & transfers RUP mitigation knowledge to WAIPRO implementers and beneficiary farmers

Continuous Actions Required for Safety and BMPs	
WAIPRO implementers ensure that beneficiary farmers do not use pesticides containing the active ingredients listed in Annex 8 & have training for those in Annex 9	WAIPRO implementers ensure that farmers use PPE and apply pesticides only during the appropriate times of day (early morning/late afternoon, low wind, no rain)
WAIPRO check the CILSS list of registered pesticides every 6 months to obtain new pesticide regulatory changes & registrations	WAIPRO ensure that implementers and farmers use pesticides following all safe use practices
As CILSS registers them, WAIPRO implementers test and promote commercially-available pesticides containing natural chemicals listed in Annexes 4 and 5	For all farms, WAIPRO implementers introduce pesticide record-keeping concepts and tools following GlobalGAP procedures

Program Management Actions on Compliance	
WAIPRO monitor beneficiary farmers for their understanding and use of best practices found in the field form in Annex 11	WAIPRO report on monitoring in Annual Reports to USAID, under a heading titled "Environmental Mitigation and Monitoring"
WAIPRO implementers report on any changes in CILLS pesticide regulations and registrations	WAIPRO annually amend this PERSUAP to contain new IPM tactics and pesticides registered for each country
WAIPRO write the names of pesticides that cannot be used on USAID-funded sites into any future grant or sub-contract	WAIPRO environmental staff draft an EMMP containing pesticide issues identified in the SUAP, with ways to mitigate these

SECTION 1: INTRODUCTION

1.1 Why Conduct a PERSUAP?

From 1975 to 1976, over 2,800 Pakistan malaria spray personnel were poisoned (5 to death) by insecticide mishaps on a USAID/WHO anti-malaria program[1]. In response to this and other incidents arising from USAID programs, a law suit was brought by a coalition of environmental groups for lack of environmental procedures for overseas projects. USAID, in response to the law suit, drafted US 22 CFR 216. This regulation, which was updated in 1979 to include extraterritorial affairs, (in response to changes in the scope of the application of the National Environmental Policy Act (NEPA)) now guides most USAID activities that could have potentially negative environmental impacts.

Regulation 216 (also called Part 216) of 22 CFR states that certain environmental compliance processes and procedures must be followed on overseas projects in order to:

- Respond to market demand for clean, high-quality agricultural produce, and meet import expectations
- Create modern state-of-the-art development
- Achieve optimal economic results with every dollar invested
- Avoid harming people in both our partner countries and the US
- Avert unintended negative economic growth
- Reinforce practical civil society and democracy through transparency and public participation
- Reduce diplomatic incidents
- Engender public trust and confidence in USAID
- Comply with the law
- Represent good business.

According to Regulation 216, all USAID activities are subject to analysis and evaluation via – at minimum – an Initial Environmental Examination (IEE), and – at maximum – an Environmental Assessment (EA). A large part of Regulation 216 – part 216.3 – is devoted to pesticide use and safety. Part 216.3 requires that 12 pesticide factors be analyzed and recommendations be written to mitigate risks to human health and environmental resources, to be followed up with appropriate training, monitoring and reporting for continuous improvement on risk reduction and adoption of international best practices for crop production, protection and pesticide use safety.

1.2 Umbrella IEE for WA Agriculture Portfolio

An umbrella IEE was drafted in September 2009 by USAID West Africa (WA) Regional Office for the entire Agriculture Portfolio, including IWMI/CILSS/WAIPRO. To cover pesticide training, procurement or use on demonstration irrigation farms it was recommended that this PERSUAP be produced. Pesticides require special attention due to the risks inherent with their use. This PRESUAP responds to that recommendation and request.

1.3 Integrated Pest Management—USAID Policy

In the early 1990s, USAID adopted the philosophy and practice of Integrated Pest

[1] http://www.ncbi.nlm.nih.gov/pubmed/74508

Management (IPM) as official policy. IPM is also strongly promoted and required as part of Regulation 216.3. Since the early 2000s, IPM—which includes judicious use of pesticides—has been an integral part of GAPs and is increasingly considered to constitute best management practices in agriculture.

1.4 The Pesticide Evaluation Report and Safer Use Action Plan (PERSUAP)

In the USA, the EPA can rely on the following safety-enhancing factors, not present to the same degree in most developing countries—including WAIPRO countries:

- An educated literate population of farmers
- Quality IPM information and Pest Management Plans (PMPs)
- A well-functioning research and extension system to extend IPM information to farmers
- Certification systems for farmer training on restricted and other pesticides
- Quality affordable Personal Protection Equipment (PPE) to reduce pesticide exposure
- Quality pesticide labels and Material Safety Data Sheets (MSDS) to guide farmer safety
- Accurate information and training on pesticide use, transport, storage and disposal

In the late 1990s, USAID's Bureau for Africa developed a tool to analyze the pesticide system in any given country or territory. The tool, which is called a Pesticide Evaluation Report and Safe Use Action Plan (PERSUAP) focuses on the particular circumstances, crops, pests and IPM/pesticide choices of a project or program. This "systems approach" analyzes the pesticide sector or system from registration to import through use to disposal, and develops a pesticide risk profile based on the analysis.

A PERSUAP is generally recommended by and submitted as an amendment to the project IEE or an Environmental Assessment. Further, the application of PERSUAP recommendations helps prepare project participants to be able to more rapidly adopt GlobalGAP, Organic and other S&C systems principles, as desired for future market access.

1.5 WAIPRO PERSUAP Methodology

The PERSUAP Consultant was first contacted by IWMI in March 2010, and his services were contracted through IWMI in late May to early June of 2010. The Consultant requested background documents and began internet searches for additional information. A systems approach was planned for determining levels of risk throughout the pesticide systems in which WAIPRO country projects operate.

The Consultant traveled to West Africa in April 2010 to visit agriculture activities and a special visit was made to a potential WAIPRO field site in Burkina Faso. The Consultant interviewed WAIPRO staff, farmers, pesticide shops, and staff members of the Ministry of Agriculture. The Consultant also requested specific information on crops, pests, IPM and pesticide tools and technologies and PPE available and used from each of the sites in Burkina Faso and Niger.

Using websites linked to EPA, FAO, other donors and US universities, IPM and pesticide registrations and best practices were researched and are compiled, as best practices, in this PERSUAP.

SECTION 2: COUNTRIES & WAIPRO BACKGROUNDS

2.1 Country Background

Burkina Faso

Burkina Faso is a landlocked West African country, bordered by Mali in the north and west, Niger in the East, and Benin, Togo, Ghana, and Côte d'Ivoire in the south. Burkina Faso has a land area of 274,200 km2, with 85 percent considered "shrublands, savanna, and grasslands," and 14 percent "cropland and crop/natural vegetation mosaic."

The majority of Burkina lies on a savanna plateau, 200-300 meters above sea level, and is generally characterized by a tropical climate of the Sudanese and Sahelian categories, with a long dry season from October to April, and a short rainy season from May to September. The arid Sahelian zone covers the northern part of the country, and has an annual rainfall that does not exceed 350-500 mm in most areas. The Sudanese zone is less arid and covers the southern part of the country, receiving annual rainfall that varies from 700 mm to 1200 mm.

The majority of Burkinabè streams are seasonal, with only the Mouhoun, the Comoé, and the Pendjari having perennial flows. Major seasonal streams include the Nazinon, the Nakambé, and the Sirba. Other perennial bodies of water include Bam and Dem lakes, Mare aux Hippopotames, the Oursi Pond, and the artificial lakes of Kompienga, Bagr and Ziga. Since 2006, the latter has particularly been serving as a major supplementary source of drinking water for Ouagadougou and its surrounding localities.

Burkina Faso's economy is dominated by subsistence agriculture in which 90 percent of the population engages (accounting for 37 percent of gross domestic product). Community forestry is well developed in Burkina Faso, and the country has been a pioneer in rural forestry, participatory management of natural forests and small stands, and management of plant and animal wildlife.

Biodiversity in Burkina Faso faces several major threats, which have intensified, especially since the 1970s. Some of these threats are drought and desiccation, soil degradation, and reduced and contaminated water resources.

Niger

Niger is also a landlocked West African country, bordered by Mali and Burkina Faso on the west, Algeria and Libya on the north, Chad on the east, Nigeria and Benin on the south. Niger has a land area of 1,267,000 square kilometres (489,191 square miles) of which 300 square kilometres (116 sq mi) is water (Niger River) and about 88 percent of which is covered by the Sahara desert.

Niger's subtropical climate is mainly very hot and dry, especially in desert areas. In the extreme south there is a tropical climate on the edges of the Niger River basin. The terrain is predominantly desert plains and sand dunes, with flat to rolling savanna in the south and hills in the north.

The agricultural economy is based largely upon internal markets, subsistence agriculture, and the export of raw commodities: food stuffs and cattle to neighboring countries. Niger's agricultural and livestock sectors are the mainstay of 82% of the population. Fourteen percent of Niger's GDP is generated by livestock production (camels, goats, sheep and cattle), said to support 29% of the population and 53% of the population is actively involved in crop production.

Pearl millet, sorghum and cassava are the principal rain-fed subsistence crops. Irrigated rice for internal consumption is grown in parts of the Niger River Valley in the south west. It has, in recent years, sold for below the price of imported rice, encouraging additional production. Cowpeas and onions are grown for commercial export, as are small quantities of garlic, peppers, potatoes and wheat. Oasis farming in small patches of the north of the country produces onions, dates, and some market vegetables for exports.

A small area in the southern tip of the nation surrounding Gaya can expect to receive 700mm to 900mm or rainfall. Farmers engaged in crop production in the south center and south west can expect to receive between 300mm to 600mm of rainfall annually. Northern areas which support crops, such as the southern portions of the Aïr Massif Mountains and the Kaouar Oasis rely on a slight increase in rainfall due to mountain and upwelling effects. Large portions of the desert northwest and far east see just enough seasonal rainfall to support semi-nomadic animal husbandry. Much of the non-desert portions of the country are threatened by periodic drought, soil degradation and further desertification.

2.2 WAIPRO Project

On February 25, 2009, in response to the 2007-08 food crises, USAID's Initiative to End Hunger in Africa (IEHA) and needs for more agricultural water, IWMI and CILSS developed a proposal for WAIPRO and sent it to USAID. The overall goal of the WAIPRO project is to identify and implement feasible interventions that can revitalize the performance, efficiency and productivity of irrigation systems.

The specific objectives of the project are:

1 To improve the performance and productivity of existing irrigation schemes through appropriate technological, managerial, and institutional innovations.
2 To increase irrigated crops (mainly rice) production and farmers' income and provide countries with harmonized policies, tools and references to better manage water resources

The project sites are:

Site 1: Karfiguela, Burkina Faso
Site 2: Talembika, Burkina Faso
Site 3: Dayberi, Niger

Project activities are:

Activity 1: Diagnostic activities involving scoping study, participatory analysis of constraints and opportunities of existing irrigation systems.

Activity 2: Based on the insights obtained from Activity 1, develop intervention plans, and implement the same in pilot irrigation systems in Burkina Faso and Niger.

Activity 3: Capacity building, synthesis, dissemination and communication of the lessons learned and the experiences gained from the pilot implementation.

Activity 4: Promotion of agricultural water and small-scale irrigation in the Sahel

Under the Project Goal, WAIPRO notes an increase in productivity. Increases in productivity include the use of inputs including pesticides. Under Activity 2, WAIPRO notes that "The benefits of benchmarking performance are more productive and efficient use of land, water, labor, finance, and *agricultural inputs* [italics inserted], leading to more productive and sustainable irrigated agriculture and improved livelihoods and well-being of the rural population." Agriculture inputs include pesticides.

Under the topic of training, crop protection chemicals are referred to or implied as follows: In each scheme, about 50 farmers will be selected for training in contemporaneous in-field water management technologies or practices and improved agronomic practices (including efficient soil nutrient management, *crop protection practices* [italics inserted], appropriate timing of operations, variety selection). State-of-the art technologies for water management and soil nutrient management will be acquired and demonstrated on selected farmers' fields.

Furthermore, the project provides targeted training for entrepreneurs and firms connected to irrigated-agricultural production through output marketing, input supply and processing. It helps build the capacity of private sector organizations to create supportive environment for the marketing and trade of irrigated agricultural products.

IWMI will consult with the West Africa Rice Development Association (WARDA) and the International Fertilizer Development Center (IFDC) regarding the use of best agronomic practices for rice production. At field level, WAIPRO plans to carry out a set of interventions leading to improved water application and reduced water losses (e.g. bunding, leveling, etc), and improved agronomic practices (plowing, seeds, fertilizer application, planting dates, inputs, etc). To do so, it will partner with the NARES (National Agriculture Research and Extension Systems) in collaboration with WARDA and IFDC to enhance the availability and utilization of these inputs. The specific steps will involve:

- Improving research-extension farmer linkage so that the farmers have access to improved seeds and fertilizer technologies and good agronomic practices.
- Introducing innovative ways of affordable seed multiplication and quality control mechanisms.
- Improving input credit facility based on international or regional experience.

WAIPRO has identified priority interventions which have been identified through engagement with partners, as follows:

- Improving water conveyance and distribution systems and in-field water management
- Strengthening Water Users Associations
- Enhancing linkages with support services

The project will incorporate a strong element of ensuring solutions are environmentally and economically sustainable. To this end, IPM/GAP solutions and pesticides are analyzed in this PERSUAP. Furthermore, inputs are perceived as costly by farmers, and often not used.

Under Environmental impacts, WAIPRO stated: "The project activities are judged to have no negative effect on the natural or physical environments. In fact, some of the activities such as rehabilitation of reservoir catchment positively contribute to the environmental health." The use of pesticides by beneficiary farmers does increase risks to human health and environment, which is the reason this PERUSAP is being performed.

2.3 Pesticide Regulations in Burkina Faso and Niger

Most developing countries have modeled their pesticide regulations after the UN Food and Agriculture Organization's Code of Conduct for Pesticide Safety, which itself is modeled after pesticide regulations and best practices found in the USA as well as in European countries. Amendments to these regulations are generally made when new information becomes available as well as on pressure from international environmental treaties at one end of the spectrum, and the pesticide industry's desires at the other end. Increasingly, the two ends of this spectrum are beginning to dovetail and work together for new, better, less toxic and more environmentally sound choices.

CILSS-INSAH countries, including Burkina Faso and Niger, have regionally homologized pesticide registrations.

2.4 WAIPRO Fertilizer Risks

Fertilizers and USAID Environmental Procedures (22 CFR 216)

Fertilizers are frequently lumped together with pesticides under the generic heading of "agro- or agrichemicals." From an environmental compliance perspective (22 CFR 216), as well as from a field-level implementation point of view, this is inappropriate, because it implies that fertilizers require the same level of scrutiny reserved for pesticides. Whereas pesticides are subject to clearly defined environmental review procedures and an approval process to promote safer use and integrated pest management, such procedures do not apply to fertilizers (procurement procedures do apply to quantity bulk purchase). As with any technology, however, it is recommended that fertilizers be thoughtfully employed according to best practice, promoting integrated soil fertility management, within the context of the prevailing biophysical and socio-economic conditions, as well as the desired outcomes.

For instance, the use of fertilizers may increase water and soil pollution, eutrophication of water bodies, soil acidification, and loss of microbial decomposers and with them, soil nutrients. Incorrectly applied fertilizers or manures can migrate from a farmer's field to local water sources, causing environmental harm and adversely affecting human health and activities. Nutrients from manures/fertilizers can also cause nutrient loading in local water bodies, resulting in degraded water quality, reduced wildlife, fish and mollusk populations, and toxic algal blooms. Moreover, such reductions in water quality can impact other uses of water bodies as well, such as drinking water, sanitation, fishing, aquaculture, recreation and tourism, and other farms.

General Soil Fertility Trends in Africa --

- Farmers who have taken measures to conserve moisture or increase soil organic matter are more likely to use inorganic fertilizer. When farmers in some areas have capital, they often invest first in increasing moisture retention and/or increasing soil organic matter and secondly in inorganic fertilizer.
- Farmers increase their use of fertilizer when investing more money in fertilizer is seen to be the best available option. This increase may result from changes in any of the following: fertilizer price, crop price, fertilizer availability, water availability, seed availability, knowledge about fertilizer use, or cropping pattern.
- In West Africa, Integrated Soil Fertility Management (ISFM) is progressively adopted. It concerns the combined use of soil amendments and inorganic fertilizer, leading in time to improved soil fertility and increased fertilizer use efficiency and profitability. The nutrient losses to the environment are decreasing.
- Given past and current use rates, USAID's fertilizer-related activities in Africa are unlikely to cause environmental problems**.**

Potential negative environmental effects of fertilizers --
Excessive application of nutrients over time can cause pollution. Such losses may occur when nutrients run off the land caused by heavy rainfall, are leached through the soil, beyond the root zone, eventually reaching the groundwater, or escape into the atmosphere as volatile gases.

Nitrogen fertilizers: Inorganic nitrogen fertilizers are readily converted by soil organisms to nitrate in the soil. The nitrogen in soil organic matter and organic fertilizers becomes available more slowly. Nitrates may be readily leached if not used by crops or other vegetation. Leaching is particularly likely in sandy soils following heavy rainfall. Leached nitrates may contaminate underground water. This is of concern if the water is to be used for human or livestock consumption, as high concentrations of nitrate may affect health.

Nitrogen fertilizers can also accelerate the natural process of soil acidification. Some fertilizers (e.g. anhydrous ammonia and urea) may initially raise the soil pH at the site of application but in the long term acidify the soils. This occurs when ammonium is converted to nitrate. Acid produced in the nitrification process is used if the nitrate is taken up by plants or soil organisms, but if the nitrate is leached beyond the root zone, acidification occurs. Soil acidification reduces the availability of the trace element molybdenum, fosters the development of aluminum, iron and manganese toxicity and increases nodulation failure in legumes. Lime may be required where acidity is a problem (obtained from naturally occurring calcium carbonate) or the use of acid tolerant plant species can be considered. An illustrative list of crops with acid tolerant varieties include: rice, cassava, mango, cashew, citrus, pineapple and cowpeas.

Phosphorus fertilizers: Excess amounts of phosphorus have been associated with algal blooms and the eutrophication of lakes and waterways. In most bodies of water, phosphorous is usually present in very low concentrations and thus functions as a growth-limiting factor. Algae only require small amounts of phosphorous to live. Excessive phosphorus over-stimulates the growth of algae, which could deplete the water of the dissolved oxygen that is vital to other aquatic life. Phosphorus is relatively immobile in the soil, so conservation and cultural practices which reduce soil erosion can significantly reduce phosphorus inputs into water bodies and the water table.

Phosphorus fertilizers contain various impurities from the phosphate rock and acid used in manufacturing the fertilizer. Cadmium increases is the greatest concern as its compounds are toxic to human beings. Cadmium increases are most noticeable in certain crops e.g. potatoes and leafy vegetables (lettuce and spinach) and in the organs (kidneys and liver) of animals. Almost all phosphate fertilizers contain traces of cadmium, and the concentration of cadmium varies considerably from source to source. At this time, there are efforts underway in West Africa to develop viable processes to remove cadmium from phosphate rock. Exports of rock phosphate represent a vital source of revenue for a number of developing countries in Africa.

Fertilizer Effects on Soil Biology: Good soil consists of 93% mineral and 7% bio-organic substances. The bio-organic parts are humus (85%), roots (10%) and soil organisms (5%). Most of the soil organisms are decomposers (bacteria and fungi), which are responsible for nutrient retention in soil. In order for nutrients to become available they must be mineralized by the interaction of decomposers and organisms that feed on the decomposers (protozoa, nematodes, micorarthropods and earthworms). Plant growth is dependent on microbial nutrient immobilization. When the number of decomposers declines in soils, more nutrients are lost into the ground and surface water. Heavy treatments of chemical fertilizers can kill decomposers and other soil organisms, which will lead to a reduction in nutrient retention and possible surface and ground water contamination.

Importance of Water Management to Nutrient Uptake
Proper water management is important for maximizing crop use of nutrients. About 97% of crop nutrient uptake is from soil solution (water-soluble nutrients), which makes water by far the most important nutrient or fertilizer delivery medium. This also means that, for the most part, nutrient mobility is directly linked to water movement. In sandy soils, nutrients move more quickly through the root zone and soil profile than in other soil types, and excessive water application (or heavy rainfall) can lead to nutrient loss through leaching. Run-off is most serious on loamy-sands or sandy loams that often have a strong surface crust formation. In heavier soils (clays), if nutrients are not adequately incorporated into the soil, the chances for surface runoff in the event of heavy rains or over-irrigation are increased. Sound water management is especially important in rain-fed conditions common throughout Sub-Saharan Africa. Overall, good water management leads to a more efficient use of fertilizers and increased nutrient uptake and vice versa.

