Integrated Pest Management Plan

Prior to conducting and IPM capacity needs assessment

Sudan SOMOUD Enhancing Community Resilience Project – Component 2 (P181490)

WFP
World Food Programme

SAVING LIVES
CHANGING LIVES

October 2024

Acronyms and Abbreviations

ARC	Agricultural Research Corporation
CETs	Community Extension Trainers
COD	Chemical Oxygen Demand
CP	Cooperating Partner
EIL	Economic Injury Levels
EL	Economic Limits
ET	Economic Threshold
ESMPs	Environmental and Social Management Plans
ESRM	Environmental and Social Risk Management
EA	Extension Agents
ESSs	Environmental and Social Standards
FOs	Farmers Organizations
HIV/AIDS	Human Immuno Virus/Acquired Immuno Deficiency Syndrome
IDP	Internally Displaced Person
ILO	International Labor Organization
IPPC	International Plant Protection Convention
IPM	Integrated Pest Management
IPMP	Integrated Pest Management Plan
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
MC	Mercy Corps
M&E	Monitoring and Evaluation
MOAF	Ministry of Agriculture and Forestry
NPDC	The National Pests and Diseases Committee (NPDC)
OHS	Occupational Health and Safety
PCB	Polychlorinated Biphenyl
PDO	Project Development Objective
PPE	Personal Protective Equipment
POPs	Persistent Organic Pollutants
ROS	Republic of Sudan
SOMOUD	Sudan Enhancing Community Resilience Project
STARS	Sudan Transition and Revery Support
UNEP	United Nations Environment Programme
UNICEF	United Nations Children Fund
WBG-EHS	World Bank Group Environment, Health and Safety
WHO	World Health Organization
WB	World Bank
WFP	World Food Program
WTO	World Trade Organization

EXECUTIVE SUMMARY

1.0 INTRODUCTION

1.1 BACKGROUND

Sudan is endowed with immense natural resources that could constitute a strong trigger for the development of the agriculture sector and meet the food security needs of the country. It has the largest irrigated area on the continent and ample lands exploited by rain-fed agricultural systems. However, despite its rich natural resources, the agriculture sector in Sudan has been performing poorly. It suffers from structural problems such as low productivity and high marketing costs that reduce competitiveness and result in lower prices for farmers. This situation has been caused by unpredictable and poor economic and sectoral policies and weak institutional capacities. Also, the prevailing distortions in land rights have led to misuse of the land resource and have further exacerbated the low productivity syndrome. Without the above being addressed, it will be extremely difficult to improve food security of the population and attract full engagement of the private sector and achieve any meaningful sustained growth in the sector. With the structural problems facing the agricultural sector in Sudan, the scale of crop losses due to the pests adds remarkably to the challenge. These losses take place during the crop growth, harvest, and post-harvest. Therefore, there is need to introduce ecologically preferable, socially acceptable, cost effective, rational, and sustainable pest management technologies to farmers. Integrated Pest Management (IPM) has been proposed as one of the strategies in tackling the problem. Further, the World Bank (WB) Environmental and Social Standard (ESS) 3 on Resource Efficiency and Pollution Prevention and Management expects World Bank-financed agricultural projects to give preference to IPM approaches such as biological, cultural practices, and the development and use of crop varieties that are resistant or tolerant to the pests. The ESS3 defines IPM as "a mix of farmer-driven, ecologically based pest control practices that seeks to reduce reliance on synthetic chemical pesticides. It involves: (a) managing pests (keeping them below economically damaging levels) rather than seeking to eradicate them; (b) integrating multiple methods (relying, to the extent possible, on nonchemical measures) to keep pest populations low; and (c) selecting and applying pesticides, when they have to be used, in a way that minimizes adverse effects on beneficial organisms, humans, and the environment.

1.1.1 The Sudan Enhancing Community Resilience Project (SOMOUD)

The SOMOUD project will be implemented over a five-year period, with the first three years implemented through Third Party Implementation by the United Nations Children's Fund (UNICEF) and the World Food Programme (WFP) and financed by a US$160 million grant from the Sudan Transition and Recovery Support (STARS) Multi-Donor Trust Fund, for which the World Bank acts as the grant administrator with a project code P181490. The project will have a national scope with an initial focus on urban and rural localities in Northern, River Nile and Kassala states. These states were prioritized based on Internally Displaced Person (IDP) influx, relative security, and overall project feasibility criteria, such as access and proximity to productive agricultural areas that supply food to domestic markets serving IDPs and host communities. The localities, communities, and agricultural cooperatives will be selected using a formula agreed between the WB, UNICEF, and WFP that will be based on a defined set of criteria, such as influx of IDPs, level of services, level of food security, climate vulnerability, and complementarity with other development partner interventions, defined in the Project Implementation Manual (PIM).

1.1.2 Project Development Objective-PDO

The Project Development Objective (PDO) is to improve access to basic services and food security of Select Communities in the Republic of the Sudan.

1.1.3 Project Components

Component 1 will help achieve the first project outcome of improved access to basic services by supporting: (i) delivery of improved community-led basic services: education, health, WASH, and GBV response (ii) temporary engagement of frontline workers and volunteers in such as low skills works, site beautification, and civil works installation and other selected sectors; (iii) project management and technical assistance costs; and (iv) technical assistance and training to establish and maintain a customized dash board and operation and maintenance by local authorities. Component 1 will finance goods, works, consulting and non-consulting services, training, and operating and indirect costs and be implemented by UNICEF through its ongoing programs and by competent: local or international non-governmental organizations (NGOs) or other non-government entities working with UNICEF, for example National Planning Organization (NP) and Woman and Childcare Organization (WCC).

Component 2 will help achieve the second project outcome of improved food security by supporting: (i) increased resilience and production of select crops (wheat, sorghum, and horticultural crops) and protection of livestock assets in rural areas that supply food to the target communities; (ii) agricultural value chains through provision of farm inputs and services, rehabilitation and upgrading (including with solar pumps) of existing irrigation infrastructure, transport and logistics (including storage and packaging) and small-scale processing and other post-harvest activities; and (iii) the scaling-up and strengthening of community consumer cooperatives and community food centres that distribute agricultural outputs and provide affordable food to vulnerable groups. Component 2 will finance works, goods, matching grants, small grants, consulting and non-consulting services, training, and operating costs and be implemented by WFP with its Co-operating Partner Mercy Corps.

1.2 INTEGRATED PEST MANAGEMENT PLAN (IPMP)

One of the steps to transform and increase food production is the reduction of current yield losses caused by pests, pathogens, and weeds in the field and during storage. The activities funded under SOMOUD will not use synthetic chemical pesticides and will minimize and control the release and use of hazardous materials as chemical fertilizers. To ensure that crops are managed in an integrated manner, IPM measures are mainstreamed in Component 2 activities to comply with national legislation and WB Environmental and Social Standards (ESSs). Thus, having the present IPMP in place to guide handling, application, and disposal of agro-inputs in the project activities is imperative to provide agricultural practices that can reduce problems associated with pesticide usage.

1.2.1 Objective of the IPMP

The objective of the IPMP is to promote the use of a combination of environmentally and socially friendly practices (hygienic, cultural, biological, or natural control mechanisms, and judicious use of agro-inputs) and reduce reliance on synthetic chemical pesticides and ensure that health, social and environmental hazards associated with pesticides are excluded under the project.

The specific objectives of the IPMP are to:

a. Ensure appropriate pest management techniques and technologies are applied under the project;
b. Effectively monitor use of agro-inputs and occurrence of pest issues amongst participating farms;
c. Provide for implementation of effective IPM measures as a farm/area specific IPMP if serious pest management issues are encountered; and

d. Ensure compliance with the World Bank Environmental and Social Standards (ESSs), particularly 1, 2, 3, and 4[1].

2.0 POLICY AND LEGAL FRAMEWORK

This section lists the relevant Sudanese laws and policies as well as the WB ESSs, and the international conventions that govern E&S management in Sudan. The objective is to ensure that project activities at the implementation phase are in line with the national and international laws and policies as well as the World Bank ESSs.

2.1 THE NATIONAL LEGAL FRAMEWORK

Relevant National Laws and Relevance to the Project

Table 1: Sudan laws relevant to the project

No	Legislation	Legal Provisions
1	The Environmental Law (2001)	The Environmental Protection Act of 2001/amendment of 2020 provides an umbrella law and general principles to be considered in carrying out environmental assessments, including definitions and several clarifications regarding natural resources management, sources of pollution and pollutants and endorses the principal of the "polluter pays".
2	Forests and Renewable Natural Resources Act (2002)	This Act empowers provincial governments to prohibit the clearing of forest for cultivation, grazing, hunting, removing forest produce, quarrying, and felling, logging, and topping down of trees and branches in reserved or protected areas and provides penalties for breach of regulation and payment of cash compensation.
3	Wildlife Protection and National Parks Act (1986)	This Act was issued to provide protection, preservation, conservation, and management of wildlife and setting up of a National Park. It is applicable to all areas for protection, conservation and preservation and management of wildlife.
4	Water Resources Act (1995)	This Act aims at reforming the organization of the Nile and Non-Nilotic surface waters as well as the groundwater, hence superseding the Law of 1939 that was limited to the Nile waters only. It establishes the National Council for Water Resources (NCWR) to design and rationalize the management and use of water resources to mitigate the effects of natural disasters resulting from drought and floods.
5	The Environmental Health Act of 1975 and the Public Health Act (1975)	These Acts provide regulations and restrictions (standards) for industries regarding water and air pollution. They extend protection obligations to cover animal and plant life. Specifically, they cover issues related to collection, treatment, and disposal of waste, and prohibit water pollution by addition

[1] ESS1: Assessment and Management of Environmental and Social Risks and Impacts; ESS2: Labor and Working Conditions; ESS3: Resource Efficiency and Pollution Prevention and Management; and ESS4: Community Health and Safety.

No	Legislation	Legal Provisions
		of any solid or liquid wastes, chemicals, sewage, and remains of animals on water resources such as rivers, hafirs, and wetlands.
6	Land Tenure Laws • The use of land for agriculture is covered by the Presidential Decree No. 34, • Land Settlement and Registration Ordinance 1925, • Unregistered Land Act 1970, and • Civil Transaction Act 1984.	The use of land for agriculture is covered by Presidential Decree No. 34, while the use of land for residency and other purposes is covered by the Land Settlement and Registration Ordinance 1925, the Unregistered Land Act 1970, and the Civil Transaction Act 1984. These land laws have allowed recognition of tribal and individual usufruct rights – the right to enjoy another person's property without abusing it – and inheritance rights, as well as opening the way for compensation for land appropriated by the state. Most land use for traditional farming and grazing operates under the usufruct system. The complexity of the country's land tenure and land use laws have made it difficult to allocate land for private sector investment.
7	Urban Planning and Disposition Act (1994)	This Act sets specific rules for the separation of industrial areas from the residential ones. In carrying out Environmental Impacts Assessment (EIA), the legal requirements are not confined to the above-mentioned Acts. There are other important sectoral laws that must be considered and used as yardsticks to identify the negative environmental effects.

2.1.1 The relevance of the World Bank Environmental and Social Standards within the IPMP

The following Environmental and Social Standards link to the IPMP:

ESS1: Assessment and Management of Environmental and Social Risks and Impacts

There are social and environmental risks related to pest management. This IPMP identifies those risks and how to avoid, minimize, reduce, or mitigate them.

ESS2: Labor and Working Conditions

The IPMP identifies occupational, health and safety (OHS) issues and management relevant to pest management, including use of personal protective equipment (PPE), among others.

ESS3: Resource Efficiency and Pollution Prevention and Management

The project will support the use of fertilizers, veterinary services, and port-harvest activities. This may induce the use of pesticides and makes ESS3 relevant.

ESS4: Community Health and Safety

Pest management can have a bearing on the wider environment and community health, in particular if farmers misuse pesticides. The IPMP Sets out these risks and how the project will avoid, minimize, reduce or mitigate them.

ESS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources;

The project will not support any activities that can lead to destruction of biodiversity and natural resources, however, if any subproject is deemed important to reach the project objective would imply biodiversity / natural habitat impacts, ESS6 would become relevant, and a subproject's Environmental and Social Management Plan (ESMP) will be prepared.

Stakeholder consultations

Thus far project consultations have been conducted, supported by the WB, mainly with the Agricultural Research Corporation (ARC), the Principal Government Institution responsible for carrying out research, testing of active ingredients, including residual evaluation, and carrying out trials before recommending any pesticide to be registered for use. The consultation included obtaining information on the pests that affect the target crops and the control measures.

