

Annex 7: SACEP Integrated Pest Management Plan

LIST OF ACRONYMS

AESA	Agro-ecosystem Analysis
EMSF	Environmental Management and Social Framework
ETL	Economic Threshold Limit
FFS	Farmers' Field School
GoS	Government of Samoa
IPDM	Integrated Pest and Disease Management
IPDMP	Integrated Pest and Disease Management Plan
IPM	Integrated Pest Management
IPMP	Integrated Pest Management Plan
METI	Matuaileoa Environmental Trust Incorporation
OD	World Bank Operational Directive
OP	World Bank Operational Policy
SBEC	Small Business Enterprise Corporation
USP	University of Southern Pacific
WIBDI	Women in Business Development Incorporation

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1 Introduction

The project focuses on introduction of new fruit and vegetable (F&V) crops and crop diversification and promotes crops development where there is a comparative advantage to reduce import of food commodities. Feed crop production for livestock can also potentially require increase in use of pesticides.

Since the project environmental and social management framework (ESMF) has identified that the project activities would trigger the Bank's Pest management policy (OP4.09, the two technical components of this project (F&V and livestock development) should include ecologically sound integrated pest management (IPM) strategies in their crop production planning. According to the ESMF, a pest management plan is needed in the project interventions within the production chain approach to impact:

- Change in cultivation and management practices and the use of newly improved cultivars and crops that might have better pest tolerance;
- Potential increased use of pesticide with agricultural intensification in both the production and post harvest and marketing sections of the F&V production chain; and
- Potential use in the livestock-related food sector of continued use of broad spectrum chemicals and pesticides that are expected to be reduced and gradually replaced with pest specific pesticides.

Losses in crop production from weeds, insect pests, and plant diseases are found to be significant and sometimes disastrous as taro blight of the 1980s being the case in point. The report by the crop protection department of the MAF indicates that a pest attack in vegetables such as cabbages is more severe than in case of other tree crops. Further, resistances to pesticide have also been reported in some places, probably due to the popular non-selective pesticides that are often available and promoted at the government operated Agricultural Chemical stores. Therefore, crop protection should be considered as an important aspect of fruit and vegetable production component of the project.

Since the project promotes enhanced cropping intensity and mono-cropping, the likelihood of increase in the population of weeds, insect pests and plant diseases is significant. Project's crop production activities and introduction of new crops might lead to a tendency for farmers and agricultural extension workers to promote excessive use of chemicals in agriculture, causing soil and water pollution. Such potential negative environmental impacts can be avoided through the implementation of Integrated Pest Management (IPM).

The Inter-Center Working Group on IPM (IRRI, 2000) defined IPM as "an approach to enhancing crop production, based on an understanding of ecological principles, that empowers farmers to promote the health of crops and animals within a well-balanced agro-ecosystem, making full use of available technologies, especially host resistance, biological control and cultural control methods". IPM promotes use of chemical pesticides only when the above measures fail to keep pests below acceptable levels, and when assessment of associated risks and benefits, considering effects on human and environmental health, as well as profitability (social and economic impacts) indicates that the benefits of their use outweigh the costs. Interventions would be need-based and re applied based on economic thresholds to minimize undesirable side-effects.

The project would use the World Bank listings and procedures on "Integrated Pest Management" (IPM) including IPM components (biological control, cultural practices and development of pest resilient or tolerant varieties). If pesticides are to be used, the proposed IPM approach proposed in this report should be applied, which amongst others promotes use of:

- pesticides not harmful to human health;
- their effectiveness against target pest species known;
- Ensuring negligible effect on non-target species and their habitat;
- Ensure use of pesticide to prevent the development of pesticide resilience; and

- Ensure pesticide packaging, labelling, storage, disposal and application must be performed according to acceptable standards that are in force in Samoa.

This Integrated Pest Management Plan (IPMP) provides a framework for ensuring that the Samoa Agricultural Competitiveness Enhancement Project (SACEP) supports environmentally sound pest management procedures. It directly addresses World Bank Policy OD/OP 4.09: Pest Management, and should be considered as an annex to the Environmental Management and Social Framework (EMSF) report for the project.