Fertilizer Application guidelines --

- Before applying fertilizers, do soil testing to obtain an assessment of soil conditions like composition, structure, pH and fertility.
- Indiscriminate use of chemical fertilizers should be avoided.
- Different kinds of fertilizers are required in order to maintain a given level of soil fertility. This depends on site-specific factors, including the soil type, the nutrient requirement of the crop and the various sources of available nutrients. Nitrogen and Phosphorous are the most important nutrients lacking in SSA soils.

- Fertilizer application has to be considered in the context of the overall farming system. This includes the use of organic manure and residues, soil cultivation and crop rotation and water harvesting. Collectively, these factors influence the efficiency of nutrient use.
- When fertilizers are used, it is very important to apply the correct amount for the given situation. The challenge to the farmer is to match as closely as possible the input of nutrients to the nutrient uptake of the crop, thereby minimizing losses. Over fertilization is both costly (wasteful) and potentially harmful to the environment. To apply the correct amount, the farmer has to define his production goal.

A summary of best management practices for soil fertility and health --

- Practice Integrated Soil Fertility Management (ISFM) – the use of both organic and inorganic sources of nutrients rather than either alone;
- Use of legume cover crops (plus phosphorous) and green manures by fallow rotation or intercropping;
- Promote agroforestry practices – in addition to soil conservation and production benefits, agroforestry transfers/cycles nutrients from within the soil profile (deeper levels to surface);
- Use conservation tillage rather than deep plowing (although conservation tillage can be harmful for production systems in certain regions);
- Use farm site manures and household wastes, with or without composting;
- Choose crops and associated plants that have high nutrient use efficiency.

2.5 WAIPRO Pesticide Risks

In West Africa, the countries of Ghana, Cote d'Ivoire, Senegal and Burkina Faso maintain the largest pesticide production sectors, with several companies importing pesticide active ingredients from China, India, France, UK and other countries to be formulated (mixed with other ingredients and packaged) into final products for sale in the country or region. Most of these pesticides are made for high-value cash export crops like cotton, cacao, coffee, oil palm and others.

French-speaking West African countries maintain strong ties with French companies as well as multinationals and other interests that generally have French membership or agreements. English-speaking countries maintain strong ties with British companies. One general trend is that there are fewer Chinese products found in the French-speaking countries when compared with English-speaking countries.

Issues arise when banned, highly-restricted (PIC), prohibited (POPs) or recently de-registered products like HCH, dieldrin, lindane, endosulfan and heptachlor move from countries that formulate or import pesticides to those where they are not registered or permitted. Some of these riskier pesticides also enter through normal ports of entry, albeit via informal (illegal) arrangements.

In every country or region, there exist factors that increase or decrease the risk profile of the agrochemical inputs system. These risks have been categorized into groups and enumerated below as "Factors that Increase Risks from Agrochemicals" and "Factors that Reduce Risks from Agrochemicals." Most of the farmers producing crops being promoted by WAIPRO have the potential to use several highly toxic pesticides in traditional cropping systems.

Factors that indicate *Increased* risks from pesticides

- Endosulfan, a highly politicized chemical recommended for addition to international POPs and PIC lists, is still readily available in WAIPRO countries and was found on a potential WAIPRO field site.
- Fumigant aluminum phosphide is a highly toxic compound which routinely kills unintended victims in developing as well as developed countries, and is still readily available in WAIPRO countries for small-holder purchase and use.
- Some small plastic bags of HCH, lindane (PIC chemicals) and Thioral (contains heptachlor—a POPs and PIC chemical) are making their way into informal markets for sale to farmers in southern Burkina Faso.
- WAIPRO beneficiary farmers and some staff have limited knowledge and understanding of the pesticide sector in their own country, and to some extent the major pests that attack their crops and the IPM measures to use to mitigate these pests.
- Across West Africa, one can encounter pesticides beyond their expiration date (obsolete) for sale to farmers and pesticide labels in the language of the importer or formulator, but unavailable in local languages, or with insufficient safety information
- Many farmers are illiterate and will not be able to read pesticide label information or other warning media (however, they can be trained to recognize safety pictograms)
- Lack of knowledge by most farmers and farm laborers of the acute, and especially chronic, human health risks of individual pesticides or classes of pesticides.
- Most demonstration and small-scale farmers and farm workers have not had adequate training in best practices for safe pesticide use (PPE, transport, storage, application, and disposal).
- Most WAIPRO demonstration farmers will not have access to, will not be able to afford, and will not use recommended PPE for pesticide application
- Most farmers, and even some NARs staff, cannot positively identify specific crop pests, and cannot positively identify beneficial predators, diseases and parasites of pests
- Overuse, improper applications, and routine use of the same pesticides increases risk of the development of pesticide resistance among pests.
- Lack of knowledge of when to use a specific pesticide during the life cycle of the pest leads to ineffective pest control, waste of funds, and potential human hazards.
- There are insufficient funds for enforcement of pesticide regulations.
- Due to small scale of farm operations (1 ha or less), farmers do not have the same economies of scale and resources available in highly-developed countries to manage risk.
- It is very common in West Africa to encounter unregistered, and sometimes registered substandard quality products (pesticides aldultered, spiked with organochlorine compounds, or containing highly-toxic manufacturing byproduct chemicals) from select Chinese and Indian companies that make their way through informal and formal market sectors.

Factors that *Reduce* risks from pesticides

- WAIPRO activities will involve demonstrations to farmers by well-trained staff, so there is a possibility for the transfer of safe pesticide use practices
- Burkina Faso and Niger have lists of regularly-updated pesticide products registered for import to and use, reflecting a certain level of responsibility

- Some pesticide sellers in the region understand most important crop production pests, pesticides/dosages to use against the pests, risks that come with pesticide use, and the need for PPE
- There is no field evidence of pesticide misuse leading to poisonings of domestic animal or environmental poisoning (like fish kills).

Although there are a few positive factors, there still remain numerous issues above that can increase the risk for pesticide errors to occur. This situation increases the risk of exposing small-scale farmers, laborers, farm family members near demos as well as some unaware NARs staff to dangerous poisons, and polluting their environment. Thus the pesticide risk profile for WAIPRO countries varies from country to country but is higher than might be encountered in more developed countries, so extra care is required.

2.6 Good Agriculture Practices, IPM and Natural Resources Conservation

While pesticides are considered an integral part of IPM, and IPM is considered to be USAID policy, the use of pesticides needs to be judicious and cautious. That includes so-called ‘natural’ pesticides like extracts from naturally-occurring plants, minerals and microbes as well as those synthesized in a laboratory or factory, but with low toxicity.

IPM – without the synthetic chemicals – has generally been a basic philosophy and strategy for Organic crops and markets for over 20 years. Since the early 2000s, IPM practices have been making their way into market-driven GAPs (GlobalGAP, British Retail Consortium-BRC, Fair Trade, Organic and others) S&C systems. Food safety incidents and food poisoning deaths have been publicized in domestic and international news, and have hastened the pace for GAP adoption. GAPs are also referred to as agriculture and pesticide use Best Management Practices (BMPs).

Numerous IPM practices are in place and used in Europe and the USA as well as in numerous tropical countries for high-value crops like coffee, cacao and some fruits, and they are being actively used by Organic as well as some trained conventional farmers. High fuel costs drive up the costs for most synthetic fertilizers and pesticides, which increases the cost-effectiveness of other types of production and pest control tactics (the rest of the IPM tool basket), as well as tolerance or acceptance of sub-critical (and sub-economic) levels of pest infestation and damage.

A good definition of IPM (from UC-Davis[2]):

“Integrated pest management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through 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 [pesticides] are selected and applied in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment.”

The bases for these GAP and IPM systems are as follows:

[2] http://www.ipm.ucdavis.edu/IPMPROJECT/about.html

The use of GAPs ensure the production of strong, vigorous plants (that can resist or tolerate pest damage) and safe food, while IPM focuses on decreasing risks from certain pests and other constraints to production.

GAPs emphasize maintaining proper plant health, and thus *prevention* of problems, through use of:

- Quality hybrid pest- and constraint-resistant treated seed;
- Proper land preparation and tillage such as sowing in raised-bed plantings;
- Soil fertility testing, monitoring and management;
- Water and soil moisture testing and management to avoid salinity, bacterial and chemical contaminants, and soil-borne diseases;
- Nutrient management through use of combinations of biological and mineral fertilizers;
- Organic matter management through use of manures, composting, and mulching;
- Proper pesticide choice, storage, use and disposal.

IPM can include possible pest management techniques and tools including:

- Pest scouting, monitoring, and identification for accurate decision-making;
- Cultural methods that promote pest avoidance and a healthy plant that can better tolerate or resist pests. These methods include, but are not limited to, use of resistant varieties, early/late plantings/harvestings, crop rotation, pruning, destruction of crop residues and pest refuge plants near fields, and GAP practices.
- Natural pest control by encouraging and protecting parasitoids, predators, and pest diseases (i.e. planting predator-attracting plants/flowers on field margins);
- Mechanical weed or insect pest control using manual, hoe and machine practices;
- Chemical practices such as use of judicious, knowledgeable, and safe application of synthetic and 'natural' (derived from nature; extracted from plants, microbes, and other organisms) pesticides.

The strongest selling points for IPM beyond the health and environmental benefits are:

- IPM is more effective than synthetic pesticides in the long run;
- IPM is less damaging to essential soil health and nutrient cycling;
- IPM generally requires less capital (but more labor) investment;
- IPM can be used preventatively to eliminate or minimize the need for "responsive" controls (e.g. applying pesticides after a pest outbreak occurs to an already damaged area).

Annex 3 contains a well-tested 1980s IPM Planning and Design Protocol developed by scientists and extension staff from the UN's Food and Agricultural Organization (FAO) for use in Indonesian rice ecosystems, with augmentation and modifications to bring the protocol and recommendations up to date to 2010. It contains ten steps for understanding and implementing an IPM plan.

An IPM plan is basically a management plan, similar to those in use in the business community. As such, the design of an IPM program can be developed with all of the fundamental parts of any good management plan.

The vital parts of an IPM plan include a definition or understanding of:

- primary beneficiaries (small, medium or large-holder farmers);
- secondary beneficiaries (marketers, processors, transporters, and consumers);
- farm laborers, WAIPRO extension personnel and WAIPRO field staff;
- national, regional and international organizations involved in production and IPM;
- listed pests or production constraints (problem identification);

IPM strategies incorporated into a PMP by pest or production constraint (solution planning) over a typical growing season, with available options for first preventing, and if prevention is insufficient, then ramping up management of production constraints.

Natural Resources Conservation

Natural resources need to be conserved and protected in order to strengthen the agroecosystem. The following is a list of these resources.

Environmental services provided by many critical resources (and can be negatively impacted by pesticides).

Critical Resource	Beneficial Function (services provided)
Diverse forest cover	Fruits/nuts/medicines, increase biodiversity, reduce erosion, increase soil fertility, recreation/tourism, purify air, mitigate floods/droughts & maintain watersheds
Quality clean water	Crop irrigation/nutrition, processing agricultural produce, bathing/drinking water services
Rich soil microbial/chemical health	Pest management and plant nutrition services
Fish	Human food, ecosystem web functioning and services
Honeybees	Crop pollination services, proper ecosystem web functioning services
Birds	Field pest management services, proper ecosystem web functioning services
Reptiles	Field pest management services, proper ecosystem web functioning services
Amphibians	Proper aquatic ecosystem web functioning and services
Earthworms	Proper soil fertility and friability services
Mollusks	Human food and aquatic ecosystem services
Crustaceans	Human food and aquatic ecosystem services
Aquatic insects	Proper aquatic ecosystem web functioning and services
Plankton	Proper aquatic ecosystem web functioning and services

SECTION 3: PESTICIDE EVALUATION REPORT

This part of the PERSUAP, the PER (Pesticide Evaluation Report), addresses pesticide choices based upon environmental and human health issues, uses, alternate options, IPM, biodiversity, conservation, training, PPE options, monitoring and mitigation recommendations according to the twelve Regulation 216.3(b)(1) Pesticide Procedures Factors, outlined and analyzed below.

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 USEPA without restriction, the Initial Environmental Examination 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, right)

THE 12 PESTICIDE FACTORS

Factor A. *USEPA Registration Status of the Proposed Pesticides*

Factor B. *Basis for Selection of Pesticides*

Factor C. *Extent to which the proposed pesticide use is, or could be, part of an IPM program*

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

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*

Factor F. *Effectiveness of the requested pesticide for the proposed use*

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

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

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

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

Factor K. *Provision for training of users and applicators.*

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

3.1 Factor A: USEPA registration status of the proposed pesticide

WAIPRO activities are effectively limited to mentioning during training, recommending or permitting pesticides containing active ingredients (AIs) in products registered in Burkina and Niger, and in the US by the EPA for the same or *similar* uses. Emphasis is placed on "similar use" because a few of the crops and their pest species found overseas are not present in the US, and therefore pesticides may not be registered for the exact same use, but often are registered for similar pests and pest situations. Annex 7 provides EPA registration status for each AI found in Burkina and Niger.

The USEPA now categorizes pesticides as either "registered" or "not registered." Moreover, some AIs and products containing them are labeled as Restricted Use Pesticides (RUPs). In the US, the pesticides and active ingredients that are labeled RUPs 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, or tree crops, or structural pests and so on). It is very important to note that in many cases EPA's intent for restriction is based upon a large scale of production found in the USA, often hundreds or thousands of hectares, where errors can magnify risks and impacts. In developing countries like Burkina and Niger, scale is often no more than 1 hectare, with scattered and asynchronous pesticide applications that are much less likely to lead to the same magnitude of errors and impacts. Thus, USAID considers such RUP pesticides very carefully, with an eye on EPA's intent and issues of scale. Annex 7 provides EPA RUP designation status for each AI found in Burkina and Niger.

The USEPA classifies pesticides according to actual toxicity of the formulated products, taking– formulation types and concentrations into account, thus generally making the formulated product less toxic than the active ingredients alone. This method of classifying acute toxicity is more accurate and representative of actual risks encountered in the field. By contrast, the WHO acute toxicity classification system is based on the active ingredient only (see Annex 6 for a comparison of USEPA and WHO acute toxicity classification systems), and although WHO deals primarily with pesticides used in health applications (e.g., indoor residual spraying for elimination of malaria vectors), the classification has been adopted more generally by the UN to include agricultural pesticides.

WHO has classified pesticides by human toxicity and developed a color-coding scheme easily-recognizable to illiterate farmers, such as some of those in Burkina and Niger.

WHO Acute human toxicity	Pesticide Label Color Code	Signal Words
Class Ia- Extremely hazardous	**Red**	Very Toxic
Class Ib- Highly hazardous	**Red**	Toxic
Class II- Moderately hazardous	**Yellow**	Harmful
Class III- Slightly hazardous	**Blue**	Caution
Class U- Unlikely to present acute hazard in normal use	**Green**	Caution

Issue: Products containing active ingredients not EPA-registered

Annex 8 lists CILSS-registered pesticide AIs that are not registered by EPA in any products. Products and AIs that are not registered by EPA are *not permitted* for use on USAID-supported projects (and therefore cannot be promoted during training or used on WAIPRO demonstration farms). They are either cancelled for use in the USA, or have insufficient market demand, and have thus not been through EPA's battery of environmental and human health tests.

Recommendations for Mitigation

- WAIPRO's beneficiaries do not use products containing these active ingredients that are not EPA registered (see Annex 8).

Issue: Restricted Use Pesticides (RUPs)

The EPA has developed a system for dealing with pesticides with inordinate risks to human health and/or environment for various uses. In the USA, farmers who wish to purchase and use RUPs must receive (and pay for) specialized training and certification to increase awareness of the risks and ways that can be used to mitigate these risks. These *Certified Applicators*, or those under their direct supervision, must follow the pesticide label instructions and only use the product for purposes covered under their certification. Further, in the USA, some states may require that certain active ingredients not listed on the Federal list be classified as "restricted" in their states due to local conditions, generally related to environmental concerns.

The 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*.

As noted above, in quotes under 3.0, Regulation 216.3 (b)(1)(i), "pesticides registered for the same or similar uses by USEPA *without restriction…*". The interpretation of "without restriction" is that approved pesticides will not be RUPs, regardless of RUP criteria or basis (the reason they are designated as RUPs). It is important to note that RUPs may be designated as such, by EPA, due to either: 1. Inordinate risk (hazard) to users; or 2. Inordinate risk to the environment; or 3. Sometimes both. Regulation 216 considers this distinction and deals with it in subparts (ii) and (iii) as follows (italics inserted):

"(ii) When a project includes assistance for the procurement or use, or both, of any pesticide registered for the same or similar uses in the United States but the *proposed use is restricted by the USEPA on the basis of user hazard*, the procedures set forth in §216.3(b)(1)(i) above will be followed. In addition, the Initial Environmental Examination will include an *evaluation of the user hazards associated with the proposed USEPA restricted uses* to ensure that the implementation plan which is contained in the Project Paper incorporates *provisions for making the recipient government aware of these risks and providing, if necessary, such technical assistance as may be required to mitigate these risks*. If the proposed pesticide use is also *restricted on a basis other than user hazard* [for example for risk to environment], the procedures in §216.3(b) (l) (iii) [below] shall be followed in lieu of the procedures in this section."

Thus, if user hazard is evaluated, if the recipient government is made aware of these risks, and if required technical assistance can mitigate these risks, it appears that a RUP may be used, particularly if the primary hazard is to the environment and not the user.

Regulation 216 goes on and continues to consider RUPs in subpart (iii) as follows (italics inserted):

"(iii) If the project includes assistance for the procurement or use, or both of:

(a) Any pesticide other than one registered for the same or similar uses by USEPA *without restriction or for restricted use on the basis of user hazard*; [as opposed to environmental hazard] or

(b) Any pesticide for which a notice of rebuttable presumption against re-registration, notice of intent to cancel, or notice of intent to suspend has been issued by USEPA,

The Threshold Decision will provide for the preparation of an Environmental Assessment or Environmental Impact Statement, as appropriate (§216.6(a)). The EA or EIS [Environmental

Impact Statement] shall include, but not be limited to, an analysis of the factors identified in §216.3(b) (l) (i) above."

No further distinction is made in Regulation 216 for RUPs that are designated as such on the basis of risk to environment. Several of the active ingredients in pesticides being imported to WAIPRO countries are designated as RUPs by the USEPA (compiled in Annex 7) and the RUPs that carry inordinate risks to human health are not to be promoted or used on WAIPRO (see Annex 8).

Recommendations for Mitigation

- WAIPRO's beneficiaries do not use products containing these active ingredients that are designated by EPA to be RUP based on acute risk to human health (see Annex 8).

RUP Exception Justification

Most pyrethroid active ingredients, including those extracted from plants like pyrethrum, pyrethrins as well as synthetic pyrethroids (made in a laboratory) are labeled RUP for agricultural use in the USA due mostly to aquatic ecotoxicity. EPA's RUP classification takes into account scale of production on USA farms – often hundreds of hectares – a scale rarely matched overseas in developing countries. Synchronous and intensive use by American farmers of a RUP chemical on hundreds of hectares near a watershed can indeed lead to negative impacts, so USA farmers need to know how to mitigate those impacts through RUP training and certification. For farmers and associations producing on 2-5 hectares or often less, such as in WAIPRO countries, the small patches of land are scattered and pesticide application is likely to be asynchronous, greatly diminishing the potential risks.

Other factors that diminish the risks of RUP's to aquatic ecotoxicity are the following:

- the amount of pesticide and the area covered on WAIPRO farms is likely to be much less than for farmers in the USA, so risks to both applicator and environment are magnitudes of order lower;
- the overwhelming dilution affect further reduces risks to the aquatic environment.

Further, some synthetic as well as plant-extracted pyrethroids present several advantages to farmers in WAIPRO:

- they are relatively inexpensive,
- provide rapid pest knock-down,
- degrade relatively quickly in the environment,
- keep farmers from using much more acutely toxic chemicals, and
- are generally not highly acutely toxic to humans.

The key to their safe use is to understand and minimize risks to aquatic habitats and use recommended PPE.

Thus, this PERSUAP requests that exceptions found in Regulation 216, under section 216.3b, Pesticide Procedures, Part 1, Project Assistance, subparts (ii and iii) be invoked to permit the use by WAIPRO of a limited number of RUPs, mostly natural and synthetic pyrethroids, found in Annex 9, RUP exceptions. None of these are highly acutely toxic to humans.