Integrated Pest Management Plan Implementation

Key Strategies

The project recommends the following programmes and strategies to achieve an effective pest and pesticide management processes as well as fertilization for farmers and relevant government Ministries, departments and agencies involved in supporting agricultural production and management of pesticides:

a. Formation of an Environmental and Social Risk Management (ESRM) Team
b. Education and awareness creation on safe and efficient pesticides and fertilizer use
c. Pests Monitoring and Surveillance Measures
d. IPM Capacity Building
e. Institutional Capacity Building and Training
f. Training of farmers in IPM and safe and efficient pesticides and fertilizer use
g. Participatory Monitoring and Evaluation

Key Interventions of the IPMP

a. **Identify Pests:** Identifying pests is a critical step in developing management strategies. In many cases a single pest is of primary concern, however, many pests can be managed in similar ways. Identifying all the pests that require management can provide the use of strategies that are effective in preventing a range of pests.
b. **Determine acceptable injury level (economic injury level and economic threshold):** Economic injury level (EIL) is the lowest acceptable level of pest density that will cause economic injury equal to the cost of control. The economic threshold (ET) is the population density at which control action should be determined (initiated) to prevent an increasing pest population (injury) from reaching the economic injury level. Economic threshold (ET) is set below the EIL and is the point at which management is applied to prevent EIL.
c. **Monitor pest population level:** This can be achieved/accomplished through trapping or scouting of target areas.
d. **Evaluate management options:** Determine all available control methods for the pest or group of pests' prevention or exclusion of target pests is often the first line of defence, then biological or chemical control can be used if the pest levels still reach economic levels.
e. **Develop and implement an IPM:** Pest exclusion or prevention should be used whenever possible, for all previously identified pests. The best approach is to use biological, physical, cultural approaches, and when they fail a last resort is to use chemicals. Chemical management should be supplemented and used if all other strategies fail. Chemical application should be made at the determined acceptable level of injury or ET.
f. **Monitor management effectiveness:** Continue to monitor pest population levels after control implementation to inform the need for other necessary interventions.

1. INTRODUCTION

1.1 BACKGROUND

Agricultural crops in Sudan are usually attacked by different local pests at variable levels based on the prevailing climatic and ecological conditions. However, with the modernization of agriculture coupled with the rapid movement of global trade during the last decades, new species of insects were accidentally introduced to the country. Unfortunately, most of these insects are potentially harmful species, hence imposing serious threats to agriculture and/or natural resources.

The rapid expansion of the agricultural sector in Sudan has resulted in increased demand for agrochemicals. The use of agrochemicals has many benefits such as increased crop and animal yields and reduced post-harvest losses. However, agrochemicals exist of diverse levels of toxicity and there are major differences with the substances used/prohibited between developed and developing countries and can cause serious human health and environmental damage if not properly handled. Some of highly hazardous pesticides used in Sudan include 2,2 D (acid equivalent), used on sorghum; dicamba, clodinafop-propargyl used on wheat and vegetables; fluxofenim used on sorghum (reference to Table 13, Annex 1). The banned pesticides will not be used under the project as there is no provision for supplier to the farmers. Integrated pest management (IPM) is an ecological approach to pest management as it discourages the use of pest control methods that have negative effects on the non-target organisms. Many crops grown in Sudan like elsewhere in the world, depend on insect pollinators. Most of these pollinators are insects such as bees, moths, flies, wasps, and beetles. Inappropriate use of agrochemicals could cause harm to non-target organisms including these pollinators.

The purpose of this Integrated Pest Management Plan (IPMP) is to provide a strategic framework for the integration of climate-smart productive measures that address both climate change mitigation, adaptation, and overall sustainable land management practices and technologies, including environmental and pest management considerations in the planning and implementation of the activities to be implemented under the Sudan Enhancing Community Resilience Project (SOMOUD).

Though many solutions to pest problems exist, farmers tend to rely on pesticides as the first choice of pest control measure, particularly in high input agriculture experienced in agricultural sector.

The major classes of pesticides used in Sudan are (i) organochlorines, persistent organic pollutants (POPs) that have significant toxicity to plants and animals, including humans, (ii) organophosphates that are inherently neurotoxic to humans and pose a risk to children's neurodevelopment and normal neurological function, and (iii) carbonates that act as an oxidizing agent to kill fungal and algal pests. The major source of environmental contamination by pesticides is the deposits resulting from application of these chemicals to control agricultural pests. They affect the environment by point-source pollution and non-point source pollution. The former is the contamination that comes from a specific and identifiable place, including pesticide spills, wash and rinse water from cleanup sites, leaks from storage sites, and improper disposal of pesticides and their containers. The latter is the contamination that comes from a wide area, including the drift of pesticides through the air, pesticide run off into waterways, and pesticide movement into ground water.

Environmentally sensitive areas to pesticides include areas where the water table is high, near the habitats of endangered species and other wildlife, near honeybees and near food crops and ornamental plants. Sensitive plants and animals and the water quality of water bodies in field margins can be affected directly

or indirectly. The degradation of pesticides is influenced by many factors such as the application factors, pesticide properties, weather conditions and microorganisms. Some pesticides also escape into the atmosphere through volatilization process, and some can travel long distances before they wash back down to earth in rainfall or settle out through dry deposition.

Agrochemical residues can enter streams through run-off and pose dangers to fish, birds, wild animals, and plants in the aquatic habitat. Excessive use of fertilizers, for example, can lead to the contamination of groundwater with nitrate, rendering it unfit for consumption by humans or livestock. In addition, the run-off of agricultural fertilizer into streams, lakes, and other surface waters can cause an increased productivity of those aquatic ecosystems causing eutrophication. The ecological effects of eutrophication can include an extensive mortality of fish and other aquatic animals, along with excessive growth of nuisance algae, and an off taste of drinking water.

The SOMOUD project is designed to complement the current humanitarian aid to Sudan by laying a foundation for medium- and longer-term development support in areas with high concentration of Internally Displaced Persons (IDPs). It aims to build the future of Sudan by restoring access to basic services and food, protecting human capital, and enhancing communities' resilience using a bottom-up approach. It is sequenced to first meet immediate basic service needs of vulnerable groups in areas of high IDP concentration and relative safety and accessibility, followed by community-led planning and implementation of medium-term basic services. To address these communities' food insecurity, the project will intervene in rural areas that provide food to the target communities where agricultural production is possible to increase resilience, enhance production of select crops, and improve accessibility and affordability of food in local markets.

The project will be implemented over a five-year period, with the first three years implemented through Third Party Implementation by the United Nations Children's Fund (UNICEF) and the World Food Programme (WFP) and financed by a US$160 million grant from the Sudan Transition and Recovery Support (STARS) Multi-Donor Trust Fund, for which the World Bank (WB) acts as the grant administrator with a project code P181490. The project will have a national scope with an initial focus on urban and rural localities in Northern, River Nile, and Kassala states. These states were prioritized based on IDP influx, relative security, and overall project feasibility criteria, such as access and proximity to productive agricultural areas that supply food to domestic markets serving IDPs and host communities. The localities, communities, and agricultural cooperatives will be selected using a formula agreed between the WB, UNICEF, and WFP that will be based on a defined set of criteria, such as influx of IDPs, level of services, level of food security, climate vulnerability, and complementarity with other development partner interventions and has been elaborated in the Project Implementation Manual (PIM). The project may be scaled up to additional localities in the three target states and/or to other states if context and funding allow, considering the country's overall needs and based on agreement with the World Bank. The project may also shift its focus to areas where physical recovery is possible and areas to which IDPs can return. Should conflict escalate in any of the target areas, resources may shift to other localities in the three states or to other states using the defined criteria and in agreement with the World Bank.

1.1.1 Project Development Objective (PDO)

The Project Development Objective (PDO) is to improve access to basic services and food security of select communities in the Republic of the Sudan.

1.1.2 Project Components

The project has two components, and the World Food Program will coordinate Component 2. Component 2 will help achieve the second project outcome of improved food security by supporting: (i) increased resilience and production of select crops (wheat, sorghum, and horticultural crops) and protection of livestock assets in rural areas that supply food to the target communities; (ii) agricultural value chains through provision of farm inputs and services, rehabilitation and upgrading (including with solar pumps) of existing irrigation infrastructure, transport and logistics (including storage and packaging) and small - scale processing and other post-harvest activities; and (iii) the scaling-up and strengthening of community consumer cooperatives and community food centres that distribute agricultural outputs and provide affordable food to vulnerable groups. Component 2 will finance works, goods, matching grants, small grants, consulting and non-consulting services, training, and operating costs and be implemented by WFP through our Co-operating Partner Mercy Corps.

It is within this framework that the World Food Program, in collaboration with the World Bank, has undertaken the preparation of the IPMP for Sudan under the WB-administered STARS funding. Due to the nature, the characteristics, and the scope of the SOMOUD activities, the potential environmental risks are Moderate in scale and severity, but social risks are High.

1.1.3 Component 2 Activities that Require Integrated Pest Management

As per the project description, Component 2 will support (i) increased resilience and production of select crops and protection of livestock assets in rural areas that supply food to the target communities, (ii) provision of fertilizers, veterinary inputs, and support post-harvest activities. Related activities make the World Bank ESSs 2 and 3 relevant, considering, among other aspects, potential induction of use of pesticides.

1.2 VULNERABLITY OF SUDAN TO CROP DISEASES AND PESTS' ATTACKS

1.2.1 Key Contributing Factors

The review of literature sources as well as interviews with ARC Research Scientists during the preparation of the IPMP noted that increasing vulnerability of crops to pests and diseases is occasioned by an interplay of factors that have been magnified with the ongoing war. These can be summarized as follows:

1. **Lack of adequate systems for disease control in the country**, due to limited human and physical capacity to conduct disease surveillance and implement control measures. Thus, any isolated cases of disease can easily become a large problem;
2. **Lack of controls at the border points between Sudan and neighbouring countries** in which case, plant and animal materials can be brought into the country without proper checking and any clearance/authorisation;
3. **Imported animal and plant food products** that are not properly inspected due to the weak inspection system;

4. **Poor farm level management:** One of the principle causes of poor pest management at farm level include limited awareness of pest management solutions and farmers failure to follow extension advice;
5. **Limited awareness of particularly integrated pest management solutions:** Farmers have limited capacity to identify, differentiate and diagnose disease problems and effectively respond to them. In some cases, farmers increase the dosage sprayed without knowledge of the resultant impacts and without using personal protective equipment (PPE). This lack of knowledge is partly blamed on inadequate supporting extension system as such, and better access to sources of information on technical packages is needed;
6. **Climate change related factors:** Increasing climate variability has caused augmented pest resistance to pesticides and requires new IPM strategies.
7. **Lack of collective action by farmers:** Effective management of some pests requires concerted efforts and collective action. Collective action ensures community wide management of pests, because if only a few farmers implement pest management, their crops may still be infected because of poor practices in their neighbours' fields.

1.3 INTEGRATED PEST MANAGEMENT PLAN (IPMP)

1.3.1 The Objective of the IPMP

The objective of the Integrated Pest Management Plan (IPMP) is to promote the use of a combination of environmentally and socially friendly practices (hygienic, cultural, biological, or natural control mechanisms and the judicious use agro-inputs) and reduce reliance on synthetic chemical pesticides and ensure that health, social and environmental hazards associated with pesticides are excluded under the Project.

The specific objectives of the IPMP are to:

a. Ensure appropriate pest management techniques and technologies are applied under the project;
b. Effectively monitor use of agro-inputs and occurrence of pest issues amongst participating farms;
c. Provide for implementation of effective IPM measures as a farm/area specific IPMP if serious pest management issues are encountered; and
d. Ensure compliance with the World Bank Environmental and Social Standards (ESSs), particularly 1, 2, 3, and 4[2].

1.3.2 The IPMP Rationale

The IPMP addresses relevant stakeholder concerns about pests and pesticides. It stresses the need to monitor and mitigate negative environmental and social impacts of the pesticide use and promote ecosystem management with the human health risk being the underlying principle from seed usage, through planting and growth stage and post-harvest issues including safe crops for consumption. It emphasizes the need for an integrated approach to the management of pests in line with the nation's guidelines on IPM as well as World Bank requirements on pest management and makes provision for adequate measures to enable the project to recommend the adoption of IPM techniques.

[2] ESS1: Assessment and Management of Environmental and Social Risks and Impacts; ESS2: Labor and Working Conditions; ESS3: Resource Efficiency and Pollution Prevention and Management; and ESS4: Community Health and Safety.

1.3.3 Scope of IPMP

The IPMP covers the existing national and international legislation on the use of alternative approaches other than chemicals for pest management. It also assesses the Sudan experience in pest management and capacity on IPM approach. Other areas addressed by it include training and awareness for the implementation of the IPMP. Specifically, it identifies institutional responsibility with regards to related extension services on IPM measures and monitoring indicators to be observed to evaluate the performance and effectiveness of the IPMP.

1.3.4 General Approach in the Preparation of the IPMP

With the scaling of agriculture involving farmers organizations (FO's) as part of the project, use of agro-inputs in the project area will be a major focus of project activity. The design and environmental impact screening of specific project options or interventions will consider in each case the likely agro-inputs to be used. An appropriate IPM technique shall be followed in each Component 2 intervention as pertinent to mitigate the need or demand for the use of agro-inputs.

The project through the Co-operating Partner will provide farmers training to develop their IPM approaches to managing pests and diseases. This will be done holistically from seed selection and land preparation, through planting and farm maintenance to harvesting and management of post-harvesting issues. Farmers will be trained and encouraged to make detailed observations in their fields regularly so that they can detect early infestations and make the appropriate management decisions.

In this way, pest and disease problems do not escape notice and are not allowed to develop to the extent that they cause severe damage and heavy crop losses. The project will not finance procurement of chemical pesticides or support chemical pesticide use in general, and pest issues will be addressed amongst downstream project actors or participants, including farming organizations, cooperatives, SMEs, and local communities. The emphasis will be on the use of natural alternatives to pesticides. However, farmers may procure pesticides themselves, outside of project resources, and while this is outside the sphere of control of the project, SOMOUD through the Cooperating Partner is expected to influence prevailing pest management practices positively by providing information and awareness raising to farmers and FOs about the risks and proper handling of pesticides.

Communicating any decision on pest management strategy or measure from the project implementation level will be undertaken by SOMOUD.