The SACEP is executed by the Ministry of Finance (MOF), with funding from the World Bank. The Ministry of Agriculture and Fisheries (MAF) would have an execution, monitoring and coordinating function at the national level. As per the World Bank's OP.9 requirement, the project would not finance procurement of any pesticides that are classified as Category I_a or I_b according to the WHO classification of pesticides hazard levels.

1.1 Project Overview

The Government of Samoa has requested World Bank financing of the Samoa Agricultural Competitiveness Enhancement Project (SACEP). This project is one of the Government's programs contributing towards the goals of GoS on reducing dependence on agricultural import, improving the opportunities of exporting agricultural commodities to neighboring countries, improving food quality and safety, and improving the livelihood of vegetable and livestock farmers in Samoa. SACEP corresponds with the central features of the Government Strategy for improving the agricultural sectors capacity to produce high quality livestock and agricultural produce, focusing on the fruits and vegetables and livestock industries for local and export markets, as specified in its Agricultural productivity improvement strategy. The project is designed to fund a number of small-scale, community-based subprojects that would be identified and planned by the agricultural communities and farmer associations, with the support of project financed extension teams, and then approved for funding by local government authorities.

The focus of the SACEP is on the improving the fruit and vegetable (F&V) production and livestock industries, given their strategic importance for the rural economy, to reduce agricultural commodity import and to improve the opportunities of exporting agricultural commodities to neighboring countries. Within those two major industries, the proposed SACEP would provide, over five years, the predictable and continued support required to implement some of the structural changes necessary to improve their performance and sustainability – and maintain their competitiveness in Asia-Pacific markets- by strengthening core institutions and improving the delivery of support services and infrastructure for smallholders.

The development objective of the proposed project would be to improve the performance and the sustainability of value chains in F&V and livestock producing areas, in order to improve the livelihoods of smallholder F&V and livestock producers. It would also focus on high value niche products (building on Samoa's comparative advantage for organic products and other specialty products) giving specific attention to the sustainability of farming systems and increased returns for farmers.

This would be achieved through strengthening industry coordination and institutions, expanding and strengthening linkages between smallholder farmers and agribusiness for the provision of technologies and services, and through the provision of critical market access infrastructure.

Key outcomes would be that: (i) smallholder farmers adopt efficient, market responsive and sustainable production practices leading to an increase in their income; (ii) demand-driven productive partnerships are established with the help of public support; and (iii) key infrastructure bottlenecks in the targeted agricultural areas are addressed.

The proposed project would include the following components:

Component 1 - Livestock Production and Marketing: Under this component, the project would promote the sustainable intensification and profitability of selected livestock enterprises such as beef cattle, pigs, sheep and poultry to produce meat, through improved farmer access to: (1) advice on

improved breeding, feeding, animal health and general husbandry practices; (2) upgraded breeding stock and quality animal feed supplies; (3) demand-driven matching grants to finance eligible investments (such as the purchase of breeding stock and construction of housing etc) along livestock value chains; and, (4) efficient and hygienic slaughter and cold storage facilities.

Component 2 - Fruit and Vegetable Production and Marketing: Promoting the sustainable expansion and profitability of fruits and vegetables production and other specialty/organic products by: (1) facilitating farmer organization through a variety of operational models to facilitate access to technical and market knowledge, and aggregate product to encourage more effective and efficient marketing; (2) improving access to improved fruit and vegetable varieties; (3) providing advice on variety selection, crop nutrition, improved husbandry practices, (particularly in relation to seasonal rainfall excesses and shortfalls), and post harvest handling; and (4) demand-driven matching grants to finance eligible investments (such as on-farm capital investments, appropriate mechanization and start-up working capital etc) along fruit and vegetable value chains.

Component 3 - Institutional Strengthening: Improving the ability of participating Government ministries and institutions, and collaborating non-government organizations to implement and monitor the project through the provision of finance for (1) targeted technical assistance, short term training, studies and exposure visits; (2) incremental staff needed to effectively administer the project, especially regarding project coordination, procurement, and monitoring and evaluation; (3) provision of vehicles to increase mobility and field coverage; (4) access to increased operating expenditure to maximize field operations; and (5) monitoring and evaluation including the baseline and impact assessment surveys.