Mitigation of RUP risks in WAIPRO

- *EA (Environmental Assessment):* If any pesticide active ingredients are specified to be RUPs based upon the criteria "human hazard" and WAIPRO beneficiaries wish to use them, a specific EA is required to assess and sufficiently mitigate such hazards.
- *Training/Repeated Message Enforcement:* For RUPs that pose a risk to the environment and natural resources, not human hazards, training is the best method for enforcing the message that certain targeted pesticides need to be used with care near (especially) aquatic environments.
- *Paid/Free Applicator Certification:* WAIPRO countries do not have pesticide applicator certification systems set up, so this measure would not likely work well until they do. Scale is the major reason. Further, WAIPRO country farming systems are very small in scale compared with American farming systems, and farmers do not have the resources or motivation to encourage such a certification system.

Additional Recommendations for Mitigation

- Do training on GAPs/IPM, the production and use of pest management plans and safe pesticide use and management. Training will introduce beneficiary farmers to: Pesticides not permitted for use, those the project recommends, and those that might be used with significant training and certification; IPM philosophy, tools and tactics; and Safe Pesticide Use practices including use of basic PPE.
- Get all project offices copies of commonly-used pesticide MSDSs to keep on-hand, with a source of exact information on risks and risk mitigations for each product, and what measures to take in case of an accidental spill, fire or poisoning. MSDS information can also be used during training.
- As this PERSUAP is amended, WAIPRO Project Managers will need to report to USAID changes to less toxic products on the list of pesticides recommended to USAID.

3.2 Factor B: Basis for Selection of Pesticides

This procedure generally refers to the practical, economic and/or environmental rationales for choosing a particular pesticide. In general, best practices and USAID – which promote IPM as policy – dictate that the *least toxic* pesticide that is effective is selected. Up until recently, the bases for selection of pesticides have most often been availability, efficacy, and price; not environmental or human safety. Farmers have wanted a pesticide that has rapid knock-down action to satisfy the need to defeat the pest quickly and visibly – they want to see the pest immediately drop on its back with legs twitching and flailing in the air as it dies.

Farmers using GAP systems for export crops or high-value local markets focus more on factors such as human safety and low environmental impact, by necessity as much as by choice. Such lower toxicity pesticides may take longer to kill the pest – usually after the farmer has left the field – but they are effective, nevertheless. Another factor of importance is the abeyance of pesticide-specific PHIs and MRLs, which can be influenced by choosing products with rapid post-application degradation. The three most common bases for traditional farmer pesticide selection for crops in Burkina and Niger are currently price, availability and efficacy.

Issue: Most farmers do not consider factors such as:

- Reducing risks to human health by using products that contain active ingredients with low acute human toxicity and few to no chronic health risks;
- Reducing risks to scarce and valuable water resources on the surface and underground;
- Reducing risks to biodiversity and environmental resources, and the services they provide.

Recommendations for Mitigation

- Choose and use pesticides with low human and environmental risk profiles (see decision matrix in Annex 7, MSDSs, and pesticide labels), as practical
- WAIPRO staff be aware of biological and naturally-derived pesticides, as practical, such as those listed in Annexes 4 and 5.
- During training courses, include training on pesticide selection factors based on findings and recommendations of this report, material found in MSDSs and pesticide labels, and material found on pest management websites (like UC Davis IPM site found at: http://www.ipm.ucdavis.edu/PMG/crops-agriculture.html) which can emphasize the importance of pesticide selection factors safety and environment.

3.3 Factor C: Extent to which the proposed pesticide use is, or could be, part of an IPM program

USAID promotes training in, and development and use of, integrated approaches to pest management tools and tactics whenever possible. This section emphasizes how the proposed pesticides used can be incorporated into an overall IPM strategy.

The susceptibility of crop plants to pests and diseases is greatly influenced by the general health of the plant, as discussed above in Section 2.6. Therefore, good crop management practices can strongly affect IPM, and good agronomic or cultural practices are the most basic and often the most important prerequisites for an effective IPM program. A healthy crop optimizes both capacity to prevent or tolerate pest damage while maintaining or increasing yield potential.

Issue: Most Burkina and Niger farmers are not aware of all of the IPM tactics available

Among the tactics used include resistant varieties, sanitation, raised-bed, proper water management, monitoring, hand-picking, trap crops, crop rotation, proper fertilization, deep plowing, soil solarization, and taking advantage of some naturally-occurring parasites. The analysis shows that there are plenty of areas for improvement among WAIPRO field staff and demonstration farmers.

Annex 1 shows a Crop-Pest-IPM-Pesticide matrix for each crop to be assisted by WAIPRO, most major pests of each crop, IPM tactics currently in use in Burkina and Niger, and a list of tools and tactics used for the same pests in developed countries, and recommended to be tried and adopted. In conclusion, some of the beneficiary farmers, whether or not they understand the IPM philosophy fully, do know about, and use some GAP and IPM tools and tactics. However, there is room for improvement as many tools/tactics remain unused, if not unknown.

Recommendations for Mitigation

- WAIPRO field staff assist with the production of crop and pest-specific Pest Management Plans (PMPs), using the attached Annex 1 containing Crop-Pest-IPM-Pesticide suggestions for all major pests on all crops, organized by crop phenology or seasonality, and developed into field technical flyers or posters
- During training and field visits by WAIPRO field staff, enhance understanding of, and emphasis on, IPM philosophy, tools and techniques for each crop-pest combination, with synthetic pesticide use as a last resort and choice of least toxic alternatives
- WAIPRO staff correct misuses of pesticides found in Burkina and Niger, such as the use of insecticides for fungal and bacterial diseases (see Annex 1).

3.4 Factor D: Proposed method or methods of application, including the availability of application and safety equipment

This section examines how the pesticides are to be applied, to understand specific risks with different application equipment available and application methodologies, and the measures to be taken (repeated training especially of younger future farmers, use of PPE) to ensure safe use for each application type. Pesticides can and do enter the body through the nose and mouth as vapors, through the skin and eyes by leaky sprayers, mixing spillage/splashing and spray drift, and mouth by accidental splashing or ingestion on food or cigarettes.

Most project pesticides will be applied by hand-pumped backpack sprayers (liquids) or by hand (powders and granules). Although most WAIPRO farmers do not use PPE, WAIPRO-supported projects will be promoting their use as a best practice.

Issue: Leaky back-pack sprayers

Hand-pump backpack sprayers, used by the poorest farmers among others, can and do eventually develop leaks at almost every junction (filler cap, pump handle entry, exit hose attachment, lance attachment to the hose and at the lance handle) and these leaks soak into exposed skin. Clothing serves to wick and hold these pesticides in contact with skin, and to concentrate them use after use, until washed.

Recommendations for Mitigation

- WAIPRO, as part of its provision of inputs, should include budget allocations for repair and maintenance of application equipment, and develop a management program that includes oversight of repair and maintenance by a selected member of a farmer cooperative or association.

Issue: Pesticide granules and powders applied by hand

Most farmers that use pesticides formulated as granules or powders apply these by hand, with benefit of gloves. Gloves should be used for these applications, especially granules as these are often highly toxic chemicals like carbofuran (which should not be used by WAIPRO farmers).

Recommendations for Mitigation

- WAIPRO ensure that farmers that use powders or granules, do so only with gloves.

Issue: WAIPRO farmers do not use PPE

Reasons that many WAIPRO farmers do not use PPE to reduce pesticide exposure risks include:

1. Farmer workers either discredit or do not completely understand the potential health risks associated with pesticides. Since they have not associated health problems with pesticide exposure they continue to take risks;

2. Climatic conditions (particularly heat) make it uncomfortable to use the equipment (despite the fact that it is recommended that many pesticides should be applied very early in the morning when it is cool and there is a lack of wind and rain);

3. Appropriate PPE (especially carbon cartridge respirators necessary for filtering organic chemical vapors) equipment is generally not available at all and if it is available, it is too expensive;

4. Farmers may not understand either the warning labels or pictograms provided on the pesticide labels.

Most pesticide containers, on each pesticide label, either list or put pictograms showing PPE that is recommended for use of that certain product.

Recommendations for Mitigation

- Training under WAIPRO should include descriptions of health risks to spray operators, their families, and their village (see risks for each pesticide AI in Annex 7).
- Training should include advice on minimizing discomfort from wearing PPE, like spraying in early morning before it becomes hot, or late in the afternoon.
- Ensure that (i.e., budget for) protective clothing (carbon-filter respirator mask, gloves, long-sleeved shirt and pants or Tyvec outfit, boots, and goggles if indicated on the label) are available to farmers and farm workers involved with pesticide use. General examples of PPE to be used for different types of pesticide are found in the following website: http://www.epa.gov/oppfead1/safety/workers/equip.htm.
- Provide training on the need for exclusion times and zones for areas that are being or have been sprayed. Include information about sensitive populations (pregnant women, children, elderly, sick).
- Put into place sprayer equipment maintenance procedures, proper spray techniques that reduce sprayed area walk-through, as well as frequent washing of application clothing.
- Considering illiteracy issues, training should use and explain pictogram representations. Some general mitigation measures to ensure safe pesticide use are contained in Chapter 13 of the following website: http://pdf.usaid.gov/pdf_docs/PNADK154.pdf.
- Set out a schedule for, and budget for, continuous training in safe handling and use of pesticides – including aspects such as types and classes of pesticides, human and environmental risk associated with pesticides, use and maintenance of PPE, understanding information on labels and proper disposal of packaging. Ensure that training ‘sticks’ by developing a system to certify trained farmers for safe use.

3.5 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

This section of the PERSUAP examines the acute and chronic toxicological risks associated with the proposed pesticides.

The pesticide matrix in Annex 7 contains information on acute and chronic human and environmental toxicological risks for every pesticide AI registered by Burkina and Niger. USAID-supported projects must be limited to EPA-registered pesticides, and decisions should be biased toward those pesticides with lower human and environmental risks. Nevertheless, pesticides are poisons, and nearly all of them present acute and/or long-term toxicological hazards, especially if they are used incorrectly. For instance, the WHO estimates that about 220,000 acute pesticide poisoning occur per year globally[3.] And, in the Benin cotton sector, farmers are routinely poisoned to death by endosulfan and its residues on vegetables[4.]

Issue: Pesticide Active Ingredients on POPs and PIC lists

The Persistent Organic Pollutants (POPs) and Prior Informed Consent (PIC) Treaties which list banned and highly regulated chemicals, respectively, were not known when Regulation 216 was written, so there is no language directly governing their use on USAID projects. Nevertheless, they present high risks to users and the environment. It is thus prudent that they be discussed. The following websites contain current lists of all POPs and PIC chemicals: http://www.pic.int; http://www.pops.int.

Heptachlor—one of the AIs found in the pesticide Thioral (found being recommended for use in Burkina and Niger) and HCH found in Banfora in informal (illegal) markets. Endosulfan has been nominated for addition to the POPs list (2009) and the recent (June 2010) phase out and ban in the USA will hasten this decision.

Recommendations for Mitigation

- None of these POPs or PIC chemicals, listed in Annex 8, should be used on WAIPRO beneficiary farms.

Issue: Very high acute toxicity

A few of the pesticides found on CILSS' list of pesticides registered for import contain active ingredients that are EPA Class I or WHO Class Ia or Ib, which are *too toxic for small-scale (USAID's target), unaware and uninformed farmers to use*. These very highly acutely toxic pesticide AIs are found in Annex 8. Less toxic alternatives exist for all of these Class I chemicals, and should thus be used.

Recommendations for Mitigation

- With the exception of rodenticides and copper-containing products, WAIPRO's beneficiaries may not use products containing active ingredients that are WHO Class 1a or 1b, or EPA Class I acute toxicity (see Annex 8).

[3] http://magazine.panna.org/spring2006/inDepthGlobalPoisoning.html
[4] http://www.panna.org/resources/panups/panup_20080403

Issue: Moderate acute toxicity

All pesticide products that have at least acute WHO and EPA toxicity ratings of II (see Annex 7) are considered to be *too toxic for use without farmer training and proper use of PPE*.

Recommendations for Mitigation

- Products containing active ingredients with Class II acute toxicity ratings (see Annex 7) should not be recommended unless there are no safer effective alternatives (Class III or IV).
- Moreover, recommendations should not be made to use such products unless it can be ascertained that appropriate training and PPE are available *and will be used*.

Issue: WAIPRO use of lower toxicity Pesticides registered by EPA

Even EPA Class III and IV and WHO Class III and U pesticides, mostly classified as General Use Pesticides (GUPs), sold to the public at large in the USA, may present acute and chronic human health and environmental risks (see decision matrix in Annex 7). In sufficiently high doses, they may kill or harm humans or the environment. Thus pesticide safe use and handling training and practice are required for their use as well as for more toxic products.

Recommendations for Mitigation of Human Toxicological Exposures

Most pesticide poisonings result from careless handling practices or from a lack of knowledge regarding the safer handling of pesticides. Pesticides can enter the body in four major ways: through the skin, the mouth, the nose, and the eyes. Chapter 13 in the web site resource http://pdf.usaid.gov/pdf_docs/PNADK154.pdf contains measures to reduce risks of exposure via oral, dermal, respiratory and eyes. The time spent learning about safer procedures and how to use them is an investment in the health and safety of oneself, one's family, and others.

- WAIPRO field staff should encourage the demonstration farmers with whom they work as partners to not use POPs or PIC products (Thioral, Endosulfan, HCH), or products containing very highly toxic active ingredients.
- Train farmers and provide posters/flyers on pesticide safe-use BMPs. For each group of farmers to be trained, identify the pesticides most likely to be used on their specific crops, and then identify the human health risks associated with each by using information on pesticide labels, in the attached Annex 7, and on MSDSs.
- Provide training on, and follow basic first aid for pesticide overexposure. Train farm managers and farmers on basic pesticide overexposure first aid, while following recommendations found in Chapter 13 of http://pdf.usaid.gov/pdf_docs/PNADK154.pdf, as well as any special first aid information included on labels and MSDSs for commonly-used pesticides.

Recommendations for Mitigation of Exposures to Environmental Resources

Ecotoxicological exposures can be mitigated by adhering to the following do's and don'ts:

Do's

- Emphasize and use IPM practices in crop production
- Read and follow pesticide label instructions

- Choose the pesticide least toxic to fish and wildlife (see Annex 7)
- Protect field borders, bodies of water and other non-crop habitats from pesticide
- Completely cover pesticide granules with soil, especially spilled granules at the ends of rows
- Minimize chemical spray drift by using low-pressure sprays and nozzles that produce large droplets, properly calibrating and maintaining spray equipment, and use of a drift-control agent
- Properly dispose of chemical containers (provide training on what this means locally)
- Maintain a 2.5 to 5 km buffer no-spray zone around national parks, water bodies or other protected areas
- Warn beekeepers of upcoming spray events so that they may move or protect their hives

Don'ts

- Do not spray over ponds and drainage ditches
- Never wash equipment or containers in streams or where rinse water could enter ponds or streams
- Do not use pesticides with potential or known groundwater risks near drinking water sources, or where the water table is less than 2 meters, and on sandy soils with high water tables
- Do not apply pesticides in protected parks
- Do not use aerial applications near sensitive habitats
- Do not spray when wind speeds are more than 8 to 10 mph
- Do not apply granular pesticides in fields known to be frequented by migratory waterfowl
- Do not apply insecticides from 10 am to 4 pm when honeybees are foraging; insecticides are best applied early in the morning when it is cool with no wind or rain, and when honeybees do not forage

3.6 Factor F: Effectiveness of the requested pesticide for the proposed use

This section of the PERSUAP requires information similar to that provided previously, but more specific to the actual conditions of application and product quality. This section considers the potential for use of low-quality products (such as many of those imported from China and India) as well as the development of pest resistance to proposed pesticides, both of which will decrease effectiveness (efficacy).

Issue: Lack of knowledge and information on pesticide effectiveness

Local knowledge is essential to choosing the correct pesticides. Local farmers know what has or has not worked for them in the past, and WAIPRO programs can increase local knowledge as to what is available, possibly effective, and presents the lowest risk.

Resistance of pests to pesticides used on WAIPRO crops is likely present in some degree. Many traditional farmers over- and under-dose and use non-selective pesticides, all of which increases chances for resistance development. At some point, WAIPRO field staff and demonstration farmers may begin to note that some products no longer work well to control pests in their field, and will likely begin to blame pesticide manufacturers for a weaker product. This could be the development of insecticide resistance, and it could be the result of improper dosing. Farmers should be trained to monitor for the development of insecticide resistance, and WAIPRO project implementers should be on the lookout for it during their field visits.

Recommendations for Mitigation

- Through training, WAIPRO field staff increase local knowledge on pesticides available, possibly effective, and present the lowest risk
- Teach farmers to rotate pesticides to reduce the build-up of resistance
- Monitor resistance by noting reduction in efficacy of each pesticide product

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

This section examines the potential effect of the pesticides on organisms other than the target pest (herein called critical resources). Non-target species of concern include fish, honeybees, birds, earthworms, aquatic organisms, and beneficial insects. The potential for negative impact on non-target species should be assessed and appropriate steps identified to mitigate adverse impacts; and this should be included in the WAIPRO project's Environmental Mitigation and Monitoring Plan (EMMP).

Annex 7 shows the relative known risks to the types of terrestrial and aquatic organisms referred to above for each pesticide active ingredient found in pesticide products registered by CILSS, so that informed product choices can be made if the pesticide is to be used in or near sensitive areas or resources.

Issue: Biodiversity, conservation and protected or endangered species

Critical natural resources to be conserved, with listings of the services they provide, are included above in Section 2.6. An Environmental Threats and Opportunities Analysis (ETOA, also called an FAA 118-119 Analysis) has been performed for Burkina (2007) and Niger (2008). Refer to those documents, found at http://www.encapafrica.org/bioformatrix.htm for details on critical resources negatively impacted by agricultural activities and pesticides use and misuse.

Issue: Pesticide Persistence

The effect of each pesticide on non-target ecosystems will depend on how long it stays in the environment, or rather its rate of break-down, or half-life. Half-life is defined as the time (in days, weeks or years) required for half of the pesticide present after an application to break down into degradation products. The rate of pesticide breakdown depends on a variety of factors including temperature, soil pH, soil microbe content and whether or not the pesticide is exposed to light, water, and oxygen.

Many pesticide breakdown products are themselves toxic, and each may also have a significant half-life. Since pesticides break down with exposure to soil microbes and natural chemicals, sunlight and water, there are half-lives for exposure to each of these factors. In the soil, types and numbers of microbes present, water, oxygen, temperature, pH, and soil type (sand, clay, loam) all affect the rate of breakdown. Most pesticides also break down, or photo-degrade, with exposure to light, especially ultraviolet rays. Lastly, pesticides can be broken down, or hydrolyzed, with exposure to water.

Recommendations for Mitigation

- Consider the toxicity, half-life and breakdown products of pesticides during the selection process.
- Avoid using pesticides in or within a 2km buffer zone from protected areas or national parks and where endangered species are known to exist.
- If agricultural production is done within 10km up-wind or up-stream from a protected area, investigate the use of botanical and biological controls, as practical, or produce Organic crops near these valuable natural resources.
- Apply pesticides early in the morning before honeybees forage. Do not apply during heavy rains or winds. Follow instructions on pesticide packaging.
- Apply pesticides at least 35 meters from open water.

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

In general, in addition to element G above, this requirement attempts to protect natural resources from the dangers of pesticide misuse and contamination, especially of groundwater resources.

Climate

WAIPRO operates within the Sahel and Savannah. The climate is hot and dry and characterized by a summer rainy season followed by a winter dry season.

Geography

The geography of characteristic WAIPRO countries is shown and discussed, above, in Section 2.1.

Hydrology

The average rainfall in the Sahel ranges from 10 cm in to 50 cm in per year. Major river systems in Niger and Burkina include the Niger and Volta Rivers. The relatively large amounts of pesticides likely to be used across the demonstration irrigation schemes can have a serious impact on these resources, especially if pesticides and fertilizers are used synchronously. Best practices, such as those listed above, should be followed.

Soils

See soil maps http://eusoils.jrc.ec.europa.eu/Esdb_Archive/EuDASM/Africa/index.htm for Burkina and Niger. Many of the soils are sandy and hardpan, meaning that pesticide leaching could be an issue for especially mobile pesticides (see Annex 7 for pesticide groundwater pollution potential) like herbicides.

Issue: Pesticide Soil Adsorption, Leaching and Water Contamination Potentials

Each pesticide has physical characteristics, such as solubility in water, ability to bind to soil particles and be held (adsorbed) by soil so they do not enter the soil water layers and the ground water table, and their natural breakdown rate in nature. This data can be found for the pesticides registered by CILSS by checking each pesticide on the following website: http://sitem.herts.ac.uk/aeru/footprint/en/index.htm. The water solubility, soil adsorption and natural breakdown rates, if available, are included throughout the webpage, for each parent chemical.