1.3.5 Methodology

The preparation of the IPMP involved extensive literature reviews and stakeholder consultations. Various documents and literature reviewed included:

a. Guidelines on the implementation of Integrated Pest Management (IPM) for Sudan SOMOUD;
b. The Sudan Country Situation report on highly hazardous pesticides (HHPs) by the Sudan Environment Conservation Society (SECS), May 2020;
c. Integrated Pest Management Plan (IPMP) for the National Agricultural and Rural Inclusive Growth Project (NARIGP) for Kenya, October 2018;
d. Integrated Pest Management Plan, Sustainable Agricultural Intensification and Food Security Project, Rwanda, April 2018;
e. Integrated Pest Management Plan, Hydro-agricultural Development Project with Climate Resilient Smart Farming Practices in Niger, December 2019;
f. Integrated Pest Management Practices for the Production of Cereals and Pulses, Ministry of Agriculture, Republic of Ghana;

g. Tanzania, Agricultural Sector Development Program (ASDP), IPMP, Revised Version, March 2009; and
h. Pest Management Plan for Agriculture Cluster Development Project (ACDP) Ministry of Agriculture, Animal Industry and Fisheries, Uganda.

1.3.5 Stakeholder Consultations

Stakeholder consultations were done during the preparation of the IPMP, supported by the World Bank ESRM team, with the research scientists from the Agricultural Research Corporation (ARC). The consultation included obtaining information on the pests that affect the target crops and the control measures. Some relevant experts working in various Government institutions such as the National Council for Pesticides, the National Pests and Disease Committee, the Higher Council for Environment and Natural Resources could not be reached sometimes because of connectivity and others did not honor the requests for consultation.

1.3.6 Summary of Issues Raised during Stakeholder Consultations

Some of the key stakeholder concerns among ARC scientists relating to pests and pesticides from the consultation included the increasing resistance of some pests to pesticides, which they attributed to climate change. There is an issue of farmers increasing the dosage sprayed without appropriate guidance and without using any personal protective equipment (PPE). There is weak enforcement of appropriate use of agrochemicals mainly attributed to the ongoing war. However, it was also pointed out that the hot climatic conditions in Sudan have also limited the number of pests that attack crops.

1.3.7 Stakeholder Consultations and Participatory IPM Assessments during IPMP Implementation

It's important to study the pest problems affecting farmers while considering the indigenous knowledge on techniques applied by farmers for the target crops. The following approach will be used:

1. Study the pest problems affecting the farmers in each of the target states;
2. Organize farmers in groups and with the support of community extension trainers/community extension agents, carry out on farm interviews to understand the needs of the farmers;
3. Obtain information on existing crops, the pest management practices applied by the farmers and origins, the challenges being faced, and their preferred learning styles;
4. Provide relevant examples of possible IPM techniques that could be applied to solve farmers problems;
5. Obtain feedback from each group on their concerns regarding the different IPM techniques and the recommendations;
6. Recommend the IPM techniques that meet farmers' needs considering the indigenous knowledge; and
7. Disseminate the information to the farmers through the community extension trainers and community extension agents.

The participatory approach at every stage of the IPMP implementation will assist in transmitting fundamental aspects of IPM to the farmers and will help farmers pursue better pest management options that meet their needs. However, the consultations with farmers will continue throughout the project and will be done in line with the Stakeholder Engagement Plan (SEP) that was developed for SOMOUD.

2.0 POLICY FRAMEWORK

2.1 POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK FOR THE MANAGEMENT OF PESTICIDES IN SUDAN

This section reviews the national policies, regulations, procedures, and legal provisions relating to the management of pesticides in Sudan. The reviews have been made against the World Bank Environmental and Social Standards requirements as well as applicable Sudanese laws/policies as summarized below:

2.2 INSTITUTIONAL FRAMEWORK

MINISTRY OF AGRICULTURE AND FORESTRY

The Ministry of Agriculture and Forestry oversees agricultural policies, including implementation of the Sudan Agricultural Investment Plan, and performs important sanitary and phytosanitary functions. The Directorate of Plant Protection and the Directorate of Irrigated Schemes are mandated to control crop pests. The Pesticide and Pest Control Act of 1994 has six regulations relating to trafficking, trading, deportation and storage of active substances, and chemical and physical properties, including such quality control. The Act established the National Council for Pesticides entrusted to manage pesticides. It has mandatory members from 19 organizations representing most of the interests relevant in managing pesticide substances and their adverse impacts.

The Pesticides Council is headed by the Undersecretary of the Ministry of Agriculture and Forestry, and its members include: (a) Registrar/Director General of Plant Protection, (b) Representatives of the Agricultural Research Authority (4 members), (c) The Ministry of Health (4 members), (d) The Ministry of Livestock, (e) University of Khartoum (2 members), (f) Sudanese Standards and Measurement Authority (SSMA), Customs under the Ministry of Interior, and Economic Security under the Council of Ministers, (g) Higher Council for the Environment, and (h) an experienced legal adviser.

2.3 Relevant National Laws and Relevance to the Project

Table 2 Sudan National Laws relevant to the project

No	Legislation	Legal Provisions
1	The Environmental Law (2001)	The Environmental Protection Act of 2001/amendment of 2020 provides an umbrella law and general principles to be considered in carrying out environmental assessments, including definitions and several clarifications regarding natural resources management, sources of pollution and pollutants and endorses the principal of the "polluter pays".
2	Forests and Renewable Natural Resources Act (2002)	This Act empowers provincial governments to prohibit the clearing of forest for cultivation, grazing, hunting, removing forest produce, quarrying and felling, logging and topping down of trees and branches in reserved or protected areas and provides penalties for breach of regulation and payment of cash compensation.
3	Wildlife Protection and National Parks Act (1986)	This Act was issued to provide protection, preservation, conservation, and management of wildlife and setting up of a National Park. It is applicable to all areas for protection, conservation and preservation and management of wildlife.
4	Water Resources Act (1995)	This Act aims at reforming the organization of the Nile and Non-Nilotic surface waters as well as the groundwater, hence

No	Legislation	Legal Provisions
		superseding the Law of 1939 that was limited to the Nile waters only. It establishes the National Council for Water Resources (NCWR) to design and rationalize the management and use of water resources to mitigate the effects of natural disasters resulting from drought and floods.
5	The Environmental Health Act of 1975 and the Public Health Act (1975)	These Acts provide regulations and restrictions (standards) for industries regarding water and air pollution. They extend protection obligations to cover animal and plant life. Specifically, they cover issues related to collection, treatment, and disposal of waste, and prohibit water pollution by addition of any solid or liquid wastes, chemicals, sewage, and remains of animals on water resources such as rivers, hafirs, and wetlands.
6	Land Tenure Laws • The use of land for agriculture is covered by the Presidential Decree No. 34, • Land Settlement and Registration Ordinance 1925, • Unregistered Land Act 1970, and • Civil Transaction Act 1984	The use of land for agriculture is covered by Presidential Decree No. 34, while the use of land for residency and other purposes is covered by the Land Settlement and Registration Ordinance 1925, the Unregistered Land Act 1970, and the Civil Transaction Act 1984. These land laws have allowed recognition of tribal and individual usufruct rights – the right to enjoy another person's property without abusing it – and inheritance rights, as well as opening the way for compensation for land appropriated by the state. Most land use for traditional farming and grazing operates under the usufruct system. The complexity of the country's land tenure and land use laws have made it difficult to allocate land for private sector investment.
7	Urban Planning and Disposition Act (1994)	This Act sets specific rules for the separation of industrial areas from the residential ones. In carrying out Environmental Impacts Assessment (EIA), the legal requirements are not confined to the above-mentioned Acts. There are other important sectoral laws that must be considered and used as yardsticks to identify the negative environmental effects.

2.3.1 The World Bank Environmental and Social Framework

The following Environmental and Social Standards (ESSs) are relevant for SOMOUD activities:

ESS1: Assessment and Management of Environmental and Social Risks and Impacts

There are community infrastructure projects that will be established and will require environmental and social management plans (ESMP's) to be prepared.

ESS2: Labor and Working Conditions

health and safety (OHS) issues and management relevant to pest management, including use of personal protective equipment (PPE), among others.

ESS3: Resource Efficiency and Pollution Prevention and Management

The project will support the use of fertilizers, veterinary services, and port-harvest activities. This may induce the use of pesticides and makes ESS3 relevant.

ESS4: Community Health and Safety

This involves assessing and managing specific risks and impacts to the community arising from project activities including the behaviour of project workers, risk of labor influx, etc.

ESS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources

The project will not support any activities that can lead to destruction of biodiversity and natural resources, however, in case some sub-projects can't be avoided and are to be in ecologically sensitive areas, then relevant environmental and social management plans (ESMPs) will be prepared by the Co-operating Partner following the process set out in the ESMF, which includes tools for screening and assessment of risks, and templates for ESMPs.

The WB uses various means to assess pest management in a country and support IPM and overall safe use of agrochemicals. It also supports economic and sector work, sectoral or project specific ESRM assessments, participatory IPM assessments, and adjustment or investment projects and components aimed specifically at supporting the adoption and use of IPM.

In WB-financed agriculture operations, the WB advocates reduction of pest populations through IPM approaches such as biological control, cultural practices, and development and use of crop varieties that are resistant or tolerant to the pest. ESS3 provides the applicable requirements for safe pest management, and WB-financed rural development and health sector projects must avoid using harmful pesticides. Use of IPM techniques is the preferred and encouraged solution in the sectors concerned.

If any project involves significant pest management issues or contemplates activities that may lead to significant pest and pesticide management issues in crop protection or fight against vector-borne diseases, as detailed in ESS3, the Borrower will prepare and implement a Pest Management Plan (PMP), either as a stand-alone document or as part of an ESRM assessment. The procurement of any pesticides in a WB-financed project is contingent on an assessment of the nature and degree of associated risks, considering the proposed use and the intended users. Regarding the classification of pesticides and their specific formulations, the World Bank refers to the World Health Organization's Recommended Classification of Pesticides by Hazard and Guidelines to Classification (WHO, 2009).

The following criteria apply to the selection and use of pesticides in WB-financed projects:

a. They must have negligible adverse human health effects;
b. They must be shown to be effective against the target species;
c. They must have minimal effect on non-target species and the natural environment;
d. The methods, timing, and frequency of pesticide application must aim to minimize damage to natural enemies; and
e. Their use must consider the need to prevent the development of resistance in pests. At a minimum, pesticide production, use and management should comply with FAO's Guidelines for Packaging and storage, good labelling practice, and disposal of waste pesticide containers on the farm.

The World Bank does not finance formulated products that fall in WHO classes Ia (extremely hazardous) and Ib (highly hazardous); or formulations of products in Class II (moderately hazardous), if (a) the country lacks restrictions on their distribution and use; or (b) they are likely to be used by; or are accessible to lay personnel, farmers, or others without training, equipment, and facilities to handle, store, and apply these products properly.

ESS3 is relevant to SOMOUD as it will finance provision of fertilizers and veterinary services and support post-harvest activities. However, SOMOUD will not procure pesticides to be supplied to farmers. In every

case, during implementation, maximum caution shall be taken into consideration to ensure that local capacity exists to adequately manage the environmental and social risks and impacts from use of agro-inputs, in compliance with ESS2, ESS3, and ESS4.

2.4 INTERNATIONAL CONVENTIONS AND TREATIES

2.4.1 International Plant Protection Convention

The International Plant Protection Convention (IPPC) is an international agreement on plant health to which 181 signatories currently adhere. It aims to protect cultivated and wild plants by preventing the introduction and spread of pests. The Secretariat of the IPPC is provided by the Food and Agriculture Organization of the United Nations. The Convention makes provision for the application of measures by governments to protect their plant resources from harmful pests (phytosanitary measures), which may be introduced through international trade. The IPPC came into force in 1952, superseding previous international plant protection agreements. The Convention was revised in 1979 and the amendments came into force in 1991.

The revision of the IPPC agreed in 1997, and which entered into legal force on 2 October 2005, represents an updating of the Convention to reflect contemporary phytosanitary concepts and the role of the IPPC in relation to the Uruguay Round Agreements of the WTO, particularly the Sanitary and Phytosanitary (SPS) Agreement. The SPS Agreement identifies the IPPC as the reference organization developing international standards for plant health (phytosanitary) measures. IPPC work includes standards on pest risk analysis, requirements for the establishment of pest-free areas, and others which give specific guidance on topics related to the SPS Agreement.

2.4.2 International Treaty on Plant Genetic Resources for Food and Agriculture

The International Treaty on Plant Genetic Resources for Food and Agriculture is crucial in the fight against hunger and poverty and essential for the achievement of Millennium Development Goals 1 and 7. No country is self-sufficient in plant genetic resources; all depend on genetic diversity in crops from other countries and regions. International cooperation and open exchange of genetic resources are therefore essential for food security. The fair sharing of benefits arising from the use of these resources has for the first time been practically implemented at the international level through the Treaty and its Standard Material Transfer Agreement.

2.4.2 The FAO International Code of Conduct on the Distribution and Use of Pesticides

It establishes voluntary standards for public and private institutions involved in the distribution and use of pesticides. The revised version of the Code, adopted in 2002, has become the globally accepted benchmark for pesticide management and has enabled many countries to establish and strengthen their pesticide management systems. The Code sets out a vision of shared responsibility between the public and private sectors, especially the pesticide industry and government, to ensure that pesticides are used responsibly, delivering benefits through adequate pest management without significant adverse effects on human health or the environment. It aims to promote practices that reduce the risks of handling pesticides, prevent accidental poisoning, ensure pesticides are used effectively and efficiently, and encourage IPM and Integrated Vector Management (IVM). The 2002 revision of the Code emphasizes promoting IPM more than the previous version and specifically focuses on active food-sector participation in developing and promoting IPM.