1.2 IPMP Focus

The IPMP addresses the requirements of the World Bank OP 4.01 (D): and OP 4.09, Integrated Pest Management and, consistent with the SACEP objectives, focuses chiefly on the smallholder sector. However, other direct and indirect issues are also addressed, such as agrochemical runoff effects, etc.

2 Policy Regulation and Institutional Capacity

2.1 Conventions regarding Agrochemicals

GoS is a member of the Governing Council of the United Nations Environment Program, and it has membership to a number of international and regional treaties and conventions relating to environment, including a number that relate specifically to the control of hazardous substances:

- International Plant Protection Convention (IPPC)
- Basel Convention on the Trans-boundary Movement of Hazardous Wastes and Their Disposal;
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade¹¹;
- Stockholm Convention on Persistent Organic Pollutants;
- Vienna Convention on Protection of the Ozone Layer;
- Montreal Protocol on Ozone Depleting Substances;
- London Dumping of Wastes at Sea; and
- The regional agreement, South Pacific Regional Environmental Program.

2.2 GoS Policy, Legislation and Control

The Importation and Distribution of Agrochemicals into Samoa is under the jurisdiction of the department of quarantine at the MAF. The Quarantine department is empowered to monitor and

¹¹ Annex 1 lists the chemicals under the Stockholm and Rotterdam Conventions.

regulate the import, use and management of chemicals in the country under the Environmental Act 2004.

The Quarantine Department is also responsible for the awarding of import permits, transfer of permits, issuing of pesticide guidelines (for sales, importation, manufacture, distribution, promotion, advertisement and use). In addition, it is responsible for maintaining an inventory of pesticide impacts, for providing packaging guidelines for agrochemicals, and for enforcing compliance with the regulations.

However, there is no proper institutional framework or network established for controlling the monitoring and controlling chemicals in Samoa. While a permitting system is in place, it does not have the manpower and capacity to fully implement it due to a lack of institutional capacity.

Lack of capacity at MAF to fully enforce agrochemical import and registration is an issue. For instance, pesticide users should provide management plans for hazardous chemicals (industrial chemicals). However, these are often not provided and there is a general lack of control over both the import and use of hazardous chemicals.

Although Quarantine Department and agrochemical registrar at MAF have plans to address at least some of these shortcomings, it appears that problems exist in formalizing and finalizing these plans for implementation and enforcement.

Other departments with responsibility relating to agrochemicals and pesticides include the Ministry of Health, customs, and the Ministry of Natural Resources, Environment, and forestry. Again, the effectiveness of these institutions is constrained due to a lack of capacity.

The Ministry of Agriculture and Fisheries (MAF), besides the Quarantine Department, has a crop protection department, stationed at Nu'u Agricultural Research Station. The department is short in staff, equipment and budget and has very few on-going research program, relevant to IPM that are mainly concentrated on cabbage diseases. While some awareness is undertaken by MAF and MONRE on the use and management of the organophosphate and other pesticides, including their potential risks to humans and the environment, not much else has been provided to the farmers and the public.

Moreover, the processes for regulation and control under the Environment Act (2004) are vague and are yet to be tested in the field. Nevertheless, there are other regulations which have specific provisions and mandates to meet GoS's obligations under various International Treaties and Conventions that GoS is a signatory to.

2.3 Policy and Organizational Issues

The main public sector institutions relevant to SACEP are the WIBDI, METI, and USP.

Whilst legal statutes of Quarantine Department and mandate of Crop Protection Department are considered adequate for the purposes of IPM, there is a need for a review of the legislation related to the F&V and livestock industry. This should include for the development of environmental sustainability criteria for the mentioned industries, with a medium term goal of ensuring internationally recognized certification of sustainability.

2.4 Infrastructure, Capacity, Institutional Arrangements and Collaboration

As the IPMP is focused on the F&V industry, it is essential to note the infrastructure and institutional arrangement and collaboration within institutions involved in the success of this industry. Much of the capacity strengthening arrangement is in Component 1 of the SACEP.