In general, pesticides with water solubility greater than 3 mg/liter have the *potential* to contaminate groundwater; and pesticides with a soil adsorption coefficient of less than 1,900 have the *potential* to contaminate groundwater. In addition, pesticides with an aerobic soil half-life greater than 690 days or an anaerobic soil half-life greater than 9 days have the *potential* to contaminate groundwater. Moreover, pesticides with a hydrolysis half-life greater than 14 days have *potential* to contaminate groundwater.

The potential for pesticides to enter groundwater resources depends, as indicated above, on the electrical charge contained on a pesticide molecule and its ability and propensity to adhere to soil particles, but this also depends on the nature and charge of the soil particles dominant in the agriculture production area. Sand, clay and organic matter, and different combinations of all of these, have different charges and adhesion potential for organic and inorganic molecules. Sandy soil often has less charge capacity than clay or organic matter, and will thus not interact significantly with and hold charged pesticide molecules. So, in areas with sandy soil, the leaching potential for pesticides is increased.

A pesticide's ability to enter groundwater resources also depends on how quickly and by what means it is broken down and the distance (and thus time) it has to travel to the groundwater. If the groundwater table is high, the risk that the pesticide will enter it before being broken down is increased. Thus, a sandy soil with a high water table is the most risky situation for groundwater contamination by pesticides. Groundwater contamination potential for each pesticide active ingredient available in Burkina and Niger is provided in Annex 7.

Recommendations for Mitigation

- Since transport of pesticides absorbed to soil particles is a likely transportation route to waterways, techniques should be employed to reduce farm soil erosion (such as terracing, employing ground covers between rows, planting rows perpendicular to the slope, using drip irrigation, etc.).
- Do not use herbicides or other pesticides with high leaching and groundwater pollution potential (see Annex 7) on highly sandy soils or soils with water tables close (2-3 meters) to the surface. Pay particular care when spraying near waterways, so that pesticides do not enter surface water.
- Do not spray synthetic pyrethroid or other pesticides with high toxicities to aquatic organisms before an impending rainstorm, as they can be washed into waterways before breaking down.

3.9 Factor I: Availability of other pesticides or non-chemical control methods

This section identifies less toxic synthetic, as well as non-synthetic or 'natural' (extracts of naturally-occurring plants, spices, oils, fatty acids, induced resistance elicitors, minerals, microbes or microbial extracts) pesticide options for control of pests, and their relative advantages and disadvantages. Many of these 'natural' pesticides can be toxic to humans, and several are even classified as RUP due to environmental risks; thus safe pesticide use practices extend to these natural as well as synthetic (produced in laboratories or factories) pesticides.

Issue: Natural pest controls availability

Natural chemicals: Many non-synthetic chemical IPM tools and technologies are listed in Annexes 8 and 9. The list of natural pesticides likely entering Burkina and Niger is not as extensive as other developing countries. Most synthetic nematocides and soil pesticides/fumigants are very highly toxic. However, there are some companies producing next-generation natural chemicals in the USA: Bio Huma Netics, http://www.bhn.name for natural nematocides and Agra Quest, http://www.agraquest.com for bioactive essential oils.

For commercial operations, especially greenhouses, biological controls and beneficial organisms are available commercially from two large international companies, Koppert of Holland and Biobest of Belgium. Koppert provides many biological controls against spider mites, beetles, leaf miners, mealy bugs, thrips, aphids, whiteflies, and moth and butterfly larvae. Koppert also provides the Koppert Side Effects List, a list of the side effects of pesticides on biological organisms, at http://www.koppert.com. Biobest of Belgium provides many of the same or similar biological controls as Koppert, and includes a control against leaf hoppers. Their website is: http://www.biobest.be. These are especially useful for greenhouse and seedling production systems. Both companies also sell live bumblebees for greenhouse pollination assistance.

Recommendations for Mitigation

- As appropriate, try low-risk natural chemical pest controls that are registered by CILSS and available.

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

This section examines the host country's existing infrastructure and human resources for managing the use of the proposed pesticides. If the host country's ability to regulate pesticides is inadequate, the proposed action – use of pesticides – could result in greater risk to human health and the environment.

The Ministries of Agriculture in Burkina and Niger have research, extension and enforcement services; however all are lacking sufficient funds to operate well.

Issue: Limited resources to control pesticides

Most CILLS countries do have systems for the registration and regulation of the import, sale and use of pesticides. However, their ability to cover the country and eliminate banned or highly toxic chemicals is limited due to limited resources. The lists of registered pesticides contain some very highly toxic chemicals that should not be handled by illiterate, untrained, unprotected and often unaware small-holder farmers like those found throughout Burkina and Niger. Most farmers do not have access to and cannot afford PPE in order to follow GAPs.

Issue: Illegal Products from Neighboring Countries

"Leaky" country border crossings could be likely sources of pesticides that are not registered in CILLS countries. Some PIC chemicals have been found in formal and informal markets in the region, as have some POPs chemicals.

Issue: Disposal of Pesticide Containers

Most West African farmers retain empty and partially-full plastic pesticide containers. Some use them to store water. Before disposal, the standard practice has been to triple-rinse the containers, puncture them to discourage re-use, and bury or burn them. Burning plastic bottles and single-use pesticide sachets can lead to the formation of toxic furans and dioxins, and is not recommended. GlobalGAP and other S&C systems require that empty pesticide containers are triple rinsed over a pesticide soak pit with layered soil, lime and carbon, or a bio-active pit, and then properly stored in plastic drums in the field or storage shed, to await disposal or recycling. There are no pesticide container recycling activities occurring anywhere in Africa. The website http://www.epa.gov/oppfead1/labeling/lrm/chap-13.htm provides pesticide disposal options.

Recommendations for Mitigation

- WAIPRO staff members follow developments in the regulation and registration (http://196.200.57.138/dbinsah/index.cfm?lng=en&sect1=home&id=26) of pesticides in CILLS countries.
- Absolutely no POPs or PIC chemicals should be used on WAIPRO-supported fruit and vegetable production. This includes endosulfan, a POPs Treaty candidate, which is highly popular among vegetable producers the world over, but has killed numerous farmers as well.
- WAIPRO field staff members encourage and support the use of GlobalGAP best practices with pesticide storage, use and disposal, whether or not certification is required for market access.

3.11 Factor K: Provision for training of users and applicators

USAID recognizes that, in addition to the use of PPE, safety training is an essential component in programs involving the use of pesticides. The need for thorough training is particularly acute in developing countries, where the level of education of applicators may typically be lower than in developed countries.

Issue: Farmers need intensive and repeated training

Training in Safe Pesticide Use and GAP/IPM are of paramount importance for WAIPRO farmers and farm laborers using pesticides. WAIPRO-supported agriculture activities should focus strongly on providing GlobalGAP, IPM and safe pesticide use training. Additional and refresher training are superb means for affecting beneficiary farmer behavior, now, as they continue to expand their agricultural opportunities, and before risky behaviors become further set.

Recommendations for Mitigation

- Implement GAP, IPM and Pesticide Safe Use training for WAIPRO staff and beneficiary farmers.
- Use Annex 1 to produce and promote the use of Pest Management Plans for farmers to anticipate and better manage primary pests.

3.12 Factor L: Provision made for monitoring the use and effectiveness of each pesticide

Evaluating the risks and benefits of pesticide use should be an ongoing, dynamic process. Pest resistance is one of the risks for which this element is intended, as well as health and safety and environmental effects.

Record keeping should track quantities and types of pesticides used. Making notes on effectiveness of individual pesticides and pest numbers will help develop a more sustainable pesticide use plan for each WAIPRO beneficiary producer. Records of farmers, as well as WAIPRO agronomists, will need to make note of any reductions in pesticide efficacy experienced, which is the first indication that resistance may be developing, and then a strategy needs to be in place to determine a shift to a different pesticide class, and rotation among classes, to overcome resistance development.

Issue: WAIPRO and Farm Record-Keeping

On WAIPRO proposed demonstration farms, pesticide use documentation is either non-existent or not retained from year to year. Developing a more systemized approach to record keeping will allow seasonal and annual comparison of pesticide effectiveness, pest numbers, crop production, maintenance of safety equipment, and so on. The following aspects should be included in the record keeping system, for a USAID-funded program:

- Local, EPA and EU regulatory compliance: A list of country, EPA and EU laws related to the use of agrochemicals for plant protection, short notes on the relevance of the law, dates the laws come into or exit force and MRLs for each crop-pesticide combination.
- A pesticide checklist: This list allows agronomists to ensure that the pesticides they are using are not banned by international treaties (POPs, PIC), locally registered through CILSS and registered through the USEPA. It should also provide notes on special safety requirements.
- GAPs/IPM measures tried/used (see Annex 1): WAIPRO agronomists should try to incorporate a minimum of at least three new IPM measures per annum and document their success or failure.
- PPE: Lists of the types of equipment made available to applicators, number of pieces, prices and contact details of suppliers, dates when equipment needs to be washed, maintained or replaced. PPE should be numbered or personally assigned to applicators

to ensure that it is not taken home where (as a contaminated material) it could pose a risk to family members.

- Monitoring/recording pests: Agronomists should incorporate into their records regular field pest monitoring and identification. This could be done by the agronomists themselves, or if properly trained, by farmers.
- Environmental conditions: Field conditions should be incorporated into the record keeping system (for example; precipitation, soil analyses and moisture, soil pH, temperatures and so on).
- Information should be transmitted at least annually to WAIPRO, and WAIPRO should report to USAID on this progress in pesticide safety and GAP/IPM use in annual reports.

Issue: Monitoring by WAIPRO Field Staff and Farmers Should Detect:

- Resistance: Pesticide resistance development among pests has likely occurred and could eventually occur more, and will be noted by farmers complaining that the spray no longer works as it once did.
- Human poisonings and any incidences of chronic health issues.
- Farm animal and livestock deaths.
- Any incidences of water pollution.
- Fish, bird, wildlife or honeybee kills.

Any of the above items should be reported immediately to USAID. Other information should be transmitted at least annually to USAID, and WAIPRO should report on this progress in pesticide environmental and human health safety in annual reports.

Issue: WAIPRO Planning and Reporting

Several issues could receive more attention in WAIPRO annual work plans and annual reports. These include a section on Environmental Impact Mitigation and Best Practices, with subsections (and issues) on:

- Country and EPA regulation compliance (documents and enforcement status, risk, pollution, mitigation)
- GAPs/IPM measures tried/used and on what percent of WAIPRO farms
- Biodiversity and conservation (soil, water, energy, protected habitats, biodiversity and protected species) measures used on what percent of farms
- Inputs and PPE use and issues (types, amounts and issues with products, sprayers, MRLs, REIs, MSDSs)
- Training/capacity building in IPM and Safe Use (hands-on, demos, sessions, meetings, extension, flyers, brochures, pamphlets, posters, crop technical GAP information sheets, and radio and TV outreach/safety message enforcement)

Recommendations for Mitigation

- WAIPRO to follow all of the above best practices in monitoring, record-keeping, evaluation/analyses and reporting.
- Site managers/agronomists should develop a record-keeping system, which is also a requirement for GlobalGAP and other international market-driven produce certification systems.

- Site managers/agronomists will be responsible for developing a record keeping system. One good example is provided by the GlobalGAP system. It is highly recommended that records are kept in an electronic format for easy editing, updating and modification.
- Using Annex 11, WAIPRO staff should put plans for monitoring the environmental and human health impact of production activities, following recommendations found in this PERSUAP into the Annual Action Plans.
- WAIPRO project staff keeps records on the implementation of the recommendations found in this PERSUAP, and report on them in Quarterly and Annual Reports, under a heading titled “Environmental Impact Mitigation and Best Practices”.

SECTION 4: Pesticide Safe Use Action Plan (SUAP) for WAIPRO and Implementation Partners

Action Plan Title: Actions to increase awareness of and mitigate pesticide risks on WAIPRO Implementation Partners project sites

Action Plan Objectives: Reduce risks from pesticides

On the following Action Plan Matrix, insert the start and end dates for each activity or action with the names of those responsible for each action, and a budget. Once this is action plan is completely filled, and actions are under way or done, it can be transmitted to AID to show Regulation 216 compliance progress.

Actions	**Start**	**End**	**Who**	**Budget**
Reiterating Pesticide Restrictions				
Ensure that WAIPRO beneficiary farmers do not use locally-available insecticides containing banned endosulfan, banned HCH, carbofuran, or Thioral (which contains the banned organochlorine heptachlor) for treating their crops				
Ensure that WAIPRO demonstration farmers do not use fumigant aluminum phosphide to treat stored grain or produce (instead use trained and equipped fumigation services)				
Assign local pesticide commercial product names to Active Ingredients in PERSUAP Annexes 8 and 9				
Ensure that WAIPRO demonstration farmers do not use pesticide products containing active ingredients in Annex 8				
For use of RUP exceptions, ensure that a WAIPRO staff member receives RUP training/certification (on-line or thru a US State Extension Service) to teach mitigation to beneficiary farmers				
Check CILSS pesticide registration website every 6 months to obtain up-to-date information on new pesticide registrations/changes				

Pesticide Risk Awareness and Mitigation				
Provide annual training for project staff and beneficiary farmers using the training topic list in Annex 10				
Ensure that farmer associations each have 1 or 2 sets of PPE for the group to share; assign responsible PPE caretakers				
Ensure that farmers use PPE and apply pesticides only early in the morning or late afternoon when there is no wind or rain				
Annually test and certify pesticide users on knowledge of human safety and environmental protection				
Good Agriculture Practices/IPM				
Test pest-specific PMP information in Annex 1 with beneficiary farmers for field use, validation, modification or adaptation				
Use PERSUAP PMP information (Annex 1) to produce crop-specific production field reference guides or posters for farmers to use to anticipate and manage pests				
Test artisanal and commercially-available natural chemicals listed in Annexes 1 and 8, respectively, as available				
Follow GlobalGAP standards and website http://www.epa.gov/oppfead1/labeling/lrm/chap-13.htm for empty container disposal and pesticide record-keeping				
Project Management Responsibilities				
Define and assure safe use practices				
Define appropriate methods of pesticide handling, storage, transport, use and disposal				
Keep copies of the current list of CILSS-				

registered pesticides at all WAIPRO project sites				
Collect and keep copies of MSDSs for each commercial pesticide that beneficiary farmers use at all WAIPRO project sites				
Keep copies of prohibited pesticide products containing active ingredients in Annex 8 at all WAIPRO project sites				
Keep PERSUAP recommendation implementation records and report on them in Annual Reports, under a heading titled “Environmental Compliance and Best Practices”				
Establish pesticide quality standards and control procedures				
Provide for enforcement				

Action Plan Goals: Decrease the number of beneficiary farmers unaware of pesticide safety, environmental and natural resource protection, and IPM concepts

Action Plan Discussion:

Action Plan Final Sign-off: COP ___________________________, date: ________________

Once filled and signed by COP, this Action Plan can be sent to USAID for project management monitoring purposes, so USAID staff can see the degree to which PERSUAP recommendations are being implemented, issue with implementation, and to set future targets for impacts of pesticide safety activities.

WAIPRO Environmental Mitigation and Monitoring Plan (EMMP) Outline

An EMMP should either be included in or developed for (1) **all IEEs** that have at least one "Negative Determination with Conditions" (2) all PERSUAP recommendations and (3) all Environmental Assessments (EAs).

If the EMMP is not developed as part of the IEE, the implementing partner should usually lead development of the EMMP, subject to review and oversight by the MEO and CTO.

In all cases, the tasks identified in the EMMP are incorporated into the implementing partner's Work Plan, budget, and reporting.

The following EMMP format is recommended. It can be adapted, as necessary.

Environmental Mitigation and Monitoring Plan

Activity Title:

Implementing Partner:

Activity	Mitigation measure(s)	Monitoring indicator(s)	Monitoring and Reporting Frequency	Party(ies) responsible.
List all activities in IEE that received a "negative determination with conditions" or PERSUAP *Do not list any other activities.*	If mitigation measures are well-specified in the IEE or PERSUAP, quote directly from IEE If they are not well-specified in the IEE, define more specifically here.	Specify indicators to (1) determine if mitigation is in place and (2) successful. For example, visual inspections for seepage around pit latrine; sedimentation at stream crossings, etc.)	For example: "monitor weekly, and report in quarterly reports. If XXX occurs, immediately inform USAID activity manager."	If appropriate, *separately* specify the parties responsible for mitigation, for monitoring and for reporting.

Annex 1. Matrix of USAID WAIPRO-supported crops with major pests, farmer management tools currently in use with recommended additional tools

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
For all crops		
For all pests	Most small-holder farmers can afford, find access to and use few pesticides and IPM measures	• Do soil tests for soil structure, pH, macronutrient & micronutrient levels for precision soil amendment targeting • Regularly test soil moisture levels in order to manage soil-borne diseases and reduce amount of irrigation water needed • Use raised-bed production to better manage water use, soil moisture and speed seedling growth • Use minimum and no-tillage, cover crops, terracing and contour plowing to conserve soil • Use organic mulches and cover crops to suppress weeds, conserve irrigation water, manage soil moisture, and thus protect soil from rapid salinization • To add nitrogen and structure to the soil, rotate with nitrogen-fixing legume crops, use inter-planting with legumes, green manures and agroforestry techniques • Make and use compost; this will increase soil organic matter and nutrition, decrease soil-borne pathogens, sequester carbon, hold moisture and decrease need for increasingly more expensive synthetic nitrogen fertilizers derived from fossil fuels
Rice		
Rice stem borers (*Chilo zacconius*, *Coniesta ingnefusalis*, *Orseola oryzicola*, *Maliarpha separatella*); Pink borer (*Sesamia calamistis*)	• Early/synchronized planting & water management • Field sanitation and stubble management • Use extracts of neem, tobacco, fire ashes and chili peppers • Farmers like to use products containing cypermethrin, deltamethrin (*do not allow into enter open water, get RUP training)*, and **carbofuran—too toxic for small-holder farmers, not recommended by this PERSUAP**	• Use resistant and early-maturing varieties. Improved semi-dwarf varieties are generally more resistant to stem borers than the tall traditional ones. • Transplant & grow healthy rice seedlings and plants. • Harvest at the very base of the plants, or plow stubble under and flood.
Diopsid (stalk-eyed) fly (*Diopsis* longicornis, *Diopsis thoracica*, Diopsis spp.)	• Farmers spray with insecticides containing pyrethroids like lambda-cyhalothrin or deltamethrin (*do not allow into enter open water, get RUP training)*, and neem-based materials	• Use resistant varieties • Remove and dispose of dead-heart plants

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
Rice gall midges (*Orseolia oryzivora, Cricotopus sylvestris, Paralauterborniella subcincta, Paratanytarsus* spp.)	• Farmers use early planting/sowing • Farmers try, ineffectively, to spray with pyrethroids and **banned endosulfan—not to be used on USAID-funded projects** • Some farmers use insecticides containing **carbofuran—too toxic for small-holder farmers, not recommended by this PERSUAP**	• Use resistant varieties • Plow under ratoon from previous crop • Remove off-season alternate host plants like wild rice • Draining fields for 3-4 days controls the midge • Seeding synchronously as soon as possible after flooding • Seed parts of the field in sequence as they fill with water • Avoid over-doses of fertilizer
White fly (*Bemisia tabaci*)	• Controlled in nature by hymenopteran parasitoids (*Encarsia sp*), lady beetles and minute pirate bugs. • Spray solution of local soap (2%), horticultural oil if infestation is heavy.	• Monitoring crops and establishment of a pesticide program after finding 1 WF per 10 plants, the chemical suggested are: Azadirachtin (neem oil), Insect Growth Regulator pyriproxyfen, Imidacloprid • Yellow sticky traps may reduce populations but cannot prevent the spread. • Selective chemicals as: Azadirachtin (neem oil), Insect Growth Regulator Pyriproxyfen, abamectin, imidacloprid, *Beauveria bassiana* • Soil application of a systemic, nicotinoid insecticide (imidacloprid, acetamiprid) at crop initiation
Leafhoppers, jassids, spittle bugs and plant hoppers *(Locris rubra, Nephotettix spp, and Cofana spp*)	• Encourage predatory assassin bugs by creating refugia, i.e good weed management with scattering heaping cleared weeds to provide cover for increased natural enemy activity.	• Control grassy weeds and monitor during the summer to determine the need to treat. • Predation by spiders can provide significant reduction of leafhopper populations. • Use resistant plant varieties and avoid staggered planting • Can spray with carbaryl
Leaf-feeding beetle (*Epilachna similis, spp*.)	• Farmers like to use natural and synthetic pyrethroids like cypermethrin, deltamethrin, permethrin (*do not allow into enter open water, get RUP training)*	• Use resistant varieties • Use crop rotation
Hispid Beetle (*Trichispa spp)*	• Use close plant spacing • Keep bunds and surroundings free from grass weeds • Destroy stubble and avoid rationing • Top the tips of leaves and seedlings before transplanting to destroy egg masses. • Ensure balanced nutrition (avoid excessive nitrogen application)	• Removing weedy vegetation on the levees in spring near the time of seeding. • Winter flooding of the field to enhance straw breakdown and provide waterfowl habitat. • Use of lambda-cyhalothrin and diflubenzuron, if registered, provide some control.
Root Knot Nematode	• Management of nematodes is difficult,	• Botanical and homemade water extracts of basil, garlic and neem seed may