2.4.4 The Stockholm Convention

The Stockholm Convention is a global treaty to protect human health and the environment from persistent organic pollutants (POPs). POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife. In implementing the Convention, governments take measures to eliminate or reduce the release of POPs into the environment. The Stockholm Convention established an initial list of 12 key POPs chemicals (the so-called dirty dozen) for which signatories are required to reduce the risks to human health and the environment arising from their release. Enlisted parties must take measures (legal and/or administrative) to eliminate or heavily restrict the production and use of POP pesticides and PCBs and minimize unintentional production and release of POPs. The Convention covers pesticides, and industrial chemicals and by-products i.e., Aldrin, Chlordane, DDT, Dieldrin, Dioxins, Endrin, Furans, Hexachlorobenzene, Heptachlor, Mirex, PCBs and Toxaphene. 15 of the 22 chemicals listed under the Stockholm Convention are pesticides or pesticide production by-products. Obsolete pesticide disposal must follow the Basel Convention.

2.4.5 The Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal was concluded in Basel, Switzerland, on March 22, 1989, and entered into force in May 1992. Now ratified by 149 countries including 32 of the 53 African countries, the focus of this Convention is to control the movement of hazardous wastes, ensure their environmentally sound management and disposal, and prevent illegal waste trafficking (UNEP, 2006). The parties to this Convention recognize the serious problems posed by stockpiles of unused and unwanted chemical products which, because of their obsolescence, are now considered wastes.

2.4.6 The Rotterdam Convention

Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade: The Rotterdam Convention aims to promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals to protect human health and the environment from potential harm and to contribute to their environmentally sound use. Governments began to address the problem of toxic pesticides and other hazardous chemicals in the 1980s by establishing a voluntary PIC procedure. It required exporters to trade in a list of hazardous substances to obtain the PIC of importers before proceeding with the trade. The Convention establishes a first line of defense by giving importing countries the tools and information they need to identify potential hazards and exclude chemicals they cannot manage safely. When a country agrees to import chemicals, the Convention promotes their safe use through labelling standards, technical assistance, and other forms of support. It also ensures that exporters comply with the requirements.

2.4.7 The Safety and Health in Agriculture Convention

The Safety and Health in Agriculture Convention (Convention C 184) adopted by the conference of the International Labour Organization (ILO) addresses the protection of workers in the agricultural sector. More people work in agriculture than in any other sector, more workers are injured in agriculture than in any other sector, and pesticides are a major cause of injury and death. In addition, more children work in agriculture than in any other sector and they are differently and particularly vulnerable to the toxic effects of chemicals such as pesticides. A specific section of the Convention deals with the sound management of chemicals and advises governments to adopt good management practices for chemicals, to inform users adequately about the chemicals they use and to ensure that adequate mechanisms are in place to safely dispose of empty containers and waste chemicals. Application of the Convention is an important step in

improving pesticide management and preventing some of the problems that arise from pesticide distribution and use in developing countries.

3.0 ENVIRONMENTAL AND SOCIAL RISKS/IMPACTS OF PESTICIDES

As emphasized above, the SOMOUD will ensure that health, social and environmental hazards associated with pesticides are excluded under the project. Thus, the project will promote application of IPM methodologies, including use of biochemical pesticides, as alternatives to chemical pesticides. However, because farmers may procure them outside the project activities, it's important that information is provided on the impacts of pesticides and the mitigation measures recommended.

Pesticides are chemicals used to kill fungal or animal pests and improve productivity and control yield loss. However, reports indicate that more than 95% of applied pesticides reach a destination other than their target species because they are sprayed across the whole agricultural land. Runoff can carry pesticide into aquatic environments while wind can carry them to other fields including croplands, grazing areas, forest areas, human settlements, or undeveloped areas. A portion of the applied chemical can also infiltrate the soil or spread in the atmosphere. Over time, repeated applications will lead to soil contamination, soil fertility reduction due to soil microorganisms' population reduction, air and water pollution and affect plant and animal species (non-target organisms ranging from beneficial soil microorganisms to insects like bees, birds, fish, and plants). They can also increase pest resistance, while its effects on other species can facilitate the pest's resurgence. The best way to reduce pesticide contamination in our environment is to use safer, non-chemical pest control (including weed control) methods as recommended above.

Researchers from the Agricultural Research Corporation (ARC) have indicated that most farmers buy treated seeds (seed dressing against aphids which is comparatively safer than spraying), which gives control to 40-60 days from emergence of the crop. After this period, if there is any infestation by the insect it will be controlled by the available natural enemies, and there will be no need to spray chemicals. If there is a late attack, it will be late and it will not cause any economic damage and is not controlled chemically. However, a small group of farmers still uses seeds from their own products from the previous season. In this case they normally don't use seed dressing which lead to having vulnerable crops, and this leads to aerial spraying of pesticides.

On the contrary, when it comes to spraying, farmers overuse pesticides and they spray even when critical thresholds/economic limits were not reached (35% of the plant infected). They have an understanding that they are protecting the crop from infestation, an idea that is not correct from a scientific point of view.

In case of biological control, this is through the natural relationship between the pests and predators. However, there are no laboratories with facilities to breed predators that can be released in case there is a pest outbreak.

Consultations with smallholder farmers and sharecroppers as part of the Phase 2 Social Assessment revealed a very mixed understanding of, and concern for, pesticide risks:

- People who have been trained (by GoS), who know the dose and manage the waste: Amri scheme (Merowe) Awadat (Reifi Kassala).
- People who are aware of risks but don't know how to manage them, in particular lack of knowledge of what to do with empty containers: Farmers Co-operatives in Merowe (note a recent Warehouse Assessment for a different project also identified this problem with old containers being abandoned in warehouses).

- People who claim to know the risks but do not care about them / ignore information on containers: Al Medina (Wad Al Hilau), sharecroppers Korba (Dongola). Note the sharecroppers believed the information on the tin was not applicable to their situation, were experiencing health effects (inflammation, catarrh), but since the effects subsided within 24 hours, did not deem them significant. NB no extension workers reach the sharecroppers.
- People unaware of the risks, where empty containers were thrown into the canal / used for drinking water, without any training: Al Medina (WadAl Hilau).

3.1 OCCUPATIONAL SAFETY AND HEALTH (OHS) IMPACTS OF PESTICIDES

In addition to environmental risks, there is overwhelming evidence that some of the pesticides are hazardous to human health. Deaths and chronic diseases (like throat irritation, sneezing, coughing, cancer, etc.), reproductive toxicity, etc. due to pesticide poisoning are reported in various sources. Researchers from the Agricultural Research Corporation have raised concern regarding farmers spraying pesticides without any personal protective equipment (PPE).

3.1.1 Exposed or vulnerable populations

Plant protection agents and populations (producers and residents) are the most exposed. Indeed, field agents (phytosanitary agents) involved in treatment operations are the most directly exposed. In addition to them, there are drivers and individuals in the food chain. Producers who carry out the treatments themselves are exposed to the harmful effects of pesticides during and after the treatment operations. The lack of application of hygiene measures and good practices related to the use of pesticides (use of PPE) exposes them dangerously to the negative effects of pesticides. In addition, these empty containers are used to serve meals, drinks, to preserve food, etc., which increases the risk of contamination of the population.

4.0 CROP COMMODITIES TO BE SUPPORTED UNDER SOMOUD

The project will support the growing of wheat, sorghum, and horticultural crops, and each of these crops have specific pests and diseases that attack them. Consequently, crop rotation, timely and proper land preparation, seed treatment, and use of resistant varieties will be some of the methods promoted to reduce pests and diseases that attack the crops to be supported by SOMOUD.

4.1.1 Wheat (Common/Bread Wheat, *Triticum aestivum L.*)

Wheat is infested by several insect pests, the most common economically important one being aphid. Others such as stem borers and termites are considered minor or secondary pests. The chemical control of aphid's infestation is by spraying the recommended insecticide when the infestation level reaches the economic limit for spraying, i.e., 35% of plants are infected. However, the most common treatment is seed dressing plus fungicides for soil fungal diseases (not economically important).

In general, the wheat production season in Sudan is dry with comparatively high temperatures, which doesn't provide a favorable environment for most of the fungal and bacterial diseases known to affect productivity. However, the eastern part of Sudan (Kassala State) is known to have relatively higher humidity levels due to being affected by the Ethiopian Plateau. Therefore, rust diseases such as stem and leaf rust are considered the main factors affecting productivity in this area after heat stress. The main control measure used is the use of genetic resistance with rust-tolerant varieties for this area.

Table 3: Pests and diseases that affect Wheat

No	Major pests and Disease	Symptoms
1	Wheat Stem Sawfly	This pest lays eggs inside the wheat stems, causing the plants to weaken and break.
2	Russian Wheat Aphid	Known for injecting toxins into the plant, which can cause leaf rolling and yellowing.
3	Hessian Fly	The larvae feed on the plant, causing stunted growth and reduced grain quality.

4.1.2 Sorghum (*Sorghum bicolor, L. Moench*)

Sorghum (*Sorghum bicolor, L. Moench*) from the family *Poaceae* is the fifth important food crop in the world. It is vitally important cereal for maintenance of food security in Africa and though commercial needs and uses may change over time, sorghum will remain a basic staple food for many rural communities. (Kangama, 2017). Weeds are a major restraint in increasing sorghum productivity especially during rainy season due to the slow initial sorghum crop growth rate and ideal weather conditions for weed growth. Effective weed control programs in sorghum should start with clean fields at planting. A combination of tillage and chemical weed control is usually most effective (Smith et al. 2010). Although good cultural practices are important weed management practices in grain sorghum production, herbicides are the major component of any sorghum weed control program (Brown et al. 2004).

Chemical weed control (pre- or post-emergency herbicides) depends on proper weed identification, matching herbicide rate and timing to the weeds. Pre-emergence herbicides are applied after the sorghum has been planted and prior to emergence. These herbicides must be applied before targeted weeds germinate. Broadleaf weeds may be controlled by post emergence, but there are few options for post emergence grass control and grassy weeds are most effectively controlled with pre-emergence herbicide applications (Smith et al. 2010).

Table 4: Pests and diseases that affect Sorghum

No	Major Pests and Diseases	Symptoms
1	Sorghum Shoot Fly (Atherigona soccata)	Damage; Causes dead heart in seedlings, leading to significant yield loss.
2	Stem Borers (Chilo partellus and Busseola fusca)	Damage: Bore into stems, causing wilting and breakage.
3	Aphids (Rhopalosiphum maidis)	Damage: Suck sap from leaves, causing yellowing and stunted growth.
4	Armyworms (Spodoptera frugiperda)	Damage: Feed on leaves, causing defoliation.

4.1.3 Okra *(Abelmoschus esculentus.L*)

Okra (*Abelmoschus esculentus. L*) is a popular vegetable crop in northern Sudan and many other parts of the country as well. It is consumed by almost all Sudanese people either as green immature pods (fried or cooked or in soup or stews) or sundried and ground into a powdery form locally known "wieka", which is used as an ingredient in the preparation of a favourable Sudanese *molah* (Osman 2005). The crop sustains different insect fauna which serve to attract numerous predators. This seems to enrich the natural bio-agents in that area. The crop is subjected to attack by several pests like Bemisia tabaci and Aphis gossypii, which suck plant nutrients and transmit serious viral diseases. Although, insecticides application is the sole measure of control practiced in many areas, it is not widely used in Northern Sudan. The Northern region in Sudan is believed to be rich in natural enemies, but it is uncertain how these enemies sustain themselves in such an area of harsh climatic conditions, especially during the long summer (very hot weather and limited cultivated land) period.

Various research efforts have identified different methods of control for the various pests and diseases that affect okra. Examples include good sanitation practices and elimination of weed hosts (George, 2003), manipulation of sowing dates to avoid severe flea beetle infestation, the use of neem extracts, and intercropping okra with crops like cotton, tomato, cowpea, and groundnuts.

Table 5: Pests and diseases that affect Okra

No.	Major Pests and Diseases	Symptoms
1	Whiteflies:	These pests suck sap and can cause sooty mold on the leaves.
2	Fruit borers:	The larvae bore into the fruits, causing significant damage.
3	Spider mites	These tiny pests cause speckling and discoloration of leaves.

4.1.4 Beans *(Phaseolus vulgaris)*

Beans form an important food and cash crop in Sudan and in Africa. Beans are considered a good source of human dietary protein. The faba bean (*Vicia faba L.*) is a globally important legume cash crop and an important dietary protein source used worldwide for animal and human consumption and widely grown in Sudan. The faba bean is the most important legume in Sudan, it constitutes the main dish on the breakfast and dinner tables for large section of the population and it is consumed by all income groups.

Lesser armyworm, *Spodoptera exigu*a is an economic pest of faba bean in Sudan and is a nuisance to farmers besides aphids, *Aphis craccinora* (kock) in having a negative impact on food security of small-scale farmers and communities (Oji et al; 2004). Farmers mainly use chemicals to control the pest.

Studies carried out by the Agricultural Research Corporation, Hudaiba Research Station in Ed-Damer, using various dosages of neem extracts followed by irrigation, eliminated by suffocation weak and starving *S. exigua* larvae (neem anti feedant effect) resulted in improved yields.