2.4.1 F&V production

There is currently no systematic IPMP in place for the F&V industry, or general agricultural production as a whole. The lack of a systematic IPM development in Samoa and lack of adequate manpower and budgetary issues emphasizes the need for establishing an effective IPMP as soon as possible. Some more progressive private farms such as Aggie's Farms have adopted certain IPM

based practices, such as use of boiling water to reduce the population of nematodes before planting new crops, as an integral part of their production practices. However, not considering the organic food producers who are not using any pesticides, the number farmers who have adopted IPM related practices and/or the IPM related research activities by the MAF staff are less than desirable. On the other side of the spectrum lie the activities of NGOs such as WIBDI and METI to promote organic farming where use of no agrochemicals is mandatory.

A head cabbage (*Brassica*) IPM projects was initiated by ACIAR, and SPS, in association with researchers from the Queensland University of Australia in 2005 in Fiji and Samoa. The project proposal aimed to bridge existing technical gaps in Samoa by conducting further studies to introduce more effective and suitable natural enemies of cabbage pests. In addition, the project hopes to be able to evaluate and select more effective, and pest specific insecticides as well as considering ways to improve the cultural and agronomic practices of cabbage production in the two countries. The crop protection department at Nu'u is involved in conducting the research activities related to the above project and is involved in limited research activities on determining the economic threshold of pest and diseases for cabbage that is currently one of the main vegetable crops that is planted by most Samoan vegetable farmers. Very little IPM efforts are currently undertaken at Nu'u or any other institution in Samoa for other fruits and vegetable crops due to lack of funds and limited availability of trained staff.

The crop sciences department at the University of South Pacific (USP) in Apia has a highly knowledgeable staff including plant pathologist, and entomologist. They have been involved in training technical staff in IPM technologies as a part of the agricultural university's curriculum. Most crop protection and extension staff at MAF and other institutions that are involved in agricultural production in Samoa have been trained by the USP staff in principles of IPM. However, in practice very limited efforts and budget is allocated to this very important applied agricultural research area. The USP researchers' technical knowledge and practical experience is a valuable resource and their input should be sought for development of training modules and FFS activities in the area of IPM. Their capabilities should be further reviewed in more detail and their input in planning of appropriate practical training and capacity building modules in the areas of IPM technologies and applied research should be requested. It is proposed to use their input in the above mentioned areas to increase capacity of crop protection and agricultural extension staff in MAF in the area of IPM and providing the necessary and appropriate assistance and training to both technical staff and project farmers in the area of IPM technologies in FFS format. The crop protection staff at USP are currently undertaking limited IPM related activities at the university, including trials on disease tolerant varieties of cabbage and fruit trees; and provision of training on integrated pest management at the graduate and undergraduate levels.

Finally, it should be highlighted that since the input of agrochemical by small holders is small, any IPM or biological control methods proposed would need to be compatible with small holder farming systems.

2.4.2 Proposed major areas of intervention

The main areas of intervention that should be undertaken by Crop Protection and agricultural extension departments at MAF in relation to extension of IPM related activities include:

- Intensive farmer training;
- Provision of farmer support;
- Intensive public awareness;
- Strengthening and supporting stakeholder partnership;
- Farmer mobilization;
- Resource mobilization; and
- Development and enforcement of IPM related legislation.

3 Current IPM Practices and Proposed Changes

3.1 Current IPM Related Practices

Currently, there is no explicit IPM policy in Samoa and there is no legislation or regulation to publicize IPM principles. As was mentioned before, the crop protection department of MAF is currently working on determining the economic thresholds of pesticide application for head cabbages, but no other IPM related activities with regard to other crops are in the future plans. The IPM program should be vigorously pursued as part of SACEP through enhancing the capabilities of the crop protection and full cooperation of crop protection and agricultural extension departments. IPM should be considered as an extension program, focusing more on demonstration of researched and proven technologies, new farming systems, and improvement in the current practices.