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
(*Meloidogyne spp.*)	especially in sandy soils. Use of resistant cultivars and grow healthy plants (use appropriate seed, spacing, watering, weeding and fertilizer) • Use crop rotation, deep plowing, fallowing and avoid mono-cropping. Rotate with broccoli, cauliflower, sorghum, Sudan grass, rape, and mustard seed which are resistant to nematodes. • Use Soil Solarization: Solarization (For effective solarization, moisten the soil and then cover it with a clear plastic tarp. The tarp must be left in place for 4 to 6 weeks during the hottest part of summer) can be used to temporarily reduce nematode populations in the top 12 inches of soil to allow the production of shallow-rooted annual crops before nematode populations increase.	be effective controls. • Two new commercialized products, once registered for use, can be used as effective nematode controls: the microbe *Myrothecium verrucaria* and natural soil biopesticide labeled as Promax (containing extracts of tomatillo oil and thyme oil) • Sanitation: Remove and compost crop debris. • Use of organic fertilizer particularly chicken manure and composts to add organic matter and soil structure to sandy soils • Growing flax, a tropical herb, is good for controlling root knot nematodes. • African and French marigold (*Tagetes minuta* and *T. patula,* respectively) plowed under the soil also suppress and reduce nematodes. Plant and plow under 2 months later.
Rice blast *(Pyricularia oryzae*)	• Farmers use Kitazine (iprobenphos) and **Decis (deltamethrin)—an insecticide used in error on a fungal disease** • Do not plant too early or too late • Avoid application of excessive nitrogenous fertilizers • Avoid close planting in nurseries • Foliar spraying with recommended fungicides • Use resistant varieties	• Use of resistant cultivars, • destruction of infested residue, • use of non-infested seed, • water seeding (not drill seeding), • continuous flooding, • avoid using excess nitrogen • If registered, can use application of Apron (metalaxyl), Quadris (azoxystrobin).
Bacterial sheath brown rot (*Pseudomonas fuscovaginae*)	• Farmers use **carbofuran—a highly toxic insecticide used in error on a fungal disease, and not permitted on USAID plots** • Use clean hybrid seed • Manage water	• Sanitation—remove infected stubble • Use optimum plant spacing • Use dry heat treatment of seed (65 degrees C for 6 days) • Use streptomycin
Brown leaf spot *(Helminthosporium*	• Farmers use **carbofuran—a highly toxic insecticide-not permitted with USAID**	• Careful use of fertilizer can do much to prevent the disease • Burn or feed stubbles after harvest

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
oryzae), (*Cochliobolus myebeanus)*	**support-used in error on a fungal disease** • Some farmers use Kitazine (iprobenphos), neem and **Decis (deltamethrin)—an insecticide mistaken for a fungicide** • Some farmers use **benomyl (*Do Not Use Benomyl/Benlate—not EPA registered)***	• Hot water treatment of seeds • Seed treatment with fungicide like Agrosan GN, Apply at 145gm/50kg seed
Seedling Blight (*Sclerotium rolfsii*)	• Farmers use **carbofuran—a highly toxic insecticide used in error on a fungal disease** • Deep plough to bury crop debris reduces the disease • Use recommended chemical for seed treatment and spray fields with fungicide	• Plant high quality rice seed (preferably certified seed) with 85% germination or more. • Seed treatments with fungicides provide protection against seedling diseases. • Maintain a uniform water depth of about 4 inches or 10 cm. • Increase seeding rate if a history of the disease exists. • Use of copper hydroxide provides some control.
Rice yellow mottle virus (RYMV)	• Manage the vectors of RYMV by using synthetic pyrethroid pesticides (get RUP training and avoid getting pyrethroids into the water) • Use clean seedling material	• Many predators control the vectors of RYMV, so avoid over-spraying for insect vectors • Use resistant cultivars as they are developed
Sheath blight (*Rhizoctonia oryzae)*	• Farmers use **carbofuran—a highly toxic insecticide used in error on a fungal disease** • Field sanitation and stubble management i.e burning • Ensure balanced nutrition • Avoid close planting to reduce humidity • Spray Fungicide	• Use of azoxystrobin provides some control.
Weeds: grasses	• Farmers like to use herbicides containing glyphosate and **parraquat—RUP chemical that cannot be used on USAID projects** many farmers do hand weeding and hoe-tilling	• Ronstar PLC, 6l/ha in 200 - 300 l of H_20, Apply 14 days after planting • Risane,6-8 l/ha in 200-300l of H20, Apply 14 days after planting • Propanil (Stem F 34) + Risane300 EC 5l/ha, Apply post emergence 2weeks after transplanting • Tear 50% EC, 5-6 l/ha in 100 l of H20, Apply 0-3 days after planting
Quelea weaver birds (*Quelea quelea, Pluxius spp)*	• Bird scaring works best. • Some farmers use fenitrothion on roost trees at night (not recommended by this PERSUAP)	• Control weaver bird nests and eggs. • Kids with slingshots
Rodents (various species	• Some farmers like to use zinc phosphide—	• Dig out nests

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
of rats & mice)	do not use on WAIPRO project demos—too toxic	• Use mechanical and glass jar pit traps
Maize		
Termites (various species)	• Baits: wood stakes treated with borates • Insecticide seed treatment. • Use composted instead of fresh mulch.	• If registered, can spray imidacloprid and Insect Growth Regulators (IGRs) Gentrol, Nyguard, Precor, Nylar, Hydroprene, Methoprene, if and when they become registered, affordable and available. • Deep plowing to dig out queen • Hand dig out nest to kill queen, insecticide poured into nest
Corn stalk borers (*Chilo partellus, Busseola fusca*)	• Natural enemies include parasitoids Braconid family of parasitic wasps, wasps of the genus Cotesia, and Tachinid fly larvae. Predators include ground beetles, lacewing larvae and adults, praying mantis and weaver ants. • Use borer-resistant varieties and crop rotation and intercrop maize with cowpea. • Plow deeply, harrow and plant early at the beginning of rains or within 2 weeks. • Monitor plants for larva's presence 2-4 weeks after sowing. Select 100 plants randomly across the field. If more than five plants are infested with stalk borer larvae (out of 100 monitored plants), then control measure is necessary.	• Botanical and homemade water extracts of neem seed, chili pepper, pyrethrum from *Chrysanthemum cinerariaefolium* flowers or roots and stems of the shrub Ryania *(Ryania speciosa)*, if imported to West Africa, may provide effective control (apply into the corn seedling whorl). • Sanitation—after harvest, remove corn stalks and use for livestock food. • If registered, one can spray products containing BT toxin or spinosad (both soil microbial extracts) between the egg stage and leaf-feeding stage (before they bore into the stem). • If registered, use Bulldock (beta-cyfluthrin), Ambush/Pounce (permethrin) or Pymac (pyrethrum extract) applied into the whorl of infested plants (*do not allow into enter open water, get RUP training)*.
Cutworm species (*Agrotis ipsilon, Peridroma saucia,* and others)	• Natural enemies include Braconid wasps (*Cotesia spp.* and others) and Tachinid fly larvae. Predators include ground beetles, lacewings, praying manits and weaver ants. • Removal of weeds in and around fields will reduce egg-laying sites and will help in the prevention of cutworm infestation. Do this at least 2-3 weeks before planting to reduce the incidence of cutworm larvae transferring to newly planted crops. • Use crop rotation--plant alfalfa or beans after maize. • Interplant main crops with onion, garlic,	• Botanical and homemade extracts include basil, neem, Finger euphorbia and Spanish needle. • Use pheromone traps. • Plow and harrow fields properly before planting. This will destroy eggs and expose larvae to chicken, ants, birds, and other predators. • Use sprays of BT, if and when they become registered and available. • Find 'hot-spots' (places of high infestation) and treat only those hot-spots. If registered, can treat with carbaryl (Sevin bait, chlorpyrifos (Lorsban) and permethrin (Ambush) (*do not allow into enter open water, get RUP training)*. • **Organically Acceptable Methods:** Eliminating weeds 2 weeks before planting both within and adjacent to the field can help to minimize cutworm problems in an organically managed crop.

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
	peppermint, coriander, or garlic every 10-20 rows to repel cutworms. Sunflowers and cosmos can also be planted as a trap crop in or around fields.	
Armyworms (*Spodoptera spp*.)	• Natural enemies include parasitoid Braconid and Cotesia wasps and Tachinid flies as well as damsel bugs, ground beetles, lacewings and weaver ants. • Monitor and treat with insecticide if one second or third instar larva for every 10 plants is found. • Practice proper field sanitation. Destroy weeds from bordering fields and on field borders. Remove weeds regularly to reduce breeding sites and shelter for armyworm. Remove all plant debris after harvesting. • Employ proper seed selection when seeds for sowing are taken from the previous harvest. Adults might have laid eggs on the seeds during armyworm infestation. • Plow and harrow field thoroughly. Sometimes, the small grains or grasses are plowed-under after the eggs are laid on them. As the field is planted and the plants begin to grow, the larvae will continue to develop and will start attacking the plants.	• Botanical and homemade water extracts include basil, chili, garlic, neem, lemongrass and Meliaceae (*Lansium domesticum*) • Pheromone traps placed along the edges of fields may be used to monitor adult moths. This is a particularly good technique for detecting large emergences or migrations occurring on weather fronts. • Start monitoring before seedlings emerge by checking for egg masses and young larvae in surrounding weeds. • Pay attention to nearby armyworm movements and dig a deep ditch on the edge of the field under attack to trap and kill larvae. • Because larvae become active at dusk, and sunlight degrades many pesticides, especially biological, the best time for insecticide treatment is in the twilight evening hours. • If registered, one can use the Insect Growth Regulator (IGR) methoxyfenozide (Intrepid). • If registered, products containing indoxacarb, methoxyfenozide or cryolite may be used. • To reduce development of resistance, regularly rotate chemicals to different chemical families. • Can spray with insecticides containing BT, if and when they become registered and available. • Sprays of natural pesticides *Bacillus thuringiensis aizawai* and the Entrust formulation of spinosad are acceptable for use on organically certified crops, and best sprayed when larvae are small (large larvae are more difficult to kill with these biological compounds).
Aphids, corn leaf aphid (*Rhopalosiphum maidis, Myzus persicae*)	• Natural enemies include Braconid parasitoids, ground beetles, spiders, rove beetles, ladybird beetles, lacewings, damsel bugs, aphid midges and hoverfly larvae. • To monitor aphid populations, examine the undersides of the leaves and the bud areas for groups or colonies of aphids. Prompt control is necessary as aphids can multiply rapidly.	• Botanical and homemade water extracts of chili, ginger, neem, Andographis (see above), turmeric, tomato leaf and Yam Bean. Soap spray (caution: may injure foliage) • Water traps: Half-fill yellow pan or basin with soapy water. • Use yellow sticky board traps placed in field (spread used motor oil on yellow painted plastic, thick cardboard or wood). • If registered, can apply dimethoate or Narrow Range Oils to aphids. • **Organically Acceptable Methods:** Biological control and oil (Narrow range agriculture oil) and soap sprays are acceptable for use on organically

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
	• Management and cultural practices • Grow different crops or grow crops in rotation every cropping season. This practice provides food, shelter, and it increases the number of natural enemies that prey on aphids. At the same time, it disrupts the aphids' lifecycle and maintains its population below the economic threshold level • Plant trap crops such as lupine, nasturtiums, and timothy grass near the crop to be protected. Anise, chives, garlic, onions, and radish are good companion crops. • Control and kill ants (see above). • Avoid using heavy doses of highly soluble nitrogen fertilizers. Instead apply fertilizer into 3 phases: during seeding, vegetative, and reproductive stages of plant growth.	grown crops.
Corn rust (*Puccinia sorghi, Puccinia polysora*)	• Use resistant hybrids • Have proper plant spacing by following the recommended planting distances. This enables light penetration and air flow • Have a healthy and well-balanced soil • Always practice proper field sanitation (remove and compost crop stubble) • Control weeds • Practice crop rotation by alternating crops of non-related family groups during every cropping season	• Remove heavily infected plants and compost or burry • Generally, corn fungicides are not widely used in West Africa • If needed, and registered, pesticides containing mancozeb, azoxystrobin, propiconazole, tebuconazole can be used.
Corn earworm (*Helicoverpa/Heliothis zea, H. armigera)*	• Choose corn varieties with tight husks to prevent larva from entering. These varieties show some characteristics and tolerance to the feeding habits of the corn earworm. Ask assistance from the local agriculturist office for these varieties are available in	• Botanical and homemade water extracts include neem, tomato leaf and ginger. • Make and use pheromone or light traps: To make trap, use 1-liter containers. Cut 3 large holes into the sides of the container for the insects to enter. Fill the bottom half with soapy water. Suspend the pheromone capsule from the lid using string or wire then snap the trap closed. Attach

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
	the markets. • Practice crop rotation. Avoid planting crops successively that are hosts to corn earworm like corn, cotton, sorghum, tobacco, soybean, and tomato. • Two weeks before planting, remove weeds and grasses to destroy earworm larvae and adults harboring in those weeds and grasses. • Plow and harrow fields at least 2 times before sowing seeds. This will expose pupae of corn earworm to chicken, birds, ants and other predators. Corn earworm pupates in the soil. After harvest, remove corn stubble by feeding to cows.	the trap to a bamboo pole or stake. Put sacks or containers filled with soapy water under building lights near the corn field. • Erect bamboo/wooden poles as bird perches, or put bat houses near the corn field. • Insecticidal control of corn earworm is difficult and depends on proper timing and thorough coverage. Begin sampling soon after corn emergence but pay particular attention to corn that is silking in late summer/early fall. The presence of large numbers of eggs on fresh corn silks indicates the potential for damaging populations. Eggs hatch in 5 to 7 days following oviposition. Once larvae enter the corn ears, control with insecticides is difficult. Direct insecticidal control towards young larvae that are feeding on the exposed ear tips. Treatments are usually not needed on field or silage corn. In sweet corn, where tolerance for worm damage is low, timing of insecticide treatments is critical: begin treatments during silking stage, at the start of egg hatch. Apply additional treatments if they are necessary. • Sprays of *Bacillus thuringiensis* and the Entrust formulation of spinosad are acceptable for use on an organically grown crop.
Weeds: various sedges, broadleaves and grasses	• Proper seed selection. When possible use high quality seeds and certain crop varieties • Perform thorough land preparation (soil tillage, fertilizer, and water management) • Narrow row spacing makes the crop more competitive than the weeds, use intercropping • Place the fertilizer in such a way that the crop has access to it but the weeds do not. This allows the crop to be more competitive with weeds. • Maintain cleanliness on the irrigation canals • Keep the surroundings of your farm free of weeds, unless they are maintained and intended as habitats for natural enemies • Regularly clean farm tools	• Green manuring • Intercropping • Hand weeding. The weeds are easier to control during their earlier growing period. If possible, do not let the weeds flower. Remove them from the field before they start to flower. Pulled weed bearing seeds should not be placed in compost pile for the seeds may not be killed in the process of decomposition. Compost might be the source of the reintroduction of weeds onto your fields. • Hoeing, mowing, and cutting
Cassava		
Mealy bug (*Phenacoccus*	• Farmer like to use dimethoate (Rogar) as a	• Introduced wasps and predatory mites generally control most outbreaks of

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
herreni, Phenacoccus manihoti)	planting stock dip • *Do not use monocrotophos—too toxic*	mealy bug
Mites (various species)	• Farmers like to use deltamethrin (Decis), lambda-cyhalothrin (*do not allow into enter open water, get RUP training),* dicofol and agricultural oil.	• Weekly monitoring and sampling • Several cultural methods, such as adjusting planting time for the crop to escape severe damage at young age, mixing varieties to avoid genetic uniformity, and removing infested tips. • Use of entomopatogenic fungi, insecticidal soap or oil can be used for management. Oils and soaps must contact mites to kill them so excellent coverage, especially on the undersides of leaves, is essential and repeat applications may be required. • Can use insecticides and miticides like dimethoate and dicofol • Use of predatory mites, if available
Grasshopper (*Zonocerus variegatus*)	• Naturally controlled by nematodes • Spray with Green Muscle *Metharrizium* when nymphs are seen on weeds or the crop	• Scout for breeding sites to detect outbreaks • Hand pick early in the morning when hoppers are less active, fry with chili and garlic and consume
Long horn beetle (*Lagocheirus araneiformis*)	• Use of healthy material • Remove and burn affected plants	• Monitor the edges of the field weakly • Remove infected material and boil or burn the branches
Thrips (*Frankliniella williamsi, Corynotrips stenopterus*)	• Do regular monitoring with blue and yellow sticky traps • Use tolerant or resistant varieties • Use rotation	• Keep production areas free of weeds, which can serve as hosts for thrips populations. • The following insecticides may control thrips: *Beauveria bassiana*, abamectin, Neem extract, acetamiprid, imidacloprid, potash soap and spinosad • Most insecticides must be applied at least two times, 5 to 7 days apart, for efficacy against flower thrips.
Bacterial rots and blights (*Xanthomonas campestris* p.v. *manihotis*)	• Pruning and cleaning • Use of healthy material • Good soil preparation	• Disinfection of the cutting tools used to make propagation materials • Usage of resistant material • Use of healthy plant material • Rotation • For control, use copper hydroxide.
Weeds	• Pre-emergence: products containing pendimethalin, diuron, Harness (acetochlor) • Pre-transplant: and a selective treatment with: Command (clomazone)	• Two-hand or hoe weeding

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
Cowpea		
Aphids (*Aphis craccivora*)	• Plant resistant varieties and use crop rotation • Observe build up aphid populations and natural enemies (predators like lady bird beetles, hover flies, lacewings, parasitic wasps like *Aphidius spp*) • Some farmers use extracts of neem, tobacco, fire ashes and chili peppers. • Some farmers use SuperCal	• Natural enemies include Braconid parasitoids, ground beetles, spiders, rove beetles, ladybird beetles, lacewings, damsel bugs, aphid midges and hoverfly larvae. • Examine the undersides of the leaves and control aphid colonies promptly • Plant trap crops such as lupine, nasturtiums, timothy grass, anise, chives, garlic, onions, and radish near the crop to be protected. • Botanical and homemade water extracts of chili, tomato leaf extracts, neem, Indian Chiretta (King of Bitters, *Andrographis paniculata*) or Siam Weed (*Eupatorium odoratum*) mixed with cow urine and chili. Soap spray can also be used, but too much may injure foliage. • Water traps: Half-fill yellow pan or basin with soapy water. • Use yellow sticky board traps placed in field (spread used motor oil on yellow painted plastic, thick cardboard or wood). • If needed, and registered for use, insecticides containing malathion may be applied.
Wilts (*Fusarium oxysporum*)	• Pathogen is soil borne and probably seed transmitted • Use resistant varieties • Practice long rotations with non-host crops eg, cereals, cassava	• If resistant plants are infected with root knot nematodes, then they may become susceptible. • No additional methods.
Anthranose (*Collectotrichum lindemuthianum)*	• Use clean seeds • Grow resistant varieties • Burn crop residues • Apply appropriate fungicides, like mancozeb or others on foliage when disease symptom appears • *Do not use Benomyl/Benlate—not EPA registered*	• Use sanitation—plow under crop residue immediately after harvest. • Practice rotation.
Web Blight (*Corticum solani*)	• Destroy crop residue and weed hosts • Use clean seeds • Ensure good cultural practices e.g avoid dense planting and plan sowing to avoid peak rainfall periods.	• Practice long rotation with non-susceptible crops like cereals
Cercospora leaf spot (*Cercospora spp*)	• Some farmers use Ridomil Gold.	• Use seed treatments with metalaxyl and mefenoxam • Use clean resistant seed