It was therefore recommended that a combined effect of a botanical insecticide and cultural practices could provide a sustainable IPM package for *S.exigua* management by small-scale farmers.

Table 6: Pests and diseases that affect Beans

No	Major Pests and Diseases	Symptoms
1	Aphids (Aphis spp.):	These tiny insects suck sap from bean plants, causing stunted growth and yellowing leaves.
2	Bean Leaf Beetles (Cerotoma trifurcata):	These beetles chew on bean leaves, leading to skeletonized foliage.
3	Bean Rust (Uromyces appendiculatus):	A fungal disease-causing rust-colored spots on leaves.
4	Root-Knot Nematodes (Meloidogyne spp.):	These microscopic worms attack bean roots, causing galls and reducing nutrient uptake.
5	Whiteflies (Bemisia tabaci):	These sap-sucking insects weaken bean plants and transmit viruses.
6	Cutworms (Agrotis spp):	These nocturnal caterpillars cut bean seedlings at ground level.

4.1.5 Onions *(Allium cepa L.)*

Onion (*Allium cepa L.*) is the most important of the bulb crops and is the leading vegetable crop in the Sudan. It is eaten fresh, pickled, and dry or cooked. Onions are planted annually as a winter crop. Onion thrips (*Thrips tabaci*) is the major pest of onions in the Sudan. The onion thrips *T.tabaci* feeds directly on leaves causing silver blotches and premature senescence as well as distorted and undersized bulbs that reduce yield by 30-50% (Diaz *et al*, 2012) and is considered as a limiting factor for the bulb yield as well reducing its quality (jenser and Szenasi, 2004; Eltez and Karasa vuran, 2006; and Mahmoud, 2008).

In the Gezira Scheme, onions are normally transplanted between October and January when the thrips population is very low. Depending on the duration and intensity of infestation, three to five sprays are applied at fortnightly intervals to control thrips on the late transplanted crop. Studies carried out in Egypt revealed that the economic damage threshold of *T.tabaci* infested onion plants ranged 6 to 8 thrips (plant while injury level between 8 to 13 during two studies). The application of insecticide at economic threshold not only reduces the thrips infestation but also increases the bulb yield and quality of onion (Tripathy et al, 2014).

Table 7: Pests and diseases that affect Onions

No	Major Pest and Disease	Symptoms
1	Onion Maggots (Delia antiqua):	These tiny, yellowish-white larvae eat onion roots and bulbs, causing stunted growth, wilted leaves.
2	Thrips (Thysanoptera):	They feed on onion leaves by slurping up plant juices.
3	Onion Root Maggots (Delia platura):	These target onion roots, causing wilting, yellowing.
4	Aphids (Aphidoidea):	Leaf curling, stunted growth, and reduced yields.

4.1.6 Tomatoes *(Lycopersion esculentum mill.)*

Tomato (*Lycopersion esculentum mill.*) is a popular and widely grown vegetable in Sudan. Khartoum State is considered as one of the main producing and consuming areas of tomato in Sudan. In Sudan tomato are

grown all around the country as a winter crop (main season) and as an off-season crop during summer and autumn. The main production areas are concentrated in the northern part of Gezira scheme, southern part of Khartoum State (El Hassan 1994 cited from El Assi 2001).

The crop is used fresh for green salad, for cooking and provides raw material for manufacturing of tomato paste and juice. There is an increasing demand for tomato as fresh crop among consumers. Tomato ranks next to potato and sweet potato in production, but as canning crops, it takes the first rank among the vegetables (Michele, 1996). It is the second most important vegetable after onion.

Tomato leaf curl virus (TLCV) and Alternaria leaf blight are the most serious diseases of the tomato in Sudan. No resistant varieties are available to farmers and so other control measures must be used. The only vector of the virus is the whitefly, *Bemisia tabaci* and it is the female which is largely responsible for transmission. One of the control measures is spraying with confidor insecticide which causes significant decrease in the leaf curl disease. Spraying with Amstar Top fungicide in the farmers' fields also decreases the incidence of early blight, the combined effects of covering the tomato seedlings in the nursery and fungicide spraying in the field results in significant increase in tomato yield.

The pest, a moth known as tomato leafminer or tuta absoluta, has caused severe economic losses to farmers and increased the cost of tomato production across Sudan in recent years. Tuta absoluta infestation results in significant yield losses of tomato and other crops, including reduction in crop quality. Losses affect the farmers' income directly due to reduction in marketable yield and indirectly through higher production costs, a consequence of increased investment in pest management. It can cause total crop loss and has developed resistance to pesticides.

Studies carried out by the Canada funded Integrated Food Security Project (IFAP) in conjunction with Kassala and Gash Research Stations in Sudan, discovered that a small insect, nesidiocoris tenuis, attacks the moth while causing little or no damage to the crops or surrounding environment.

4.1.7 Eggplants *(Solanum melongena L.)*

Eggplant, *S. melongena L.*, is a typical and very profitable vegetable crop for farmers. It is locally known as bedingan or aswad and has several common names: aubergine, garden egg and brinjial. Eggplants come in different types, shapes, sizes, and colors. The popularity of eggplant in Sudan is mainly attributed to its affordability, the diversity of ways in which it can be cooked and its successful growth under warm weather conditions such as those in Sudan.

However, eggplant production negatively affects the environment due to its heavy requirement for pesticides to combat insect pests and diseases. Insecticides are repeatedly applied during the entire period of growth and sometimes even at the fruiting stage. Indiscriminate use of pesticides during its farming season, particularly at the fruiting stage, and non-adoption of a pre-harvest interval may lead to accumulation of pesticide residues in the fruits, consumers, and the environment. Due to limited knowledge of pesticide safety, farmers indiscriminately and heavily use pesticides on eggplants.

Eggplants are affected by several diseases and pests that cause economic loss although this depends on the growth stage of the plant. Injury to the older leaves at a late stage in crop development for example, will not influence the final yield. Eggplants can compensate for a lot of injury by producing more leaves, new shoots, or bigger size fruits. When plants compensate for crop injury without yield or quality loss, there is no need to implement control practices such as applying a pesticide (Eggplant Integrated Pest Management Plan, an Ecological Guide, FAO June 2003).

Table 8: Pests and diseases that affect Eggplants

No.	Pests and Diseases	Symptoms
1	Flea Beetles:	Small round holes in foliage, more prevalent on lower leaves.
2	Colorado Potato Beetle:	Leaves are stripped bare.
3	Tomato Hornworm:	Large holes and chunks gnawed in fruits and leaves.
4	Thrips:	White spots on eggplants, distorted leaf tips.
5	Aphids:	Curled, deformed, and discolored leaves; stunted plant growth.

4.1.8 Chickpea (*Cicer arietinum L.)*

The chickpea, *Cicer arietinum L.* is a leguminous annual plant in the family Fabaceae grown for its edible seeds. The plant has a branched, straight, or bending stem with small feathery leaves arranged alternatively on the stem. Chickpeas are high in nutritional value, rich in amino acids, vitamins, dietary fiber, and beneficial unsaturated fatty acids and are an important source of nonanimal protein.

Chickpea is drought- and cold-tolerant as well as barrenness-resistant, and its well-developed root system, large and numerous root nodules, and strong nitrogen fixation capacity facilitate soil and water conservation and ecological management. Chickpea suffers from erratic soil moisture under the traditional flood-irrigation cultivation. The use of resistant varieties is one of the most effective control measures.

Chickpea pod borer Helicoverpa armigera (Hubner) is one of the major pests of chickpea causing on average 30-40% damage to pods (Luckmann and Metcalf 1975). Chickpea is more tolerant of most insects than other pulses because of the malic acid they produce from hairs on their leaves, stems, and pods, making the crop unattractive to insects. The crop is less susceptible to red legged earth mite, lucerne flea and aphids than other pulses, but is highly susceptible to native budworm. Crops need to be monitored from flowering through to pod-fill. Small grubs less than 1 cm are damaging.

Economic threshold for control can be as low as 1 grub per 10 sweeps of a sweep net. When thresholds are exceeded, native budworms can be controlled with insecticides although timing and coverage are both critical to achieving good control.

The crop will need to be sprayed with an appropriate insecticide if caterpillars are present and pods have started to form. Regular monitoring will help determine whether the crop needs to be sprayed. An insecticide application will be necessary if one caterpillar is found in 10 sweeps of the crop.

Chickpeas are unique in that they do not host significant numbers of beneficial insects. Small numbers of parasitic flies (tachinids) have been recorded on chickpea, but little else. Therefore, in relation to IPM, there are no in-crop management opportunities via beneficial insects.

Table 9: Pests and diseases that affect Chickpea

No	Pests and Diseases	Symptoms
1	**Ascochyta blight** *Ascochyta rabiei (fungal)*	Water-soaked pale spots on young leaves which enlarge rapidly under cool, wet conditions and coalesce to cause blighting of leaves; if infected seeds are planted, the seedlings will develop dark brown lesions at the base of the stem and may dry up and die.

2	Fusarium Wilt *Fusarium oxysporum (fungal)*	Weak and wilting leaf stems, leaves, and flowers; lower leaves drying out and dying; leaves turning brown or pale yellow; leaves turn dull yellow in color and collapse.
3	**Damping-off** *Pythium spp (fungal)* **Oomycete)**	Failure of seedling to emerge; plant dry up and die; stunted plant growth; rotting taproot with few lateral roots.
4	***Beet armyworm*** *Spodoptera exigua (insect)*	Singular, or closely grouped circular to irregularly shaped holes in foliage; heavy feeding by young larvae leads to skeletonized leaves.
5	Leafminer ***Liriomyza cicerina***	feeding damage from larvae cause the development of winding white trails of the leaf surface; damage to young seedlings may result in the death of the plant; crop yield may be reduced.
6	**Cowpea aphid (Black aphid)** *Aphis craccivora*	Deformed leaves and shoots; if infestation is severe then plants may be killed; aphids secrete a sticky, sugary substance called honeydew which encourages the growth of sooty mould on the plants.
7	**Cutworms (Black cutworm, Winter cutworm)** *Agrotisipsilon, Agrotis segetum*	Stems of young transplants or seedlings may be severed at soil line; if infection occurs later, irregular holes are eaten into the surface of fruits.

4.1.9 Lentil (*Lens culinaris)*

Lentil, *Lens culinaris*, is a bushy, annual legume in the family Fabaceae grown for its edible seeds which are cooked and eaten. The lentil seeds can be eaten raw or are cooked and eaten in soups and other dishes. They are commonly eaten as dahl (lentils seeds which have had the husk removed and then split). Lentil seeds can be used as a source of starch for the textile industry or can be ground into flour. The young pods are sometimes eaten as vegetables.

The crop has great significance in cereal-based cropping systems because of its nitrogen fixing ability, the high protein and high micro-nutrients seeds for human diet, and its straw for animal feed. Lentil is traditionally grown in the River Nile State, particularly in the Rubatab area. Weeds are a major constraint to increasing production of lentil (Lens culinaris Medi.) in Sudan. Weeds smoother the crop because of the low competitive ability of lenticel during the early stages of growth. The traditional method of controlling weeds in lentil involves late-hand weeding, mainly by those who want to collect fodder for livestock.

Yield losses due to weeds in lentil, like any other crop, depend on the level of weed infestation, composition of the weed population, soil fertility and soil moisture levels (Kukula *et al*, 1983). The identification of the critical period of weed control is important for the developing effective weed management strategies (Swanton & Weise, 1991). This is the period during which weeds must be removed to avoid significant yield losses.

Winter weeds emerge along with the lentil crop from the weed seed bank already present in the field. To eliminate the early competition of weeds, herbicides are of great potential value. Lentil is reported to be relatively more sensitive to most herbicides compared with larger seeded legumes (Basler, 1981). Studies carried out by the Agriculture Research Corporation in 1996 showed that lentil showed good tolerance to the herbicides Pendimethalin, oxy-fluorfen, Imazelthapyr, terbutryn and prometryn. Therefore, one supplementary hand-weeding is needed as well and the use of pre-emergence herbicides. Therefore, a combination of cultural and chemical methods is more effective and sustainable.

Table 10: Pests and diseases that affect Lentil

No	Pests and Diseases	Symptoms
1	**Anthracnose** *Colletotrichum truncatum (fungal)*	Tan lesions with darker borders on leaves which often appear prior to flowering or shortly after bloom; diseased leaves may drop from the plant prematurely.
2	**Ascochyta blight** *Ascochyta pinodella (fungal)*	Tan to light brown lesions with a dark border can appear an any aerial part of the plant (leaves, stems, pods, petioles, peduncles); diseased plants may abort flowers and/ or fruits, seeds may be discolored.
3	**Cutworms *Agrotis spp (insect)***	Stems of young transplants or seedlings may be severed at soil line; if infection occurs later, irregular holes are eaten into the surface of fruits.
4	**Damping-off** Pythium ultimum Rhizoctonia solani (insect)	Failure of seedling to emerge; light brown, seedlings with light brown to red-water-soaked roots and stems; collapse of plants; plant dry up and die; stunted plant growth; rotting taproot with few lateral roots.
5	**Fusarium Wilt** *Fusarium oxysporum*	Weak and wilting leaf stems, leaves and flowers, lower leaves drying out and dying; leaves turning brown or pale yellow; splitting the stem reveals discoloration of the inner tissue; leaves turn dull yellow in color and collapse; disease appears in the fields in patches.
6	**Gray mold** *Botrytis cinerea*	Plants turning yellow and wilting; diseased tissue covered with fuzzy gray fungal growth during periods of high humidity; lesions may girdle the stem and cause the upper canopy to die.