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
Root Knot nematodes (*Meloidogyne incognita*)	• Practice long rotation with non-susceptible crops e.g cereals • Plant *Tagetes spp*. (marigold) for one season on heavily infested fields	• Management of nematodes in cowpea requires a careful integration of several cultural practices, including choice of cultivar, crop rotation, sanitation, and fallow/green manure.
Flower thrips (*Megalurothrips sjostedji)*	• Use resistant varieties • Limited control in nature by parasitoids e.g *Ceranisus menes* and predators *Orius sp*. • Scout, using threshold of 5 thrips per flower scouted as a guideline, before spraying with pyrethroids (*do not allow into enter open water, get RUP training)*, and /or neem extract.	• Predators include minute pirate bugs and lacewings. • Control local weed populations. • Do not rotate or interplant with garlic or onions. • Keep plants well irrigated. • Botanical and homemade extracts of garlic, neem and soap sprays are effective. • Use bright yellow or blue sticky board traps placed in field (spread used motor oil on plastic, thick cardboard or wood painted yellow). • Prune off and remove heavily infested plant parts.
Pod borers (*Mauruca vitrata*)	• Use trap crops e.g *Crotalaria juncea* and destroy once infested • Spray with neem extracts from flowering stage	• Parasitoids include wasps in the Braconid family and tiny egg parasitic Trichogramma wasps. Predators include spiders and praying mantis. • Intercropping sorghum with cowpea reduces the incidence of pod borer. • Use resistant cowpea cultivars • Practice crop rotation. Planting non-leguminous crops every cropping season breaks the life cycle of bean pod borers • Use of BT spray and homemade water extracts of neem
Sucking Bugs (*Anoplocnemis curvipes, Clavigrallaa tomentosicolis, C. shadabi, Aspavia sp, Nezara viridula*)	• Control weeds to destroy roosting sites	• Limited control occurs in nature by *Trissolus basalis*, a biological control agent and Assassin bug *(Reduviids*) • Spray with malathion or carbaryl, if registered
Variegated Grasshopper (*Zonocerus variegates*)	• Naturally controlled by nematodes • Spray with Green Muscle *Metharrizium* when nymphs are seen on weeds or the crop	• Scout for breeding sites to detect outbreaks • Hand pick early in the morning when hoppers are less active, fry with chili and garlic and consume
White fly (*Bemisia tabaci*)	• Spray solution of local soap (2%) if infestation is heavy.	• Controlled in nature by hymenopteran parasitoids (*Encarsia sp*), parasitic wasps, lady beetles and minute pirate bugs • Use soil mulches • Frequent scouting and establishing a sampling plan based on a threshold of 2 adults/leaf • Yellow sticky traps may reduce populations but cannot prevent the spread

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
		• Chemicals suggested are: Azadirachtin (neem oil), Insect Growth Regulator pyriproxyfen, imidacloprid, acetimiprid, insecticidal soap, *Beauveria bassiana*, and horticultural oil
Leaf miner (*Liriomyza sp.)*	• Simple cultural practice – rogueing (removal and destruction) of heavily infested leaves	• Use regular monitoring and irrigation • Use sanitation—destroy crop residue • Biological control is often adequate to control leaf miners, so evaluate levels of parasitism before making treatment decisions and use pesticides with care. • Monitor crop and apply selective insecticide if the average is 0.7 larvae per plant (0-2 true leaves) or 0.7 larvae per 3 terminal leaflets (>2 leaves per plant). • Can use Neemoil, abamectin (Vertimec), cypermethrin (cypermethrin--do not allow to enter open water and get RUP training), Dicofol
Spider mites (*Tetranychus urticae, T. cinnabarinus, T. evansi)*	• Do weed control • Use of malathion, Neemoil, Agricultural oil, abamectin	• Spider mites have many natural enemies that often limit populations; Predacious mites and some insect feeds on spider mites, eg (*Phytoseiulus persimilis and Amblyseius andersoni*); the major predator mites commercially available for purchase and release are the western predatory mite and *Phytoseiulus.* • Adequate irrigation is important because water-stressed plants are most likely to be damaged. Broad-spectrum insecticide treatments for other pests frequently cause mite outbreaks, so avoid these when possible. • Use an insecticidal soap or oil can be used for management. Oils and soaps must contact mites to kill them so excellent coverage, especially on the undersides of leaves, is essential and repeat applications may be required.
Cowpea storage weevil (*Callosobruchus maculatus*)	• Store small quantities with wood ash, ground nut oil, neem oil black pepper powder etc. • Apply recommended storage pesticides like Actellic.	• Observe sanitation in storage • Use triple bagging technology • Solar disinfestations by heating grain between black and transparent plastic sheets • Divide crops into batch for short term storage (<3months), and long term (>3months). Treat only long term storage batch.
Tomatoes and Vegetables		
White fly (*Bemisia tabaci*)	• Controlled in nature by hymenopteran parasitoids (*Encarsia sp*), lady beetles and minute pirate bugs. • Spray solution of local soap (2%), horticultural oil if infestation is heavy.	• Monitoring crops and establishment of a pesticide program after finding 1 WF per 10 plants, the chemical suggested are: Azadirachtin (neem oil), Insect Growth Regulator pyriproxyfen, Imidacloprid • Yellow sticky traps may reduce populations but cannot prevent the spread. • Selective chemicals as: Azadirachtin (neem oil), Insect Growth Regulator

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
		Pyriproxyfen, abamectin, imidacloprid, *Beauveria bassiana* • Soil application of a systemic, nicotinoid insecticide (imidacloprid, acetamiprid) at crop initiation
Onion thrips, (various species, *Thrips tabaci)*	• Alternating crops with bean, corn or other crop • Farmers like to use **endosulfan—now banned and not permitted on USAID project sites.** • Some farmers use cypermethrin, deltamenthrin and lambda-cyhalothrin (*do not allow into enter open water, get RUP training)*	• Crop rotation • Blue sticky traps for monitoring • Good irrigation, drainage and fertilization • Plant extracts of neem or garlic applied to the stem
Aphids (various species)	• Farmers use products with thiamethoxam (Actara), deltamethrin (Decis) and cypermethrin (*do not allow into enter open water, get RUP training)*.	• Use regular monitoring, yellow sticky traps • Use resistant varieties • Many types of natural enemies and pathogens may control these aphids under low insecticide input situations. However, these aphids reproduce quickly and move into protected areas of the plants, thereby greatly reducing the potential impact of their predators and parasitoids in older stage plants. • Field disking and destruction of crop residues are important for control of aphid pests of leafy vegetables to reduce their migration into nearby crops. • If control is needed, treat when aphids are found to be reproducing, particularly when second and later generation wingless females have started reproduction. Aphid populations are easier to control before the plants begin to cup. Can use insecticides available for post-emergence foliar treatments. Contact insecticides have limited impact as plants enter the cupping stage. Chemicals with systemic or translaminar penetrating activity are essential for aphid control during the cupping through harvest period. While insecticides may help reduce secondary spread of aphid transmitted viruses, they do not prevent primary infection of fields. • If they become registered, insecticides containing imidacloprid, acetamiprid or pymetrozine can be used.
Caterpillars (various	• Farmers like to use resistant varieties	• If needed, use pesticides containing BT or spinosad

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
species, cabbage and lettuce loopers and caterpillars, *Diacrisia virginica*)	• Farmers use neem if available commercially	• Hand-pick larvae
Grasshoppers (various species, *Zonocerus spp*)	• Natural enemies include locust egg parasitoid *Scelio fulgidus*, a black wasp 3-5 mm long, a parasitic blowfly (*Blaesoxipha spp*.), a Bee-fly (*Trichopsidea oestracea*) and predaceous nematodes (*Amphimermis spp*.). Predators include birds, spiders, ground beetles and reptiles. • Farmers use insecticides containing lambda-cyhalothrin, cypermethrin, deltamethrin (*do not allow into enter open water, get RUP training)*.	• Botanical and homemade water extracts include neem. • Natural fungal pesticides that contain *Metarhizium anisopliae* (products Green Muscle and Green Guard) may be effective for reducing grasshopper populations. • Commercially available insecticides as bran baits containing spores of the protozoan, *Nosema locustae* may also be effective.
Solanacearum bacterial wilt disease complex (*Ralstonia solanacearum, Pseudomonas solanacearum)*	• Very difficult for farmers to control	• Biological control using antagonist organisms (other microbes) is under development • Use of "EM (Effective Microorganisms) Instant" compound (mixed culture of photosynthetic bacteria, *Azotobacter, Streptomyces* and *Lactobacillus* spp.)
Tomato mildew (*Leveillula taurica)*	• Farmers use seed treated with fungicides	• Sulfur sprays work and are acceptable for organic production but only when temperatures are below 30 degrees C • If registered, farmers can also use fungicides containing pyraclostrobin, myclobutanil, trifloxystrobin and azoxystrobin. • Reduce plant damage by hoeing and other equipment use
Onion bulb rot (various bacteria and fungi)	• Survey irrigation and control soil moisture	• During the growing season, minimize damage to bulbs caused by insects and diseases. • Harvest only after onion tops are well matured. • Provide for quick drying following topping, especially if temperatures are high. • Rotate 3 to 4 years out of onions, garlic, and leeks. • Control soil insects and foliage diseases. • Cure onions properly before storage. • Store at cool temperatures since infection is favored by warm conditions.
Peanuts		

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
Aphids, thrips & mites (various species)	• See aphids, thrips above under Maize and Cassava	• See aphids, thrips above under Maize and Cassava
Armyworms	• See armyworm above under Maize	• See armyworm above under Maize
Cutworms	• See cutworm above under Maize	• See cutworm above under Maize
Peanut rosette disease *(Arachis Hypogaea)*	• Use clean seed • Plant early • Farmers use insecticides containing cypermethrin, deltamethrin, and lambda-cyhalothrin (*do not allow into enter open water, get RUP training)* to control aphid vectors	• Use resistant varieties • Use sanitation—destroy old plant residues • Use early-maturing varieties
Peanut Cercospora (*Cercospora arachidicola*)	• Farmers use fungicides • Rotate crops	• Can spray copper and sulfur containing compounds • Soil pH should range from 5.8-6.2 with the optimum at 6.0. • Sanitation—plow deep to burry plant residues • Use resistant varieties • Do not irrigate during cool weather • Do not injure plants when hoeing
Sorghum & Millet		
Seed rot, Seedling blight and Root rot (*Pythium spp)*	• Use clean high quality seeds, because poor quality, low vigor seeds are most susceptible. • Avoid injury to seed pericarp • Ensure good cultural practices – proper planting depths and seed bed preparation • Avoid waterlogged areas. • Ensure optimum water managemen • Some farmers use **Thioral** (25% heptachlor—**not EPA registered, international POPs & PIC lists organchlorine insecticide** and 25% TMTD—also called thiram—an EPA registered carbamate fungicide)	• Use resistant hybrids • Optimal cultural practices (balanced fertility, good water management, crop rotation, plowing crop residues under, etc.) will help to prevent or reduce the impact of these diseases. • Early plantings usually escape serious injury. • Eliminate low areas in the field and improve drainage. • Crop rotation to nonhost crops, such as small grains, can also help reduce the disease potential. • For charcoal rot, Good water management to avoid stressing plants is important in managing this disease, particularly as the crop approaches the flowering stage. • Generally, corn fungicides are not widely used in West Africa • Remove heavily infected plants and compost or burry
Downy mildew (*Sclerospora sorghii*)	• Use improved varieties with seed treatments • Farmer use plant elevation	• Rogue diseased plants • If heavy attack is experienced in unfavorable condition, use recommended fungicides
Aphids (various species)	• Plant resistant varieties and use crop	• Natural enemies include Braconid parasitoids, ground beetles, spiders, rove

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
	rotation • Observe build up aphid populations and natural enemies (predators like lady bird beetles, hover flies, lacewings, parasitic wasps like *Aphidius spp*) • Some farmers use extracts of neem, tobacco, fire ashes and chili peppers.	beetles, ladybird beetles, lacewings, damsel bugs, aphid midges and hoverfly larvae. • Examine the undersides of the leaves and control aphid colonies promptly • Plant trap crops such as lupine, nasturtiums, timothy grass, anise, chives, garlic, onions, and radish near the crop to be protected. • Botanical and homemade water extracts of chili, tomato leaf extracts, neem, Indian Chiretta (King of Bitters, *Andrographis paniculata*) or Siam Weed (*Eupatorium odoratum*) mixed with cow urine and chili. Soap spray can also be used, but too much may injure foliage. • Water traps: Half-fill yellow pan or basin with soapy water. • Use yellow sticky board traps placed in field (spread used motor oil on yellow painted plastic, thick cardboard or wood). • If needed, and registered for use, insecticides containing malathion may be applied.
Sorghum Shoot fly (*Atherigona soccata*)	• Practice early planting to escape pest • Replant losses	• Plant resistant varieties, where available
Stem Borers and miners (*Busseola fusca, Sesamia calamistis, Eldana sp.)*	• Farmers use dimethoate for control • Early planting to ensure maximum pest escape. • Use resistant varieties • Intercropping sorghum with pulses in alternate rows may reduce stem borer incidence by 20-30%. • Embark on stalk management: in dry season cut and destroy stalks	• Natural enemies include parasitoids Braconid family of parasitic wasps, wasps of the genus Cotesia, and Tachinid fly larvae. Predators include ground beetles, lacewing larvae and adults, praying mantis and weaver ants. • Use borer-resistant varieties, crop rotation and intercrop maize with cowpea. • Plow deeply, harrow and plant early at the beginning of rains or within 2 weeks. • Plant small flowering plants or herbs on field margins to attract parasitoids and other beneficial insects. • Botanical and homemade water extracts of neem seed, chili pepper, pyrethrum from *Chrysanthemum cinerariaefolium* flowers or roots and stems of the shrub Ryania *(Ryania speciosa)*, if imported to West Africa, may provide effective control (apply into the corn seedling whorl). • Sanitation—after harvest, remove corn stalks and use for livestock food. • If registered, one can spray products containing BT toxin or spinosad (both soil microbial extracts) between the egg stage and leaf-feeding stage (before they bore into the stem). • If registered, use Bulldock (beta-cyfluthrin), Ambush/Pounce (permethrin) or Pymac (pyrethrum extract) applied into the whorl of infested plants.
Army worms (*Spodoptera exempta*)	• Early warning mechanism i.e use of	• Botanical and homemade water extracts include basil, chili, garlic, neem,

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
	pheromone traps to detect flight pattern can pre-empt major damage • In major outbreaks use pesticides e.g, (pyrethroids--*do not allow into enter open water, get RUP training)*) to control the invading caterpillars to avoid their spread to other cereals • Some farmers use extracts of neem, tobacco, fire ashes and chili peppers • Some farmers use pesticides containing cypermethrin (*do not allow into enter open water, get RUP training)* or fenitrothion.	lemongrass and Meliaceae (*Lansium domesticum*) • Start monitoring before seedlings emerge by checking for egg masses and young larvae in surrounding weeds. • The best time for insecticide treatment is in the twilight evening hours. • If registered, one can use the Insect Growth Regulator (IGR) methoxyfenozide (Intrepid), or products containing BT, indoxacarb, cryolite or methoxyfenozide. • **Organic Methods:** Sprays of natural pesticides *Bacillus thuringiensis aizawai* and the Entrust formulation of spinosad are acceptable for use on organically certified crops, and best sprayed when larvae are small (large larvae are more difficult to kill with these biological compounds).
Greater Grain Weevils (*Stitophilus oryzae, S. zeamais*)	• Storage hygiene must be observed • Divide produce for long term (3>months) and short term (<3months) storage; treat only long-term storage • Use any recommended storage pesticides like Actellic • Harvest early to reduce storage infestation • *Do not use phosphine (aluminum phosphide)—too toxic for small-holder farmers*	• Use triple bagging • Use storage sanitation—clean up old residues
Striga weed	• Farmers use manure mixed with mineral fertilizers • Farmers elevate the plants before flowering	• Use resistant cowpea varieties • Use early application of nitrogen
Yams/sweet potatoes		
Grasshoppers (various species)	• Use fireplace ashes, neem and red chili extract	• Hand pick early in the morning when hoppers are less active, fry with garlic and chili and consume
Sweet potato weevil (*Cylas formicarius*)	• Use short-cycle varieties and planting material from healthy plantations. • Follow proper harvesting time	• Use of attractive barrier varieties as trap crops • Use of biological control *Beauveria bassiana* • Do 2 rigdings per cycle, with the first after the first weed cleaning and second 75 days later.
Hawkmoth larvae (*Agrius cingulatus*)	• Do weed control around and in field • Use of Marshal, *Karate (lambda-cyhalothrin)—do not allow lambda-cyhalothrin to enter open water, get RUP*	• Do Crop rotation • Many natural enemies control hawkmoth larvae • Use of biological control *Basillus thuringiensis*

Primary Pests	Management tools West Africa farmers use (IPM/pesticides)	Additional management tools that can be tried & adopted (IPM/pesticides)
	training	
Armyworm (*Spodoptera eridania*)	• Do weed control around and in field • Use of a bait composed of bran, molasses and Sevin® XLR Plus (carbaryl) • Some farmers use deltametrin (*do not allow into enter open water, get RUP training)*	• Removal of crop residue • Weed control • Use biological control *Bacillus thuringiensis* • Use of baits, deltamethrin, and with RUP training, not permitting the pesticides to enter open water, can use cypermethrin, lambda-cyhalothrin, pyrethrum and permethrin
White rust (*Albugo ipomoea*)	• Do crop Rotation	• Good soil preparation • Select fields with heavier soils that are not especially subject to drought. Early season irrigation may prevent infection of the fibrous roots, reduce disease incidence, and increase yields. • Prevent spread of the pathogen into new fields by using only certified disease-free storage roots to produce disease-free plants. • Can try fungicides containing acibenzolar, fosetyl-aluminum, mefoxonam, neem, tebuconazole, iprodione, trifloxystrobin, propiconazole, potassium bicarbonate and strobilurin.

Primary References: http://www.oisat.org/crops/staple_food/rice.html; http://www.ipm.ucdavis.edu/PMG/selectnewpest.rice.htm;

Annex 2. Guidelines for Pest Management Plans (PMPs) for WAIPRO Crops and Beneficiaries

What is a PMP?

Pest Management Plans or Guides provide field crop or livestock production decision-makers – farmers and farm managers – with best production practices recommendations, usually adapted by region, crop phenology and seasons. The aims of PMPs are to reduce the risks to production from pests by using a combination of best practices, including IPM, Integrated Vector Management (IVM) and Integrated Weed Management (IWM), that maximize crop or livestock health, and thus resilience to or tolerance of pests, and without an over-reliance on pesticides needed when best practices are not followed. Thus, prevention of pests plays a strongly pivotal role in the PMP, followed closely by management of pests when prevention alone is not adequate for the level of control needed or desired.

Who are the PMP's intended audiences and users?

- Farm land preparation and crop production decision-makers
- Farmers
- Farm managers

Why is a PMP being done?

PMP Objectives:

- Prevent or reduce pest damage risk to agricultural production
- Protect the health of farmers, farm family members, laborers and community members from pesticide risks
- Maintain economically sound practices
- Reduce environmental pollution and degradation risks
- Enhance the overall quality and quantity of biodiversity on the sustainable farm work environment
- Respond to foreign market demand for the use of agriculture sector best management practice standards, also called Good Agriculture Practices (GAPs) which include IPM measures, to achieve farm and produce certification
- Comply with local, regional, donor and international laws, conventions, and regulations

Organization of the PMP

The following pieces of crop- or livestock-specific background information are used to build a PMP base

- General information on the crop/livestock
- Crop/livestock common/species names:
- Crop/livestock developmental stages:
- Production regions and how they differ by soil type, pH, fertility, etc
- Overall concerns and priorities for crop/livestock production

- Crop/livestock cultural best practices
- Crop/livestock Good Agriculture Practices (GAPs) including some IPM (see PERSUAP section on GAPS and IPM) recommendations

Individual Pest Prevention and Management Sections for each of the following pest types:

- Invertebrate (Insects, Mites, Slugs/Snails, Nematodes)
- Diseases (Fungi, Bacteria, Viruses, Other)
- Weeds (annual grasses, broadleaves, perennial grasses, broadleaves, sedges, others)
- Vertebrates (birds, rodents, other)

For each pest type, first, identify overall priorities for pest prevention and management in the target crop or livestock.

Next, identify individual pest species noting the type of damage incurred; part of plant damaged: roots/rhizomes/tubers, stems/stalks, leaves, florescence, or seeds (field or stored); or if livestock, part of animal affected.