5.0 PEST AND DISEASE MANAGEMENT PRACTICES RELEVANT TO SOMOUD

IPM strategies are recommended and used by some farmers as much as it is possible because there is no one control practice/measure that can provide acceptable control of the target pest. Choosing appropriate measures requires significant understanding of the interactions between environment, crop, pest, and predator.

5.1.1 BIOLOGICAL CONTROL

Biological control means use living organisms to suppress pest populations and damage. These living organisms can be parasitoids, predators, and use of sterile males during breeding or pathogens. This tactic takes advantage of the fact that organisms depend or even feed on each other for survival. Thus, biological control methods try to ensure that pests are reduced by organisms which are their natural enemies. These natural enemies can be conserved by taking care with farming practices so that they are not killed but are encouraged. However, Research Scientists from the Agricultural Research Corporation (ARC) have indicated that this method is naturally occurring but not effective when there is an outbreak of pests.

5.1.2 CULTURAL CONTROL

Cultural control means use of usual crop production practices to suppress pest population and damage in the field. These practices include ploughing to expose and kill soil pests, using pest and disease-free seed, planting in time, intercropping, timely weeding, mulching, field sanitation, harvesting in time to minimize exposure of the crop. Other cultural practices include:

a. Crop rotation – crop rotation helps to prevent pest populations building over a number of years
b. Inter-cropping practices

c. Use of resistant varieties
d. Managing sowing, planting, or harvesting dates
e. Water/irrigation management
f. Scarecrow materials
g. Practices to enhance the build-up of naturally existing predator populations
h. Hand-picking of pests or hand-weeding
i. Use of traps or trap crops.

5.1.3 PHYSICAL AND MECHANICAL CONTROL

Mechanical and physical controls kill a pest directly, block pests at or make the environment unsuitable for it. Traps for rodents are examples of mechanical control. The method consists of regularly monitoring fields, to locate eggs and young caterpillars on the plants, collect them and crush them manually. This option is economically and ecologically viable but can only be effective on small farms.

Physical controls include steam sterilization of the soil for disease management or barriers such as screens to keep birds or insects out.

5.1.4 BOTANICAL PESTICIDES CONTROL

Botanical pesticides ("botanicals") are characterized by bioactive mixtures/extracts/compounds from plant materials, which serve as insecticides and repellents but also as bactericides, fungicides, herbicides and nematicide.

Farmers use a wide range of botanical insecticide products, with the formulation based on local indigenous knowledge of the local plants and products that can be used for insecticidal activity. The mode of action of botanical pesticides is broad and ranges from repellency, knock-down, larvicidal to anti-feedant, moulting inhibitors and growth regulation. However, the efficacy of such products is often unreliable as it is difficult to obtain a standard active ingredient formulation that consistently works. Sometimes the formulations can ferment and become very toxic for human exposure and for the environment, i.e., some tobacco extract formulations.

5.1.5 CHEMICAL CONTROL

Chemical control is the use pesticides. In IPM, pesticides are used only when needed and in combination with other approaches for more effective, long-term control. Pesticides are selected and applied in a way that minimizes their harm to people, non-target organisms, and the environment. With IPM its recommended to use the most selective pesticide that will do the job but also the safest for other organisms and for air, soil, and water quality. It's advisable to use spot-spray of pesticides on few weeds instead of an entire area. In Sudan, the National Council for Pesticides is responsible for approval and licensing of pesticides used in the country.

Sudan is a party to the Stockholm Convention, which prohibits the formulation, import, export, sale, or use of several synthetic pesticides classified as persistent organic pollutants (POPs), which have been enforced since 2006. However, many of the pesticides, such as fentrotion, endosulfan, and its related isomers, dimethoate, atrazine and many other Highly Hazardous Pesticides (HHPs) are still being used in Sudan, although the country is still signatory to several agreements and conventions regarding their use. The Ministry of Agriculture through the Plant Protection Department is supposed to monitor the use of pesticides but there are challenges in monitoring and enforcement.

5.1.6 POST HARVEST MANAGEMENT

Post-harvest handling or management is the stage immediately following the harvest. Post-harvest handling includes all the primary processes/steps that a harvested crop must go through to get from the producer to the end consumer. Such processes include raw material handling, storage, transport, distribution, and marketing, add value to the harvest produce. It determines the final quality of product.

It has been recognized that farmers suffer losses due to poor post-harvest handling of produce in Sudan and this leads to post-harvest losses that range between 40-50 percent of agricultural produce. Therefore, to avert these losses, the Cooperating Partner (Mercy Corps) will build post-harvest management capacities of smallholder farmers to reduce these losses. Practices like drying grains on plastic sheets, shelling, threshing, winnowing, sorting, grading, and storage materials (PIC bags) play an important role in maintaining quality, reducing aflatoxin contamination, and extending the agricultural produce shelf life.

6.0 THE INTEGRATED PEST MANAGEMENT PLAN FOR IMPLEMENTATION UNDER SOMOUD

6.1 Integrated Pest Management

Integrated Pest Management (IPM) is a comprehensive approach to solving pest problems. IPM shifts the focus from controlling a pest now, to making the best management decisions for the long-term, and builds a comprehensive response to pest problems. The goal is to identify and implement coordinated strategies that work together in an integrated manner to provide optimum results, with the view to achieving long-term positive environmental and social benefits. The concept of integration works on multiple levels in that remedial strategies for individual pests are integrated with each other to ensure compatibility with the need to manage other pests.

The pest management strategies must be consistent with the objectives to protect the environment and to address social concerns. IPM approach arises as a response to negate over-reliance on pesticides and short-term solutions that do not account for all the long-term costs and externalities. IPM acknowledges that pesticides are still valuable, but stresses that chemical control is but one of the many approaches considered in an IPM approach. Pesticide use in IPM is limited to situations where there is an identified need and lack of suitable alternatives. This contrasts with a preventive chemical approach where pesticides are used on a prescribed basis without determining the need or making full use of alternative measures.

The project will not finance or support use of chemical pesticides, so alternative approaches are the most important content of the present IPMP to guide relevant SOMOUD activities. They are described in Table 10 below.

Note: The column on frequency of monitoring and cost of implementing the IPMP have not been included because Mercy Corps is yet to select the beneficiary FOs, carry out capacity needs assessment and the costs are not known at this stage of preparing the IPMP.

Table 10: The target crops for the SOMOUD, the pests and diseases that affect and the IPM approach for control

Crop Pest and Diseases	Impacts and symptoms	Pest management approach/techniques	Post harvest management per crop	Monitoring institution
Wheat (*Triticum aestivum L.*)				
Aphid *(Aphis gossypii*	They are small insects that can cause significant damage by sucking sap from the plants, leading to stunted growth and reduced yields.	**Biological Control:** Introducing natural predators or parasites to control pest populations. For the Aphids these include Lacewings (*chrysoperia),* Ladybird *(coccinella*), Orius bug, Flowerflies *(syrphid*) Parasites; Aphidus wasp. Entomopathogens Exp. (Beaveria) **Mechanical Control**: Using physical barriers or traps to reduce pest numbers. **Cultural Practices**: Crop rotation, timely planting, and using pest-resistant wheat varieties. **Use of Resistant Varieties**: Planting wheat varieties that are resistant to specific pests can significantly reduce damage. **Good Agricultural Practices**: Regular monitoring of fields, proper irrigation, and maintaining field hygiene can help in early detection and management of pests. **Chemical control:** chemical control of aphid's infestation is by spraying the recommended insecticide when the infestation level reaches the critical economic limit for spraying (i.e. 35% of plants are infected). However, the most used treatment is the use of seed dressing insecticides. The recommended insecticides seed treatment include the Imidacloprid group, such as gaoshu and coleus (used at a rate of 0.5	This involves drying, threshing, transportation and storage, processing, and marketing. Farmers store the wheat in their homes and use traditional repellants against pests during storage. ARC recommended the Hermetic bags for seed storage to reduce losses.	CP EA, MOAF
Wheat Stem Sawfly *(Cephus Cinctus Norton)*	This pest lays eggs inside the wheat stems, causing the plants to weaken and break.			
Russian Wheat Aphid *(Diuraphis noxia)*	Known for injecting toxins into the plant, which can cause leaf rolling and yellowing.			
Hessian Fly *(Mayetiola destructor)*	The larvae feed on the plant, causing stunted growth and reduced grain quality.			

		grams (cc) or (ml) of gaushu per kilogram of seed).		
Sorghum ***Sorghum bicolor, L. Moench*)**				
Sorghum Shoot Fly *(Atherigona soccata)*	Causes deadheart in seedlings, leading to significant yield loss. **Control measure;** use of resistant varieties, timely sowing, and seed treatment with insecticides.	**Cultural Controls:** crop rotation, inter cropping, and maintaining field hygiene. **Biological Controls:** Use natural predators and parasitoids. **Chemical Controls:** Judicious use of insecticides, focusing on botanicals and microbial pesticides to minimize environmental impacts.	Sorghum like all other cereals, the post-harvest includes harvesting, which is by hand among small holder farmers, transporting, threshing, the time of threshing depends on a variety, the degree of dryness of the grain and the method of threshing. drying, the moisture level of sorghum must be reduced to a safe level (10-12 percentage) before storage. This to prevent mould growth (and thus possibility of mycotoxin development by a range of storage fungi especially Aspergillus Flavus- which can under appropriate storage and field conditions produce carcinogenic aflatoxins), cleaning, packaging, and storage.	CP, EA, MOAF
Stem Borers *(Chilo partellus and Busseola fusca)*	Bore into stems, causing wilting and breakage. **Control measure**: Crop rotation, destruction of crop residues, biological control using parasitoids			
Aphids (Rhopalosiphum maidis)	Suck sap from leaves, causing yellowing and stunted growth. **Control measure**: Use of natural predators like lady beetles and application of neem-based insecticides			
Armyworms (*Spodoptera frugiperda*)	Feed on leaves, causing defoliation. **Control measure:** Regular monitoring, use of pheromone traps, and biological control through use of Bacillus thuringiensis			
Okra ***(Abelmoschus esculentus)***				

Aphids *(Aphids gossypii*)	The small insects suck the sap from okra plants, causing yellowing and curling of leaves. They can also transmit viral diseases.	**Cultural Practices**: **Crop rotation**: Avoid planting okra in the same field consecutively to reduce pest buildup. Manipulation of sowing dates to avoid severe flea infestation. Intercropping of okra with crops like cotton, tomatoes, cow pea and ground nuts. **Sanitation**: Remove and destroy infested plant debris to prevent the spread of pests. **Biological Control**: **Natural predators**: through beneficial insects like lady beetles and parasitic wasps that prey on pests. **Neem oil**: This natural insecticide can help control aphids and whiteflies. **Chemical Control**: **Insecticides**: Use recommended insecticides like Flubendiamide for fruit borers and Deltamethrin for other pests.	Post harvest management of Okra involves cleaning, grading, and storage. After harvesting the fruits are cleaned and this involves elimination of leaves, stem sections, and other types of debris from the pods. Broken pods should be discarded. The fruits are stored under shade. The diseased and deformed fruits are sorted. Before sending to the market, the fruits may be graded according to the size. The harvested fruits are packed in baskets and covered with gunny bags before transporting to the local markets. Okra should not be washed since this would lead to a greater incidence of postharvest decay. **Grading** - The initial grading of the harvested okra takes place in the field at the time of harvest. Pickers separate unmarketable or damaged pods from the marketable ones. Oversized and partially decayed pods should also be removed from the plant and out graded in the field.	CP, EA, MOAF
Whiteflies (*Bemisia tabaci*	The pests suck sap and can cause sooty mold on the leaves.			
Fruit borers, *Earias Vitella (Fabricius)*	The larvae bore into the fruits, causing significant damage.			
Spider mites, Tetranychus telarius *(Tetranychidae*)	The tiny pests cause speckling and discoloration of leaves.			
Beans *(Phaseolus vulgaris)*				
Aphids *(Aphis spp.)*	The tiny insects suck sap from bean plants, causing stunted growth and yellowing of leaves.	**Cultural practices:** carry out crop rotation. **Biological control:** use beneficial predators. **Chemical control:** targeted spraying to keep pests in check using pesticides such lamda-cyhalothrin and floricamid. Use of neem extracts sprayed before irrigation.	The seeds are harvested when they are dark and dry. After harvesting, the seeds are cleaned for any contaminating debris in a way that causes least damage to the seeds. The clean seeds should be stored in an area with low humidity.	CP, EA, MOAF