To best understand how to manage a pest, one needs to understand how, where, when and on what parts of the plant or animal the pest feeds. For field pests and stored grain/food pests, many PMPs are designed and outlined as follows containing the following information, *for each major species of pest (insects, mites, slugs/snails, nematodes)*:

- Photographs of each pest, life stages
- Photographs of plant or livestock damage
- Description of the pest, life cycle and survival strategies[5]:
- Description of damage symptoms
- Best Prevention Practices
  - Use any and all of the above GAPs including IPM
  - Country or region-specific information
- Best Management Practices
  - Focus on prevention (above)
  - Country or region-specific information

Information on PMP-recommended pesticides:

Information needed for each pesticide referenced in the above PMP, by pest (so the farmer/farm manager has the information at their fingertips and do not need to refer to other documents and tables to find it):

Pesticide essential information needed

[5] Survival strategies: All pests have survival strategies that allow them to live and breed in each crop's farming systems. Knowing the survival strategies, including overwintering habit and alternate host plants, that are employed by the pest can help with decision making at the farming systems-level (e.g. choice of rotation crops) and also can help to anticipate pest outbreaks.

- Active Ingredient (AI) name
- Product Trade names (with EPA and WHO Acute Toxicity Classifications in parenthesis)
- Amounts to use per hectare
- Pre-harvest interval (PHI)
- Special comments on best application methods and frequency
- Specialized training/certification/permits for use of RUPs
- Any resistance management strategies needed
- Pesticide application record sheet
- Guidelines for reducing spray drift
- Re-entry interval (REI): field safe re-entry period after spraying
- Maximum residue levels (MRL) permitted by markets
- Pesticide precautions with use including
- Reading the label
- Legal responsibilities and permitted registration uses
- Permit requirements for possession and use
- Recommended and obligated use of PPE and best practices
- First aid and antidotes
- Transportation best practices
- Storage best practices
- Safe use best practices
- Container disposal best practices
- Leftover pesticide disposal best practices
- Protection of non-pest animals, plants, endangered species and water body quality
- Protect natural enemies & honeybees: http://www.ipm.ucdavis.edu/PMG/r584310111.html
- Posting signage in treated fields
- Some chemicals not permitted on processed crops
- Potential for phytotoxicity (crop injury) on some crops
- Documentation and record-keeping on farms

Information needed on Natural Enemies of Pests:

Common Names of Predators and Parasitoids effective against above pests: For a list of common natural enemies of crop pests, see http://www.ipm.ucdavis.edu/PMG/NE/index.html. Genera will likely be the same around the world, with different species in different continents, filling similar niches.

Additional Information Needed:

Will there be an IPM Coordinator, an IPM Advisory Committee, Education and Licensing for Applicators, Currency and Approval of the PMP?

Annex 3. Elements of IPM Program

Although farmers are likely using numerous IPM tactics, without really calling them that, IPM philosophy or planning is not generally an active part of crop production in WAIPRO plots; thus, a basic understanding of the steps or elements needed in an IPM program are addressed below.

Step 1: Learn and value farmers' indigenous IPM tactics. Most farmers are already using their own forms of GAPs and IPM, many of which are novel, self-created, adapted for local conditions, and many of which work well. These local tools and tactics need to be well understood and taken into account when making PMPs. Accurate assessments of these farmer's GAP and IPM technologies, as well as an understanding of actual losses due to different constraints in farmers' fields are required before designing a crop production and pest management program. S&C farmers will have records of historical pesticide use and trends, as well as information on current use of artisanal or local IPM tactics.

Step 2: Identify key pests for each target crop. Although perhaps up to ten species of pests may impact a crop and yields at different plant growth stages, generally only two or three are considered serious enough to spend money controlling. Farmers should be encouraged to monitor their population size, their life cycle, the kind of damage they cause and actual losses. Note that crop loss figures based on farmers' perceptions of damage and loss are often overestimated.

Step 3: Evaluate all management options. Use of best management practices, preventive measures, and "organic" options to control pest impacts may eliminate the need for synthetic pesticides.

Step 4: Choose IPM methods, identify Needs and Establish Priorities.

Continue dialog with project field staff, ministry extension staff and farmers when choosing methods to be used. Consider the feasibility of attractive methods, including the availability of resources needed, farmers' perceptions of pest problems, their abilities to identify pests, their predators, diseases and parasites, and to act upon their observations.

Step 5: Do effective activities and training to promote IPM.

Next, identify strategies and mechanisms for fostering the transfer of the needed IPM technology under various project and institutional arrangements, mechanisms, and funding levels. Define what is available for immediate transfer and what may require more adaptation and validation research. Set up an initial planning workshop (with a COP-supported and signed Action Plan) to help define and orient implementation activities, and begin to assign individual responsibilities.

Learning-by-doing/discovery training programs

The adoption of new techniques by small-, medium- and large-holder farmers occurs most readily when program participants acquire knowledge and skills through personal experience, observation, analysis, experimentation, decision-making and practice. At first, frequent (usually weekly) sessions are conducted for 10–20 farmers during the cropping season in farmers' fields by trained instructors or extension agents.

Smallholder support and discussion groups

Weekly meetings of smallholders, held during the cropping season, to discuss pest and related problems can be useful for sharing the success of various control methods. However, maintaining attendance is difficult except when there is a clear financial incentive (e.g., credit).

Educational material

In many countries, basic written and photographic guides to pest identification and crop-specific management techniques are unavailable or out of date. Videos featuring graphic pictures of the effects of acute and chronic pesticide exposure, and interviews with poisoning victims can be particularly effective.

Youth education

Promoting and improving the quality of programs on IPM and the risks of synthetic pesticides has been effective at technical schools for rural youth. In addition to becoming future farmers, these students can bring informed views back to their communities.

Food market incentives (especially important in the last decade)

Promoting Organic, GlobalGAP, BRC, Fair Trade or other certification for access to the lucrative and rapidly growing S&C systems-driven international and regional food markets can be, and is, a strong incentive to adopt IPM.

Step 6: Partner successfully with other IPM implementers.

The following design steps are considered essential.

Articulate the partnership's vision of IPM

Organizations may forge partnerships based on a common commitment to "IPM" – only to discover too late that that their visions of IPM differ considerably. It is therefore highly important that partners articulate a common, detailed vision of IPM, centered on the crops and conditions the project will encounter.

Confirm partner institutions' commitment

The extent of commitment to IPM integration into project, design, and thus implementation depends strongly upon the following key variables:

IPM program integration into larger project. The IPM program is likely to be part of a larger "sustainable agriculture" project. The IPM program must fit into a partner's overall goals. The extent of this integration should be clearly expressed in the proposed annual work plan.

Cost sharing. The extent of funds (or in-kind resources) is a good measure of a genuine partner commitment.

Participation of key IPM personnel. Organizations should have staff with expertise in IPM. In strong partnerships, these staff members are actively involved in the partnership.

Step 7: Monitor the fields regularly.

At minimum twice a week, farmers should monitor their fields for pests, as some pest populations increase rapidly and unexpectedly; this increase is usually related closely to the stage of crop growth and weather conditions, but it is difficult to predict the severity of pest problems in advance.

Step 8: Select an appropriate blend of IPM tools.

A good IPM program draws from and integrates a variety of pest management techniques, like those presented in the above list. Flexibility to fit local needs is a key variable. Pesticides should be used only if no practical, effective, and economic non-chemical control methods are available. Once the pesticide has been carefully chosen for the pest, crop, and environment, it should be applied only to keep the pest population low, not necessarily eliminate it.

Step 9: Develop education, training, and demonstration programs for extension workers.

Implementation of IPM depends heavily on education, training, and demonstration to help farmers and extension workers develop and evaluate the IPM methods. Hands-on training conducted in farmers' fields (as opposed to a classroom) is a must. Special training for extension workers and educational programs for government officials and the public are also important.

Step 10: Monitoring, Record-Keeping and Evaluation (M&E).

Develop data collection forms and checklists, collect baseline GAP/IPM data at the beginning of the project, and set targets.

For the use and maintenance of Good Agriculture Practices (that include safe pesticide storage, use and disposal), maintain farm or project files of: farmer and farm employee training records certification; farm soil, water, biodiversity, cropping and pesticide use maps; pesticide purchase and stock records; chemical application instructions including target pest, type of chemical applied, dosage, time of spray, rates at which pesticides were applied, harvest interval days, application machinery, PPE required and used, and any special instructions on mixing, exposure to children or dangers. Further, for project staff, beneficiaries, produce processing facilities, food warehouses, seed multipliers, or farmers that store seed or food and deal with stored seed and food pests, there are warehouse BMPs and monitoring reports that incorporate some IPM tactics. These monitoring forms track, by location or warehouse, use of pallets, stacking, general hygiene and sanitation, damaged packages, actual infestations or signs of rodents, molds, insects, drainage, locks and security measures, use of IPM tactics including least toxic chemicals and strict BMPs for use of common but hazardous fumigants like aluminum phosphide.

Annex 4. Natural Pesticides that have been commercialized:

Insecticides

azadirachtin—component in neem oil	botanical extract
Bacillus thuringiensis-BT	microbial
Beauveria basiana	microbial
cartap hydrochloride	marine worm (*Lumbriconereis heterodopa*) extract
chili pepper extract	botanical (spice)
emamectin benzoate	botanical extract (RUP-request exception)
garlic extract/allicin	botanical extract (spice)
harpin protein	plant induced resistance elicitor
kaolin clay	inorganic mineral
d-limonene	citrus extract (spice)
Metarhizium anisopliae	microbial
narrow range dormant oil	paraffin oil
neem oil	botanical extract
nuclear polyhedrosis virus (NPV)	microbial
Paecilomyces lilacinus	microbial
Paecilomyces fumosoroseus	microbial
pyrethrin	botanical extract (RUP-request exception)
pyrethrum	botanical extract (RUP-request exception)
pyriproxyfen	IGR (Juvenile Hormone mimic)
ryania	botanical extract
soap (insecticidal)	fatty acids
spinosad	microbial extract
buprofezin	IGR (Chitin Synthesis inhibitor)

Fungicides

Bacillus subtilis	microbial
Bordeaux mix	inorganic (Bordeaux ingredients EPA registered)
copper	inorganic
copper hydroxide	inorganic
copper oxychloride	inorganic
copper sulfate	inorganic
harpin protein	plant induced resistance elicitor
sulfur	inorganic
Trichoderma spp.	microbial

Nematocides

Myrothecium verrucaria	microbial
tomatillo oil + thyme oil extracts (Promax[6])	botanical + spice extracts—soil biopesticide

Molluscicide

iron phosphate	inorganic

[6] http://www.bhn.name/humagro/biopesticides.html

Annex 5. Botanical Pesticides, Repellents, and Baits Regulated by USEPA

Name	Other Names	Use	Toxicity	EPA Tracking Number
Allium sativum	Garlic	Repels insects	Low	128827
Allyl isothiocyanate	Oil of Mustard	Kills & repels insects	Questionable	004901
Anise Oil	Repels vertebrates	Low	004301	
4-allyl anisole	Estragole	Kills beetles	Low	062150
Azadirachtin	*Azadirachta indica* Neem tree extract	Kills & repels insects	Low, IV	121701
Bergamot		Repels vertebrates		129029
Canola Oil	*Brassica Napus B. Campestris*	Kills many insects	Low	011332
Capsaicin	*Capsicum frutescans*	Repels vertebrates	Low, III	070701
Castor Oil		Repels vertebrates	Low	031608
Cedarwood Oil		Repels moth larvae	Low	040505
Cinnamaldehyde	*Ceylon and Chinese* cinnamon oils	Kills insects, fungi & repels vertebrates*	Low	040506
Citronella Oil		Repels insects & vertebrates	Low	021901
Cloves, Crushed			Low	128895
Dihydroazadirachtin	Neem tree extract *Azadirachta indica*	Kills & repels insects	III-IV	121702
Eucalyptus Oil		Repels insects, mites fleas & mosquitoes	Low	040503
Eugenol	Oil of cloves	Kills insects**	Low	102701
Geraniol	Oil of rose isomeric w/ linalool	Repels vertebrates**	Low	597501
Geranium Oil			Low	597500
Indole	from all plants	Trap bait: corn rootworm beetles	Low	25000-
Jasmine Oil			Low	040501
Jojoba Oil		Kills & repels whitefly kills powdery mildew	Low	067200
Lavandin Oil		Repels clothes moth	Low	040500
Lemongrass		Repels vertebrates	Low	040502
Linalool	Oil of Ceylon isomeric w/geraniol	Repels insects, ticks, mites & spiders	Low	128838
Maple lactone		Roach trap bait	Low	004049

Methyl salicylate	Oil of wintergreen	Repels moths, beetle & vertebrates	May be Toxic in large quantity	76601-
Mint	Herb	Kills aphids	Low	128892
Mint Oil		Kills aphids	Low	128800
Mustard Oil		Repels insects, spiders & vertebrates	Low	004901
Neem Oil		Kills whitefly, aphids	Low	025006
1-Octen-3-ol	From clover, alfalfa	Trap bait: mosquitoes	Low	69037-
Orange		Repels vertebrates	Low	040517
p-Methane-3,8 diol	*Eucalyptus sp.*	Repels biting flies, mosquitoes	Low	
2-Phenylethyl-propionate	From peanuts	Kills insects, ticks, mites & spiders	Low	102601
Pyrethrum	*Chrysanthemum sp.*	Stored products use	III	
Red pepper	Chilli	Repels insects	Low	070703
Rosemary	Herb		Low	128893
Rotenone	*Derris sp., Tephrosia*	Controls ticks	III	
Ryania	*Ryania speciosa*	Kills thrips, codling moth, corn borers		
Sabadilla	*Schoenocaulon sp.*		III	
Sesame Oil	*Sesamum indicum*	Pyrethroid synergist	Low	
Soybean Oil	Soja	Kills insects, mites	Low	031605
Thyme	Herb	Controls aphids	Low	128894
1,2,4 Trimethoxy-benzene	From squash	Trap bait: corn rootworm, cucumber beetles	Low	40515-
Verbenone	From pine trees	Repels bark beetles	Low	128986

* attracts corn rootworm beetles, ** attracts Japanese beetles. Not all plant extracts are listed. More detailed information available for most of the oils: http://www.epa.gov/pesticides/reregistration/status.htm. Natural Source: Only one or a few sources are listed. Most of these chemicals are found in many different plants.

Annex 6. Toxicity of Pesticides: EPA and WHO Classifications

General Toxicity

Pesticides, by necessity, are poisons, but the toxicity and hazards of different compounds vary greatly. Toxicity refers to the inherent intoxicating ability of a compound whereas hazard refers to the risk or danger of poisoning when the pesticide is used or applied. Pesticide hazard depends not only on toxicity but also on the chance of exposure to toxic amounts of the pesticide. Pesticides can enter the body through oral ingestion, through the skin or through inhalation. Once inside the body, they may produce poisoning symptoms, which are either acute (from a single exposure) or chronic (from repeated exposures or absorption of smaller amounts of toxicant).

EPA and WHO Toxicity Classifications

Basically, there are two systems of pesticide toxicity classification. These are the USEPA and the WHO systems of classification. It is important to note that the WHO classification is based on the active ingredient only, whereas USEPA uses product formulations to determine the toxicity class of pesticides. So, WHO classification shows relative toxicities of all pesticide active (or technical) ingredients, whereas EPA classification shows actual toxicity of the formulated products, which can be more or less toxic than the active ingredient alone and are more representative of actual dangers encountered in the field. The tables below show classification of pesticides according to the two systems.

a) USEPA classification (based on formulated product = active ingredient plus inert and other ingredients)

Class	Descriptive term	Mammalian LD_{50}		Mammalian	Irritation		Aquatic invert/fish (LC_{50} or EC_{50})[2]	Honey bee acute oral (LD_{50})
		Oral	Dermal	Inhalation LC_{50}	Eye[1]	Skin		
I	Extremely toxic	≤50	≤200	≤0.2	Corrosive	Corrosive	< 0.1	
II	Highly toxic	50-500	200-2000	0.2-2.0	Severe	Severe	0.11-1.0	< 2 µg/bee
III	Moderately toxic	500-5000	2000-20000	2.0-20	No corneal opacity	Moderate	1.1-10.0	2.1-11 µg/bee
IV	Slightly toxic	≥5000	≥20000	≥20	None	Moderate or slight	10.1-100	

	Relatively non-toxic						101-1000	
	Practically non-toxic						1001-10,000	> 11 µg/bee
	Non-toxic						> 10,000	

[1] Corneal opacity not reversible within 7 days for Class I pesticides; corneal opacity reversible within 7 days but irritation persists during that period for Class II pesticides; no corneal opacity and irritation is reversible within 7 days for Class III pesticides; and Class IV pesticides cause no irritation

[2] Expressed in ppm or mg/l of water

b) WHO classification (based only on active or ‘technical’ ingredient)

Class	**Descriptive term**	**Oral LD_{50} for the rat (mg/kg body wt)**		**Dermal LD_{50} for the rat (mg/kg body wt)**	
		Solids	**Liquids**	**Solids**	**Liquids**
Ia	Extremely hazardous	≤5	≤20	≤10	≤40
Ib	Highly hazardous	5-50	20-200	10-100	40-400
II	Moderately hazardous	50-500	20-2000	100-1000	400-4000
III	Slightly hazardous	≥501	≥2001	≥1001	≥4001
U	Unlikely to present acute hazard in normal use	≥2000	≥3000	-	-

Annex 7: Analyses of Active Ingredients in Pesticides Registered in CILSS Countries

Introduction to Annex 7

Annex 7 below compiles all of the AIs in pesticides (natural and synthetic) registered, imported to and found in West Africa and presents this data in Annex 7. Project decision-makers—especially those who interface at the field level with beneficiary farmers—are encouraged to look at the label of potential pesticide choices to determine the AIs contained in them and then use this Annex as a quick reference guide to attributes and issues with each chemical. These attributes include pesticide class (to manage resistance by rotating chemicals from different classes), EPA registration and Restricted Use Pesticide (RUP) status (to comply with Regulation 216) and acute toxicity (judged by this document to be safe, or not, for small-holder farmers—most Class I chemicals are not considered safe for smallholder farmers to use). Annex 7 also presents chronic health issues, water pollution potential, and potential toxicities to important non-target organisms like fish, honeybee pollinators, birds and several aquatic organisms.

Further, Annex 7 contains basic pieces of human safety and environmental data needed for the various analyses required throughout the PER; ergo it is referred to throughout this document. And it provides data used to produce the project-critical information contained in Annexes 8 and 9. Thus, this PERSUAP provides useful tools for evaluating and choosing among IPM options, including natural and synthetic pesticides, while adhering to 22 CFR 216, as well as aiming at the market-driven best practices found in Standards and Certification (S&C) systems—the highest international standards available.

See Annex 7 Matrix, below.

Annex 7: Analyses of Active Ingredients in Pesticides Registered in Burkina and Niger

CILSS-INSAH homologized pesticide Active Ingredients in Products permitted for import/use in CILLS countries

								Ecotoxicity*								
Active Ingredients	**Class***	**EPA Registered**	**Restricted Use Pesticide**	**WHO Acute Toxicity Class***	**EPA Acute Toxicity Classes***	**Chronic Toxicity***	**Groundwater contaminant**	**fish**	**bees**	**birds**	**amphibians**	**worms**	**Mollusks**	**Crustaceans**	**Aquatic Insects**	**Plankton**
Insecticides/Miticides																
acetamiprid	chloro-nicotinyl	yes	no	none	III	none	no data	NAT	MT					NAT		
aluminum phosphide	inorganic	yes	**yes**	none	**I**	none	no data	HT	HT	HT				MT		
beta-cyfluthrin	pyrethroid	yes	no	II	III	ED	no data	VHT	HT	PNT			ST		VHT	VHT
Bacillus thuringiensis-BT	microbial	yes	no	none	III	none	no data		PNT	NAT	NAT		ST	ST		
bifenthrin	pyrethroid	yes	**some**	II	II, III	PC, ED, RD	no data	VHT	HT	MT				HT		
chlorpyrifos-ethyl	organophospate	yes	**some**	II	II, III	ED	no data	HT	HT	HT	MT	PNT	MT	VHT	HT	MT
cyhalothrin (lambda)	pyrethroid	yes	**some**	II	II, III	ED	no data	VHT	HT	PNT		VHT	VHT	VHT	VHT	
cypermethrin	pyrethroid	yes	**yes**	none	II, III	PC, ED, RD	no data	HT	HT	PNT			MT	VHT	VHT	VHT
deltamethrin	pyrethroid	yes	**some**	II	II, III	none	no data	HT	MT		VHT		NAT		VHT	VHT
diflubenzuron	benzoyl urea IGR	yes	**some**	U	III	none	no data	ST	NAT	PNT	NAT		NAT	NAT	ST	MT
fenitrothion	organophospate	yes	no	II	II, III	ED	no data	MT	HT	MT	MT	MT	MT	VHT	HT	MT
flubendiamide	benzene dicarboxamide	yes	no	none	III	none	no data	HT	NAT	MT		MT		HT		
imidacloprid	chloro-nicotinyl	yes	no	II	II, III	none	potential	NAT		MT					VHT	
indoxacarb	oxadiazine	yes	no	none	III	none	no data	HT		PNT		PNT		HT		
malathion	organophospate	yes	no	III	II, III	PC, ED, RD	potential	MT	HT	MT	HT	ST	VHT	MT	VHT	HT
profenofos	organophospate	yes	**some**	II	III	none	potential	HT						VHT	VHT	VHT
spinosad	microbial	yes	no	U	III	none	no data	MT	HT	PNT		ST			HT	MT
spirotetramat	keto-enol	yes	no	none	II, III	none	no data		MT	MT		MT		MT		
tralomethrin	pyrethroid	yes	**yes**	II	III	ED	no data	VHT	HT	NAT				HT		
thiamethoxam	neonicotinoid	yes	no	none	III	PC	no data	PNT	HT	PNT		PNT	PNT	PNT	PNT	
thiodicarb	carbamate	yes	no	II	II	PC	no data	MT	MT	PNT			MT	VHT		HT
triazophos	organophospate	**no**	no	**Ib**	none	none	no data									
zeta cypermethrin	pyrethroid	yes	**some**	**Ib**	II, III	PC, ED	no data	VHT	VHT	NAT		NAT	VHT	VHT	VHT	

***Keys: Class** (IGR = Insect Growth Regulator)

WHO Acute Toxicity (Class Ia = Extremely Hazardous, Ib = Highly Hazardous, II = Moderately Hazardous, III = Slightly Hazardous, U = Unlikely to Present Acute Hazard in Normal Use)

EPA Acute Toxicity (Class I = Extremely Toxic, II = Highly Toxic, III = Moderately Toxic, IV = Slightly Toxic)

Chronic Toxicity (KC=Known Carcinogen; PC=Possible Carcinogen; ED=Endocrine Disruptor potential; RD=Reproductive or Developmental Toxin potential; P=Parkinson's Disease)

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

CILSS-INSAH homologized pesticide Active Ingredients in Products permitted for import/use in CILLS countries

								Ecotoxicity*								
Active Ingredients	**Class**	**EPA Registered**	**Restricted Use Pesticide**	**WHO Acute Toxicity Class**	**EPA Acute Toxicity Classes**	**Chronic Toxicity***	**Groundwater contaminant**	**fish**	**bees**	**birds**	**amphibians**	**worms**	**Mollusks**	**Crustaceans**	**Aquatic Insects**	**Plankton**
Fungicides																
iprodione	dicarboximide	yes	no	U	III	PC	potential	MT	NAT	ST				HT		
mancozeb	dithiocarbamate	yes	no	U	III	PC, ED, RD	no data	MT	MT	ST	HT					NAT
myclobutanil	azole	yes	no	III	III	RD		MT	ST	MT		MT		MT		HT
orthosulfamuron	pyrimidinylsulfonylurea	yes	no	U	III	none	potential	NAT	NAT	MT		MT		NAT		
thiram	carbamate	yes	no	III	III	ED RD	no data	HT	NAT	PNT	VHT	HT		NAT	HT	HT
Herbicides																
2 4 D	chlorophenoxy acid	yes	no	II	III	PC	potential	ST	HT	MT	ST	NAT	NAT	NAT	ST	ST
aclonifen	diphenyl ether	**no**	no	U	none	none	no data	MT	MT	Mt		MT		MT		
ametryne	triazine	yes	no	III	III	ED	potential	ST	MT	NAT	MT		MT			ST
bensulfuron methyl	sulfonyl urea	yes	no	U	II, III	none	no data	NAT	MT	ST		MT		ST		NAT
clethodim	cyclohexenone	yes	no	none	II, III	none	potential	MT	MT	MT		MT		MT		
cycloxydim	cyclohexanone	**no**	no	U		none	no data									
diuron	urea	yes	no	U	III	KC	known	ST			ST		ST	ST	MT	ST
fluazifop-p-butyl	propionic acid	yes	no	III	II, III	none	no data	MT	ST	PNT					ST	
fluometuron	urea	yes	no	U	II, III	PC	potential	ST					ST			MT
glyphosate	phosphonoglycine	yes	no	U	II, III	none	potential	ST	ST	NAT		PNT		MT		ST
haloxyfop R methyl	a propionic acid	**no**	no	none		KC	no data	HT	MT	MT				MT		
hexazinone	triazinone	yes	no	III	III	none	known	NAT	MT	NAT				NAT	ST	ST
isoxaflutole	isoxazole	yes	**some**	none	III	KC	no data	ST	MT	ST		MT		MT		MT
s-metolachlor (alpha)	chloroacetanilide	yes	no	none	III	PC, ED	known	MT								
nicosulfuron	sulfonylurea	yes	no	U	II, III	none	potential	MT	MT	MT		MT		MT		
oxadiazon	oxidiazole	yes	no	U	II, III	KC, RD	no data	MT	MT	ST	MT	MT		ST		HT
oxadiargyl	unclassified	**no**	no	none		none	no data	MT	NAT	MT		MT		NAT		
pendimethalin	dinitroanaline	yes	no	III	III	PC, ED	no data	MT	NAT	ST				MT	MT	
prometryn	triazine	yes	no	U	III	RD	potential	MT	NAT	PNT	ST	NAT		NAT	ST	ST
propaquizafop	a propionic acid	**no**	no	U		none	no data									
trifloxysulfuron (sodium)	sulfonylurea	yes	no	none	III	none	potential	NAT	MT	MT		MT		NAT		
Rodenticides																
aluminum phosphide	inorganic	yes	**yes**	none	**I**	none	no data	HT	HT	HT				MT		
zinc phosphide	inorganic	yes	**yes**	**Ib**	**I**, II, III	R&D toxin	no data	HT	VHT	HT						

Annex 8: Pesticide Active Ingredients[7] NOT to be used on WAIPRO beneficiary farms

Pesticides AIs Contained in International Treaties	
Insecticide AIs on the International POPs Treaty Banned List	
• dieldrin	• heptachlor
Insecticide AIs on International PIC Treaty Restricted List	
• dieldrin • heptachlor • HCH (mixed isomers)	• lindane • monocrotophos
Pesticide AIs not registered by EPA in any Products	
Insecticide AIs not registered by EPA	
• allethrin/bio-allethrin • alphacypermethrin • bendiocarb • boron • cadusafos • carbosulfan • cartap hydrochloride • cyanophos • D-allethrin • diafenthiuron • dieldrin • diethyltoluamide • ethion • fenubucarb • fenvalerate	• furathiocarb • heptachlor • HCH • isofenphos methyl • isoxathion • lindane • monocrotophos • phentoate • phoxim • potassium chlorate • teflubenzuron • thiocyclam hydrogen oxalate • transfluthrin • triazophos • trifulmeron
Fungicide AIs not registered by EPA	
• benomyl (benlate) • bitertenol • dichlofluanid • diniconazole	• pencycuron • phenpropimorph/fenpropimorph • prochloraz • tridemorph

[7] Active Ingredients found both in pesticide products registered for use in CILSS countries and those informally (illegally) imported from coastal countries to formal and informal markets in Burkina and Niger

• epoxiconazole • hexaconazole • maneb	• tricyclazole • zineb
Herbicide AIs not registered by EPA	
• 2 4 D amine • aclonifen • benthiocarb • butachlor • chlorimuron ethyl • cyanazine • cyclosulfamuron • cycloxydim(e) • diafenthiuron • dipropetryne • glyphosate trimesium	• haloxyfop R methyl • metolachlor • oxadiargyl • paraquat/paraquat dichloride • penoxysulam • piperofos • pretilachlor(e) • propaquizafop • propisochlor • pyribenzoxim(e) • terbutryne
Nematocide AIs not registered by EPA	
• benfuracrab • cadusafos	• carbosulfan • isazofos (miral)
Rodenticide AIs not registered by EPA	
• coumatetralyl	• flocoumarfen
Active Ingredients that are in Restricted Use Pesticide (RUP) Products	
Insecticide AIs that are RUP	
• alphacypermethrin • aluminum phosphide • carbofuran • endosulfan • etofenprox • fipronil • isofenphos methyl	• magnesium phosphide • methidathion • methyl parathion • monocrotophos • phorate • terbufos • zeta cypermethrin
Herbicide AIs in Pesticide Products that are RUP	
• alachlor	• metolachlor
Nematocide AIs in Pesticide Products that are RUP	

• aldicarb (Temik) • carbofuran • 1, 3 dichloropropene • ethoprop(hos)	• fenamiphos • fosthiazate • oxamyl • terbufos
Rodenticide AIs in Pesticide Products that are RUP	
• aluminum phosphide	• zinc phosphide
Molluscicide AIs in Pesticide Products that are RUP	
• metaldehyde	
Class I (too toxic for small-holder farmers) Pesticides	
Insecticide AIs in Pesticide Products that are Class I	
• aluminum phosphide • carbofuran • dichlorvos (DDVP) • furathiocarb • isofenphos methyl • isoxathion • magnesium phosphide	• methidathion • methyl parathion • monocrotophos • phorate • terbufos • triazophos • zeta cypermethrin
Herbicide AIs in Pesticide Products that are Class I	
• paraquat/paraquat dichloride	
Nematocide AIs in Pesticide Products that are Class I	
• aldicarb (Temik) • carbofuran • 1, 3 dichloropropene • ethoprop(hos)	• fenamiphos • fosthiazate • oxamyl • terbufos
Serious groundwater pollution issues	
• atrazine	

Annex 9: RUP Exceptions Requested for WAIPRO (with RUP training and PPE conditions)[8]

Synthetic Pyrethroid Insecticides

- bifenthrin (RUP for all EC formulations on cotton due to toxicity to fish and aquatic organisms)
- cyhalothrin (lambda) (RUP for all formulations and uses due to toxicity to fish and aquatic invertebrates)
- cypermethrin (RUP for all formulations on all crops due to oncogenicity—non-cancerous tumors, hazard to non-target organisms)
- deltamethrin (RUP for all EC formulations on cotton due to high toxicity to aquatic organisms)
- lambda-cyhalothrin (RUP for all formulations and uses due to toxicity to fish and aquatic invertebrates)
- tralomethrin (RUP for all formulations on all crops due to toxicity to aquatic organisms)

Insect Growth Regulator (IGR) Insecticides

- diflubenzuron (RUP only for *wettable powder formulations* due to hazards to wildlife)

Organophosphates (OPs) Insecticides

- chlorpyrifos-ethyl (RUP *only for EC formulations* on *wheat* due to avian and aquatic toxicity)
- profenofos (RUP only for *59.4% EC formulations* on cotton due to corrosiveness to eyes)

Herbicide

- isoxaflutole (RUP due to possible injury to non-target plants)

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[8] Insecticide Active Ingredients that are RUP[8] primarily due to aquatic toxicity, but requested to be used under 216.3(b)(1)(ii), with the condition that RUP training is received by WAIPRO staff and incorporated into WAIPRO's training programs for beneficiaries so that they understand how to mitigate risks to aquatic toxicity and use appropriate PPE. Further, WAIPRO should make provisions for making the recipient government aware of these risks. Moreover, some pyrethroids, three organophosphates and one IGR designated as RUPs by EPA for specific formulations and uses (in italics) that are unlikely to be encountered on WAIPRO project sites, like use on cotton or wheat.

Annex 10. WAIPRO Training Topics and Safe Pesticide Use Web Resources

- GAP and IPM concepts, tactics and tools found in Annex 1 that can reduce pesticide use and associated risks on specific pests of WAIPRO IP target crops
- PMPs—Pest Management Plans: Making and using these farm crop-management tools
- Pest identification: How to recognize common important pests and diseases
- Regulations: International, Local and American treaties and laws that guide pesticide use
- Monitoring/Spot Treatments: The importance of frequent crop monitoring and use of spot treatments if needed (instead of crop-wide treatments)
- Natural pesticides: Raise awareness of and promote the use of natural pesticides found in Annexes 1, 4, 5 and 7 as well as green-label synthetic pesticides with relatively low risks
- REI—Re-Entry Intervals: Pesticide-specific risks associated with entering a sprayed field too soon after the spray operation
- MRL—Maximum Residue Level: Risks associated with pesticide residues on human food
- PHI—Pre-Harvest Interval: Pesticide-specific risks associated with harvesting a crop before pesticides have had a chance to break down
- Vulnerable individuals: The importance of keeping children, pregnant women, elderly and infirm away from the field while spraying and kept out after spraying
- Understanding pesticides: Types, classes, registration and acute toxicities of commonly-used pesticides
- MSDS: How to use MSDSs for pesticide-specific information on risks and risk reduction measures
- Human and environmental risks: Risks associated with more commonly-used pesticides (use information from MSDSs and Annex 7)
- When to spray: Early in the morning or late in the afternoon, without wind or rain
- Use of recommended PPE: Why it is used (see product MSDSs, product labels and web reference below)
- Safe Use: How to transport, store and use pesticides safely
- Maintenance: of PPE and sprayers
- Monitoring for the development of pesticide resistance
- Proper collection and disposal of pesticide rinsate and packaging (see disposal web reference below and MSDSs)
- The use of pesticide spray buffer zones or organic production near national parks or headwaters leading to rivers that enter national parks
- How to reduce and mitigate risks to critical environmental resources and biodiversity (found in PER Factors E and G)
- Honeybees: Ensuring pesticide applicators notify beekeepers about spray activities, and spray early morning or late afternoon when no heavy winds or rain are present
- Water Pollution: Raise awareness of pesticides (especially some herbicides) with high ground water contamination potential where water tables are high or easy to reach (use Annex 7 and MSDSs)
- Exposure routes: Ways pesticides enter the body and ways to mitigate entry
- Basic first aid: Understanding how to treat pesticide poisonings (see first aid web reference below and MSDSs)
- Record-keeping: Pesticide used, when used, which crop, how applied, who applied

Web Safe Pesticide Use Training Resources

General Mitigation of Potential Pesticide Dangers General Measures to Ensure Safe Use:
http://pdf.usaid.gov/pdf_docs/PNADK154.pdf, Chapter 13

EPA Recommended Worker Protection Standards: http://www.epa.gov/oppfead1/safety/workers/equip.htm (all types of PPE)
http://www.cdc.gov/nasd/docs/d001701-d001800/d001797/d001797.html (respiratory PPE)

Routes of Pesticide Exposure and Mitigation of Risks:
http://pdf.usaid.gov/pdf_docs/PNADK154.pdf, Chapter 13

Basic First Aid for Pesticide Overexposure:
http://pdf.usaid.gov/pdf_docs/PNADK154.pdf, Chapter 13

International PIC & POPs Lists:
PIC Pesticides and Industrial Chemicals (http://www.pic.int)
POPs Pesticides and Chemicals (http://www.pops.int)

Pesticide Disposal Options:
http://www.epa.gov/oppfead1/labeling/lrm/chap-13.htm

Annex 11. Monitoring for Best Practices on WAIPRO Beneficiary Farms

Name of NARS Staff Responsible for Monitoring Demonstration Farms:

Name of Demonstration Farmer: Crop: Date:

What are the major pests encountered by the farmer?:

Which of the *attached* IPM tools and tactics are used by farmer?

Are pesticides used by demo farmer? Yes__ No__

How are pesticides applied? backpack sprayer__ other__

What are the names of the pesticides used?:

Which PPE does farmer have and use? gloves__ overalls __ boots__

mask__ goggles__

Has the farmer had WAIPRO IPM and Safe Pesticide Use training? Yes__ No__

Are there any empty pesticide containers scattered in the field? Yes__ No__

Are there signs that the backpack sprayer has leaks? Yes__ No__

Does the farmer understand the pesticide label information? Yes__ No__

Is the pesticide stored safely out of the house or away from kids? Yes__ No__

Does the farmer use gloves for mixing the pesticide with water? Yes__ No__

What time of the day is/are the pesticides applied? ________

Are pesticides applied during rain or windy conditions? Yes__ No__

Are women or children permitted to apply pesticides? Yes__ No__

Is there any evidence that empty pesticide containers are used to store water? Yes__ No__

Does the farmer rinse equipment away from streams and open water? Yes__ No__

Does the farmer wash clothes after applying pesticides? Yes__ No__

How does the farmer dispose of empty pesticide containers? puncture/burry__ burn__

Is there any evidence that pesticides are becoming less effective? Yes__ No__

Preventive and Curative GAP and IPM options:

Preventive	Preventive	Curative
Soil nutrient, texture and pH testing	Farmer ability to correctly identify pest predators, parasites and diseases	Mechanical insect control by hand picking
Pest resistant/tolerant seed/plant variety	Weekly field scouting to assess pest levels/damage	Farmers make & apply local artisanal plant extracts (neem, pyrethroid, garlic, chili, other)
Early/late plantings or harvestings to avoid pests	Use of trap crops to trap and destroy pests	Weed control by machine cultivation, hoe or hand
Seed treatment with pesticides	Removal/pruning of diseased or heavily infested plants/tree branches	Purchase and release of predators or parasitoids to control major pests
Soil moisture testing	Planting parasite-attracting plants on field margins	Use of pheromone traps to reduce overall pest levels
Raised-bed production or mounding	Put baits and use other practices to encourage predator/parasite build-up	Use of pheromone inundation to confuse pest mating
Irrigation and drip irrigation	Use of pheromone traps to monitor pest levels	Spot treatment of pest hotspots with insecticides, miticides or fungicides
Use of natural fertilizers (manure, compost)	Inter-planting crops with aromatic herbs (celery, cilantro, parsley, dill or local plants) that repel pests	Area spraying (complete field coverage) using synthetic and natural insecticides, miticides or nematocides
Use of purchased mineral fertilizers	Mulching with organic materials or plastic to control weeds	Use of synthetic and natural fungicides or bactericides
Combinations of organic and mineral fertilizers	Plant living barriers or bamboo/tree barriers on windward edge of field	Use of herbicides for weed control
Crop rotation	Exclude insect pests by using vegetable tunnels and micro-tunnels	Farm use of a locked storage building for pesticides
Use of green manure crops	Use of biodiversity or energy conservation practices	Farmer use of pesticide in-ground compost trap for depositing and capturing spilled or leftover pesticides
Farmer ability to correctly identify pests and their damage	Crop stalks, residue and dropped fruit destruction or composting at end of season	Farmer use of receptacle for empty pesticide bottle disposal

References:

Baker EL, Zack M, Miles JW, Alderman L, Warren M, Dobbins RD, Miller S, Teeters WR. 1978. Epidemic malathion poisoning in Pakistan malaria workers. The Lancet, January: 31–33.

Websites: Website references used to develop the PERSUAP

International Treaties and Conventions:
POPs website: http://www.pops.int
PIC Website: http://www.pic.int
Basel Convention: http://www.basel.int/
Montreal Protocol: http://www.unep.org/OZONE/pdfs/Montreal-Protocol2000.pdf
Pakistan malaria poisonings: http://pdf.usaid.gov/pdf_docs/PNACQ047.pdf.
Pesticide poisonings:
http://www.panna.org/resources/panups/panup_20080403
http://magazine.panna.org/spring2006/inDepthGlobalPoisoning.html
IPM and PMP websites:
http://www.ipm.ucdavis.edu/
http://edis.ifas.ufl.edu/pg058
http://www.ipmcenters.org/pmsp/index.cfm
http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/154769/Cotton-pest-management-guide-1.pdf
Pesticide Research Websites:
http://extoxnet.orst.edu/pips/ghindex.html (Extoxnet Oregon State database with ecotox)
http://www.agf.gov.bc.ca/pesticides/f_2.htm (all types of application equipment)
http://www.greenbook.net/Search/AdvancedSearch (pesticide Material Safety Data Sheets)
http://www.epa.gov/pesticides/reregistration/status.htm (EPA Registration Eligibility Decisions)
Ecotoxicity:
http://www.ohioline.osu.edu/hyg-fact/2000/2161.html (pesticide toxicity to honeybees)
http://wihort.uwex.edu/turf/Earthworms.htm (pesticide toxicity to earthworms)
Safety:
http://www.epa.gov/oppbppd1/biopesticides/ingredients/index.htm (EPA regulated biopesticides)
http://www.ipm.ucdavis.edu/index.html (IPM, PMPs and pesticide recommendations)
http://edis.ifas.ufl.edu/pdffiles/PI/PI07300.pdf (Restricted Use Pesticides)
http://www.epa.gov/pesticides/health/ (EPA Health & Safety)
http://www.epa.gov/opppmsd1/PPISdata/index.html (EPA pesticide product information)
Personal Protection Equipment (PPE):
http://www.epa.gov/oppfead1/safety/workers/equip.htm (all types of PPE)
http://www.cdc.gov/nasd/docs/d001701-d001800/d001797/d001797.html (respiratory PPE)