		Natural Predators: Encourage beneficial insects like ladybugs and lacewings that feed on aphids. **Neem Oil Spray**: Neem oil acts as a natural insect repellent. **Insecticidal Soap**: Use a mild soap solution to deter aphids.		
Bean Leaf Beetles *(Cerotoma trifurcata)*	The beetles chew on bean leaves, leading to skeletonized foliage.	**Crop Rotation**: Rotate bean crops to reduce beetle populations. **Insecticides**: Apply approved insecticides when necessary.		
Bean Rust *(Uromyces appendiculatus)*	A fungal disease-causing rust-colored spots on leaves.	**Fungicides**: Use copper-based fungicides during early stages of infection. **Plant Resistant Varieties**: Choose rust-resistant bean varieties.		
Root-Knot Nematodes *(Meloidogyne spp.)*	They are microscopic worms that attack bean roots, causing galls and reducing nutrient uptake.	**Soil Solarization**: Expose soil to sunlight to reduce nematode populations. **Nematode-Resistant Varieties**: Plant beans with natural resistance.		
Whiteflies *(Bemisia tabaci*)	They are sap-sucking insects that weaken bean plants and transmit viruses.	**Yellow Sticky Traps**: Attract and trap whiteflies. **Neem Oil**: Apply neem oil to deter pests.		
Cutworms *(Agrotis spp.)*	They are nocturnal caterpillars that cut bean seedlings at ground level.	**Physical Barriers**: Place collars around young plants. **Biological Control**: Introduce parasitic nematodes.		
Onions ***(Allium cepa L.)***				
Onion Maggots *(Delia antiqua*)	They are yellowish-white larvae, feast on onion roots and bulbs, causing stunted growth, wilted leaves.	**Cultural Control.** Plant onion sets or transplants instead of seeds. Keep the onions weed free.	The main post harvest treatment required for long storage of bulb onions is thorough curing of the bulbs. This is intended to dry off the necks and outer	CP, EA, MOAF

Thrips (*Thysanoptera*	They feed on onion leaves.	**Physical Control** Cover onion beds with a floating row cover to keep adult flies from laying eggs near the plants. **Chemical control** Use insecticides that are specifically labelled to be used for onions. Use insecticidal soap or neem oil.	scale leaves of the bulbs to prevent the loss of moisture and the attack by decay during storage.	
Onion Root Maggots *(Delia platura)*	They target onion roots, causing wilting, yellowing.			
Aphids *(Aphidoidea)*	aphids cause leaf curling, stunted growth, and reduced yields.			
Tomatoes *(Lycopersion esculentum mill.)*				
Tomato leaf curl virus *(TLCV)*	Causes small leaves to become yellow between the veins. Leaves curl upwards and towards the middle. In seedlings, the shoots become shortened and give young plants a bushy appearance.	**Physical control.** Good nursery practices such as covering the nursery bed with a net. Hand picking the caterpillars. **Chemical control** Field treatment with fungicides like Amstar Top. Spray with neem oil underneath where the caterpillars tend to hide. Mix liquid dish soap and water in a spray bottle and apply to the affected plant.	This involves initial sorting/grading in the field, field parking in plastic crates, transportation to the whole sale market, handling in the whole sale market, transportation to retail markets and groceries, handling in retail markets, marketing.	CP EA, MOAF
Alternaria Leaf Blight (*Alternaria alternata)*	Causes leaf spots, rots, and blights.			
Early Blight (*Alternaria Solani)*	Causes bulls eye patterned leaf spots and can also cause stem lesions and fruit rot.			
White flies (Trialeurodes *abutilonia*)	Sucks juices from the leaf underside causing the leaves to become pale and wilt.			
Thrips palmi karnyi	Causes the tomatoes to develop silver lesions, become irregular in size and shape.			

Caterpillars *(Manduca quinquemaculta)*	Eat large areas and can also attack stems rendering them fragile and liable to break.			
Eggplants (*Solanum melongena L.)*				
Flea Beetles (*Epitrix fuscula)*	Cause small round holes in foliage, more prevalent on lower leaves.	**Physical Control** Handpicking beetles. Maintaining garden sanitation, Keeping the garden weed free. Dusting with diatomaceous earth. **Cultural Control** Keeping the garden free of plant debris. Crop rotation to reduce pest populations by disrupting their life cycle. **Biological Control** Using Bacillus thuringiensis to control larva. Encouraging natural predators like ladybugs. **Chemical Control** Using insecticide such as cedarcide, seven or pyrethrum. Using insecticidal soaps.	Post harvest handling of tomatoes involves various approaches. Freshly harvested leaves and fruits can be easily transported and kept in good conditions for an extended period, particularly in shaded or cool area. To maintain the freshness of the leaves, sprinkling them with water can be effective. This not only helps to keep the leaves hydrated but also slows down their respiration rate, which can ultimately extend their shelf life. Another method of preservation is using a pot. The pot should be surrounded by sand or charcoal dust which should be kept moist by regularly adding water. It is important not to pour water into the pot.	CP EA, MOAF
Colorado Potato Beetle *(Leptinotarsa decemlineata)*	Leaves are stripped bare.			
Tomato Hornworm: *(Manduca quinquemaculta)*	Large holes and chunks gnawed in fruits and leaves.			
Thrips *(Thrips Palmi)*	Visible white spots on eggplants, distorted leaf tips.			
Aphids *(Aphis gossypii)*				
Chickpea (***cicerina arietinum)***				
Ascochyta blight *Ascochyta rabiei (fungal)*	Water-soaked pale spots on young leaves which enlarge rapidly under cool, wet conditions and coalesce to cause blighting of leaves; if infected seeds are planted, the seedlings will develop dark brown lesions at the	**Cultural Control** Growing more resistant varieties. Crop rotation. Planting chickpeas in early winter instead of spring when the populations of the insects are at less damaging levels. Early planting which promotes early closure of the plant canopy and reduced	Keep harvested crop for drying in the field, drying to optimum moisture content results in safe storage of produce over a longer period. The harvest should not be done during adverse weather conditions. After drying, the seeds will be cleaned,	CP EA, MOAF

	base of the stem and may dry up and die.	the spread of viruses. Crop debris should be plowed deeply into the soil to destroy overwintering pupae. **Biological Control** Armyworms control by natural enemies which parasitize the larvae of the Beet army worm. **Physical Control** hand-pick larvae after dark. Spread diatomaceous earth around the base of the plants (this creates a sharp barrier that will cut the insects if they try and crawl over it. **Chemical control** Resistant varieties require fungicide application at early podding to ensure high quality seed. Treat seeds with fungicides prior to planting.	graded, and stored depending on the end use.	
Fusarium Wilt *Fusarium oxysporum (fungal)*	Weak and wilting leaf stems, leaves, and flowers; lower leaves drying out and dying; leaves turning brown or pale yellow; leaves turn dull yellow in color and collapse.			
Damping-off *Pythium spp (fungal* **Oomycete)**	Failure of seedling to emerge; plant dry up and die; stunted plant growth; rotting taproot with few lateral roots.			
Beet armyworm *Spodoptera exigua (insect)*	Singular, or closely grouped circular to irregularly shaped holes in foliage; heavy feeding by young larvae leads to skeletonized leaves.			
Leafminer *Liriomyza cicerina*	feeding damage from larvae cause the development of winding white trails of the leas surface; damage to young seedlings may result in the death of the plant.			
Cowpea aphid (Black aphid) *Aphis craccivora*	Deformed leaves and shoots; if infestation is severe then plants may be killed; aphids secrete a sticky, sugary substance called honeydew which encourages the growth of sooty mold on the plants.			
Cutworms (Black cutworm, Winter				

cutworm) *Agrotisipsilon, Agrotis segetum*				
Lentil (*Lens culinaris*)				
Anthracnose *Colletotrichum truncatum (fungal)*	Tan lesions with darker borders on leaves which often appear prior to flowering or shortly after bloom; diseased leaves may drop from the plant prematurely.	**Cultural Control** Planting disease free seeds. plant crop as early as possible. Remove all plant residue from soil after harvest or at two weeks before planting, this is especially important if the previous crop was another host such as alfalfa, bean, or a leguminous cover crop. Avoid planting lentils in fields or areas adjacent to fields which had an outbreak of gray mold the previous year. **Physical Control** use overhead irrigation (washes fungus from leaves and reduces viability), hand-pick larvae after dark. **Chemical Control** Planting seeds treated with fungicides. Application of fungicides. Frequent applications of sulfur may be required to control heavy infestations.	After harvest, the crop should be allowed to dry on the threshing floor for 4-7 days and threshed manually or by a bullock/power drawn thresher. Clean seeds should be sun dried for 3-4 days, taking their moisture content to 9-10 percent. After cleaning, the seeds are sorted and graded and stored. The most important determinants of grain quality during post-harvest storage are moisture level of lentils, relative humidity, storage temperature and aeration.	CP EA, MOAF
Ascochyta blight *Ascochyta pinodella (fungal)*	Tan to light brown lesions with a dark border can appear at any aerial part of the plant (leaves, stems, pods, petioles, peduncles); diseased plants may abort flowers and/ or fruits, seeds may be discolored.			
Damping-off *Pythium ultimum* *Rhizoctonia solani* (insect)	Failure of seedling to emerge; light brown, seedlings with light brown to red-water-soaked roots and stems; collapse of plants; plant dry up and die; stunted plant growth; rotting taproot with few lateral roots.			
Fusarium Wilt *Fusarium oxysporum*	Weak and wilting leaf stems, leaves and flowers, lower leaves drying out and dying; leaves turning brown or pale yellow; splitting the stem			

	reveals discoloration of the inner tissue; leaves turn dull yellow in color and collapse.			

6.2 SAFE MEASURES FOR THE MANAGEMENT OF PESTICIDES

To prevent, reduce, or control the potential contamination of soils, water (groundwater or surface water resources) and biodiversity (humans, plant species, animal species) caused by accidental spills during the transfer, mixing, storage and application of pesticides, pesticides must be stored, handled, and applied in a way consistent with the recommendations for hazardous materials management.

Pesticide transportation, storage, handling and use under local conditions need much improvement. Similarly, the disposal of containers requires much more effort. The following are the recommended good practices for handling pesticides that farmers and extension agents (EAs) need to be aware of:

a) Labeling

Pesticides should be packaged and labeled according to WHO standards. The label should be written in **English** and in the local language (as applicable); it should indicate the content, the safety instruction (warning) and any action to be taken in case of accidental ingestion or contamination. The product should always remain in its original container. Farmers should be advised to take all appropriate precautionary measures and wear protective clothes in accordance with recommendations.

b) Storage and transportation

Pesticides must be stored in a place that can be locked up and is not accessible to unauthorized individuals or children. Pesticides must not be stored where they could be mistaken for food or beverage. They must be kept dry and out of the sun. They are not to be transported in a vehicle that also carries food products.

To ensure safety during storage and transportation, the public or private sector agency in charge of managing purchased pesticides, must comply with these recommendations as well as the guidelines recommended by the manufacturer, regarding:

a. Preservation of the original label;
b. Prevention of accidental pouring or overflowing;
c. Use of appropriate containers;
d. Appropriate marking of stored products;
e. Specifications regarding the local population;
f. Products separation;
g. Protection against humidity and contamination by other products;
h. Restricted access to storage facilities;
i. Locked storage facilities to guarantee product integrity and safety;
j. Pesticides warehouses must be located far from human residences or animal shelters, water supplies, wells, and channels. They must be located on an elevated surface and secured with fences with restricted access for authorized individuals only;
k. Pesticides are not to be stored in places where they could be exposed to sunlight, to water or to humidity, which could harm their stability. Warehouses are to be secured and well ventilated;
l. Pesticides must not be transported in the same vehicle with agricultural products, food products, clothes, toys or cosmetics, as these products could become dangerous in case of contamination;
m. Pesticide containers are to be loaded in vehicles to avoid damage during transportation, so that their labels will not tear off and they would slip off and fall on a road with an uneven surface. Vehicles transporting pesticides must bear a warning sign placed conspicuously and indicating the nature of the cargo; and
n. Packaging (original or new packaging) must ensure safety during the distribution and avoid unauthorized sale or distribution of products intended for vector control.

c) Handling

- Operators must read, understand, and follow product label directions for safe mixing, application, and disposal of pesticides; trained personnel must be used for critical operations (e.g., mixing, transfers, filling tanks, and application).
- The cooperating partners must insist the beneficiary farmers and FOs that correct PPE (e.g., gloves, overalls, eye protection) for each exposure route be always worn when handling and applying pesticides.
- Mixing and filling of pesticide tanks must take place in a designated filling area.
  - This must be set away from watercourses and drains.
    - If on concrete, water should be collected in a separate sump and disposed of as a hazardous waste.
    - Ensure that spills are cleaned up immediately using appropriate spill kits; spills should not be washed away into watercourses or drains.

d) Application

- Preference must be given to the application method with the lowest environmental, health and social risks and ensure that non-target organisms are not affected.
- Selection of pesticide application technologies and practices designed to minimize off-site movement or runoff (e.g., low-drift nozzles, using the largest droplet size and lowest pressure that are suitable for the product).
- Establish buffer zones around watercourses, residential and built-up neighbourhoods, as well as livestock and food storage areas.
- Ensure that all equipment is in good condition and properly calibrated to apply the correct dosage.
- It is recommended that applications are carried out under suitable weather conditions, avoiding wet weather and windy conditions.

e) Disposal

- Any unused dilute pesticide that cannot be applied to the crop—along with rinse water, and out of date or no-longer approved pesticides—must be disposed of as a hazardous waste, as per FAO guidelines.
- Empty pesticide containers, foil seals and lids must be triple rinsed, and washings used in the pesticide tank be sprayed back onto the field or disposed of as hazardous waste in a manner consistent with FAO guidelines and according to the manufacturer's directions.
- Containers must be stored safely and securely under cover prior to their safe disposal; they must not be used for other purposes.

6.3 INTEGRATED PEST MANAGEMENT PLAN IMPLEMENTATION FRAMEWORK

6.3.1 Roles and Responsibilities for IPM and Related Research

The implementation of the present IPMP involves several stakeholders and therefore the WFP will be working with the Co-operating Partner (Mercy Corps), the Ministry of Agriculture and Forestry, the Agricultural Research Cooperation, and Farmers Organizations (FOs). The relevant institutions responsible for managing pests and implementing the IPMP are listed below in Table 11.

Table 11: Government of Sudan institutions with responsibilities in pesticides and pest management

Authorities		Roles
Ministry of Agriculture and Forestry	Directorate of Agricultural Extension	Information and awareness-raising of farmers through extension workers, who are trained by ARC. In the agricultural schemes, the technical personnel from the schemes are also involved in information / awareness raising.
	Directorate of Plant Protection	Spearhead the control/management of crop pests and diseases. Control migratory pests.
Sudan Standard Measurement Organization		Consumer protection through improving products quality. Set out standards of different commodities and services according to internationally acceptable standards.
Higher Council for Environment and Natural Resources		Plan and coordinate all issues related to environment and natural resources management in Sudan at the national level. Elicit and coordinate national policies and plans, as well as proposing legislation for environmental protection and conservation of natural resources. Serve as a focal point of all the international and regional conventions and agreements concerned with natural resources and environment.
Ministry of Health	Directorate of Environmental Health	Govern the control of malaria and other vector-borne diseases. Register and control the administration of pharmaceuticals, medical devices, and pesticides for public health. Register and control pesticides for public health and when farmers face health issues/diseases arising from pesticide use.
Agricultural Research Corporation (ARC)		The principal arm of government on agriculture and responsible for carrying out research on new pests affecting the agriculture sector and recommending the most appropriate interventions.
World Food Program (WFP)		Together with the Cooperating Partner will ensure that the project is implemented in compliance with the present IPMP and the relevant World Bank Environment and Social Standards (ESSs).

6.3.2 Training and Capacity Building Needs

IPMP is a knowledge intensive and interactive methodology that requires precise identification and diagnosis of pests and pest problems and solid technical knowledge on the control measures. Comprehending the relevant ecosystem interplays equips farmers with biological and ecological control knowledge and assists them in making pragmatic pest control decisions. However, at the time of preparing this IPMP, the Cooperating Partner (Mercy Corps) is yet to select the Farmers Organizations/farmers to work with in implementing the project.

Successful implementation of the present IPMP is largely dependent on developing and sustaining institutional and human capacity to facilitate experiential learning. Experiential learning is a prerequisite to making informed decisions in integrating scientific and indigenous knowledge.

Once the Farmers Organizations are selected, a capacity need assessment of the farmers organizations/farmers will be completed, along with, selection of community extension trainers (CETs), who will be trained on IPM measures. The CETs will then carry out training for the FOs.

6.3.3 Training

Farmers need to have the capacity to do basic diagnosis and identification of at least the most common pests, pest problems and diseases in their crops and understand trophic relationships that underpin biological control opportunities and use such knowledge to implement the relevant IPM measures. Through the participatory approaches, farmers need to learn cultural, biological, and ecological processes underpinning IPM options, and use the newly acquired knowledge to choose compatible methods to reduce losses in production and post-harvest storage.

The Co-operating Partner will provide the necessary training to the targeted FOs and cooperatives within the project areas through Community Extension Trainers (CETs).

6.3.4 Community Extension Trainers (CETs)

For the Co-operating Partner (Mercy Corps) to train the farmers on IPM, it will require community extension trainers (CETs), who will be selected from within the project target areas. In addition to these roles created for the project, field extension agents (EAs) under the Ministry of Agriculture at state level, who advise farmers on all aspects of agricultural production, including pest management, will also be invited to training.

6.3.5 Recommended Course Content

Community Extension Trainers need training in the areas of pest and disease identification, IPM and technical solutions respect to alternatives to chemical pesticide use. WFP will work with Mercy Corps to develop and provide the following training content to CETs and FOs/farmers:

a. General introduction to causes of pest problems,
b. Introduction to use of participatory methods in understanding pest problems,
c. Introduction to insect pest sampling/monitoring and use of action thresholds,
d. Overview on use of cultural, biological, and host plant resistance methods in control of crop pests,
e. Introduction to elements of pesticide control tactics,
f. Impact of pesticides on the environment, and
g. Integrating as low-hazard chemical pesticides as economically viable in crop/area-specific IPMPs.

6.3.6 PEST MONITORING PLAN

Successful implementation of the SOMOUD Integrated Pest Management Plan in the project locations will require regular monitoring and evaluation of the project activities undertaken by the beneficiary farmers. The focus of monitoring and evaluation will be on assessing the build-up of IPM capacity among the FOs/farmers and the extent to which IPM techniques are being adopted in agricultural production, and the economic benefits that farmers derive by adopting IPM.

Tentative Indicators include the following (these will be further developed and defined, and the indicator targets will be set following the capacity needs assessment):

a. Number of farmers engaged in IPM capacity building in the project locations;
b. Number of farmers who have successfully received IPM training in IPM methods;
c. Number of trainees practicing IPM according to the training instructions;
d. Number of women as a percentage of the total number of farmers regarding indicators a, b and c;
e. Number of youths (XX-XX years) as a percentage of the total number of farmers regarding indicators a, b, and c;
f. Improvement in the health status of farmers.

6.3.7 COST OF INTEGRATED PEST MANAGEMENT TRAINING

It is assumed that some of the mitigation measures will be part of the normal responsibility of the respective government ministries, farmers, and other relevant stakeholders, within their institutional mandates and budgets. The cost of training in managing impacts will be provided for in Table 12 and the complementary notes once the capacity needs assessment has been conducted. The table will also include costs for conducting awareness and sensitization campaigns on pesticides application, management, and adoption of IPM in the project areas.

6.3.8 Workplan and Budget

Table 12 will be updated after the capacity needs assessment has been carried out and the actual budget is determined for implementation of the SOMOUD IPMP. The cost components cover IPM capacity building and awareness program and project management including the cost of monitoring.

Table 12: Indicative Budget Estimate for IPMP under SOMOUD

	Item/Activity	**Total (USD)**
A	**Capacity building & awareness**	
	Training of Community Extension Trainers	
	Awareness campaign and sensitization of FOs/farmers	
	Development manuals for use by CET/EA	
	GRAND TOTAL	

ANNEX 1: LIST OF HIGHLY HAZARDOUS BANNED PESTICIDES USED IN SUDAN

The following pesticides are known to be used within Sudan, despite being banned. The farmer training will include clear messaging and content on these hazardous substances, including explaining the hazards, and that they are not to be used in conjunction with SOMOUD.

Table 13: The most common Highly Hazardous Banned Pesticides used on crops in Sudan.

Herbicide/crops		**Fungicides/crops**		**Insecticides/Crops**					
2,4-D	Sorghum, wheat	Azoxystrobin	Vegetable	Abamectin	vegetable	Diafenthiuron	cotton	omethoate	vegetable
2,4-D (acid equivalente)-dicamba	Sorghum, wheat	Benomyl	Vegetable	Acetamiprid	vegetable	Dimethoate	vegetables	Permethrin	vegetable
Ametryn +trifloxysulfuron sodium	Sugar cane	Carbendazim	Vegetable	Aluminum phosphate	Wheat	Emamectin benzoate	vegetables	Pinoxaden-clodinafop-propargyl-cloquiinocet-mexyl(safener)	Vegetable
Clethodim	Potatoes, cotton, vegetable	Difenconazole-azoxystrobin		Alphacypermethrin	Vegetable	Ethephon	Sugar cane	Prallethrin	vegetable
Clodinafop-propargyl	Wheat, vegetable	S-metolachlor	Vegetable	Bacilus megateriumwp	Vegetable	Fenpropathrin	Vegetable	Profenofos	Vegetable
Cycloxydim	Sesame	Sulphur	Vegetable	Bacilus megateriumwp	Vegetable	Fenthion		Prometryn	vegetable
Diuron	Cotton	Mancozeb-metalaxyl	Vegetable	Bendiocarb	Wheat	Fenvalerate	Vegetables	Pymetrozine	Vegetable
Fluofenim	Sorghum	Metalaxyl-mmefenoxam/mancozeb	Tomato	Beta-cyfluthrin	Vegetable	Fluazifop-p-butyle	Vegetable	Thiacloprid dletamethrin	Vegetable
Glyphospahte	Vegetable sugar cane	Fludioxonil,metalaxyl	Potatoes	Bromadiolin	Vegetable	Flubendiamide-spirotetramat	Vegetable	Thiamethoxam	
Glyphosate acid	Sugar cane	Haloxyfop-p-methyl	Vegetable	Carbaryl	Vegetable Farmers	Flusilazole	Vegetable		
Glyphosphate (acid equivalent)	Sugar cane	Hexaconazole	Vegetable Farmers	Carbofuran	Vegetable sorghum	Fluvalinate	Vegetable		
Imazathapyr	Alfafa	Tebucconazole	Cotton	Carbosulfan	Vegetable Sorghum	Imidachlorprid	Seed treatment cotton		

Sulfosolfuron	Sunflower	Tetramethrin-Rich-d-t—prallethrin/deitamethrin	Sorghum	Chloropyrifos	Wheat, Vegetable	Lamda-cyhalothrin	Vegetable		
Oxyflurofen	vegetable	Thiram	Sorghum	Cypermethrin	Vegetableveterinary	Omethoate	Vegetables		
Pendimethalin	Vegetable sugar cane	Triadimefon	Vegetable						
Propiconazole	Sunflower	Triflumurom	sorghum						

ANNEX 2: LIST OF APPROVED/ALLOWED/REGISTERED PESTICIDES IN SUDAN

Table 14: List of Approved/Allowed/Registered Pesticides in Sudan

Brand Name	Active Ingredient	Concentration of a.i. (g/l)	Dose Rates for Desert Locust (ga.i./ha)	Formulation	WHO Classification
Cyprofen C 220 ULV	Profenofos 200+ Cypermethrin 20 Co.	220	110	ULV	II
Decis 12.5 ULV	Deltamethrin	12.5	12.5	ULV	II
Diazinon 80% ULV	Diazinon	800	400	ULV	II
Mavrik 50 ULV	Fluvinate	50	500	ULV	
Nomolt 50 ULV	Teflubenzuron	50	22.5	ULV	U
Malathion VAP 96% ULV	Malathion	960	960	ULV	III

ANNEX 3: WHO Pesticide Classification

Table 15: WHO Pesticide Classification

Pesticides Product	Active Ingredient	Chemical Class	Toxicological Class	Main Use
BASUDIN	Diazinon	Organophosphate	11	Insecticide
HERBOXONE	2,4-D	Chlorophenoxy-acid	11	Herbicide
TOPIK	Clodinafop-Propargyl	Arylozyphenoxy propionics	111	Herbicide
AATREX	Atrazineq	Triazines	U	Herbicide
MACHETE	Butaclor	Chloroacetanilides	U	Herbicide
CERTAINTY	Sulfosulfurone	Sulfonylureas	U	Herbicide
ERADICANE	EPTC	Carbamides	11	Herbicide
LASSO	Alachlone	Chloroacetanilides	111	Herbicide
DECIS	Deltamethrin	Pyrethroides	11	Insecticide
ALTO	Cyproconazol	Triazoles	111	Fungicide
SENCOR	Metribuzin	Triazines	11	Herbicide
CONFIDOR	Imidacloprid	Neonicotinides	11	Insecticide
GRANDSTAR	Tribenulon-methyl	Sulfonylureas	U	Herbicide

ANNEX 4: WHO Code of Conduct for Pesticide Use

Table 15: WHO Code of Conduct for Pesticide Use Code of Conduct - 2001 revised version
10.1 All pesticide containers should be clearly labelled in accordance with applicable guidelines, at least in line with the FAO guidelines on good labelling practice (3).
10.2 Industry should use labels that:
10.2.1 comply with registration requirements and include recommendations consistent with those of the recognized research and advisory agencies in the country of sale;
10.2.2 include appropriate symbols and pictograms whenever possible, in addition to written instructions, warnings and precautions in the appropriate language or languages (3);
10.2.3 comply with national or international labelling requirements for dangerous goods in international trade and, if appropriate, clearly show the appropriate WHO hazard classification of the contents (3,35,36);
10.2.4 include, in the appropriate language or languages, a warning against the reuse of containers and instructions for the safe disposal or decontamination of used containers;
10.2.5 identify each lot or batch of the product in numbers or letters that can be understood without the need for additional code references;
10.2.6 clearly show the release date (month and year) of the lot or batch and contain relevant information on the storage stability of the product (21).
10.3 Pesticide industry, in cooperation with government, should ensure that:
10.3.1 packaging, storage and disposal of pesticides conform in principle to the relevant FAO, UNEP, WHO guidelines or regulations (27,28, 37, 39, 40) or to other international guidelines where applicable;
10.3.2 packaging or repackaging is carried out only on licensed premises where the responsible authority is satisfied that staff are adequately protected against toxic hazards, that the resulting product will be properly packaged and labelled, and that the content will conform to the relevant quality standards.
10.4 Governments should take the necessary regulatory measures to prohibit the repackaging or decanting of any pesticide into food or beverage containers and rigidly enforce punitive measures that effectively deter such practices.
10.5 Governments, with the help of pesticide industry and with multilateral cooperation, should inventory obsolete or unusable stocks of pesticides and used containers, establish and implement an action plan for their disposal, or remediation in the case of contaminated sites (41), and record these activities
10.6 Pesticide industry should be encouraged, with multilateral cooperation, to assist in disposing of any banned or obsolete pesticides and of used containers, in an environmentally sound manner, including reuse with minimal risk where approved and appropriate.
10.7 Governments, pesticide industry, international organizations and the agricultural community should implement policies and practices to prevent the accumulation of obsolete pesticides and used containers (37).