3.2 Proposed New IPM Related Activities

IPM packages should be developed through research and on-farm trials for major crops including the ones proposed by the SACEP project. The packages should identify the pests that are usually found in such type of crops in the region and identify the IPM economic threshold for application of pesticides, and identify the adaptable biological control and pest specific narrow spectrum pesticides to control economic impact on crop production. Techniques suggested for monitoring pests are:

- **Rapid Roving Survey (RRS):** Regular monitoring of insects and diseases along pre-selected routes at weekly interval to assess bio-control and alert the farmers about the potential of pest attack;
- **Field Scouting:** Field scouting shall be done once a weekly basis to keep close watch on appearance and infestation of insects, pests, diseases and bio-control of fauna to assess the Economic Threshold limit (the point where the potential loss due to crop damage by pests outweighs the cost of pesticide treatment). Pesticide treatment before surpassing the economic threshold is not justified and nature itself has a way of working against an increase in pest levels. In other words, the economic benefits of pest and disease control outweighs the economic benefits of increased crop productivity;
- **Pest Monitoring through Pheromones/Sticky Traps:** Traps coated with grease or sticky substances are placed at specified intervals to traps insects. In pheromone traps female sex hormone capsules are kept inside the trap to attract male population, which are eventually killed;
- **Identification of activities of fruit flies, using IPM approach by identifying, introducing and expanding the suitable means of fruit fly control such as fruit fly traps, sanitation, protein bait spraying, and sticky tapes and monitoring their success rates in both Upolu and Savai'i; and**
- **Agro Ecosystem Analysis:** This can be employed by a group of farmers for decision making on IPM. The basic components of agro-ecosystem analysis are:
 - ✓ Health of plant at different stages of growth;
 - ✓ Compensation ability of plant;
 - ✓ Pest and defender population;
 - ✓ Soil condition and irrigation status;
 - ✓ Weather condition;
 - ✓ Past experiences; and
 - ✓ Other investment opportunities.

The pest management strategy proposed in SACEP is to define the Economic Threshold limits for major pests, identified for the major crops under consideration in Samoa. The presence of a pest in a field does not necessarily mean that the pest population would reach damaging levels. Crop protection department should be provided with adequate resources to enable them to determine the economic threshold limits for all promoted crops to allow for implementation of proposed IPM related activities.

Economic returns from control of pests below the economic threshold limits are not justified. Thus the farmers need to be trained to recognize the economic threshold limits to ensure that crops would be treated based on IPM principals to work towards economic benefits.

Some of the methods suggested for control of pests in the Integrated Pest Management Package are:

- Cultural Practices;
- Mechanical Practices;
- Bio-Control Practices; and
- Chemical application.

These have been briefly described below.

Cultural Practices: These are agricultural practices that make the environment less favorable for proliferation of insect pests. Some typical cultural practices include cultivation of alternate hosts (e.g., weeds), crop rotation, selection of planting sites, trap crops, adjusting the timing of planting or harvest, tilling practices, and nutrient and irrigation application.

Mechanical Practices: The use of physical barriers such as row covers or trenches prevents insects from reaching the crop. Other methods include hand picking of pests, collection and destruction of larvae, sticky boards or tapes for control of flying insects, having sources which attract pests such as sugar or yeast solutions, and other trapping techniques.

Bio-Control Practices: Bio-control practices include managing of major insect pests through conservation of existing natural biological control agents including the African giant snails, say by introduction of flat worms, etc.

Chemical Application: Application of chemical pesticides should be recommended only when control of pests below the threshold limits are not possible by other techniques suggested above. Appropriate selective chemicals in recommended doses shall only be applied when economic threshold is reached. Gestation time for action of chemical pesticide should be provided for control of pests.

The main objective of the IPM component is to ensure capacity building of the farmers to be able to analyze (on their own) the agro-ecosystems and find out the threshold levels of the pest and defenders in order to decide about the appropriate intervention under the spirit of IPM. The efforts and cooperation of crop protection and extension departments of MAF are paramount in ensuring the success of the IPM activities.

For IPM to succeed, it requires that IPM demonstration cover a fairly large area. These demonstrations should cover all crops grown in an area. It should include cultivation of pest resistant/tolerant varieties, adoption of agronomic practices to minimize pest attack, promotion of use of bio-pesticides and need based application of bio-rational pesticides in the selected IPM villages.

There is a need to include IPM demonstration in Farmers' Field Schools (FFS) training for duration of some 10 days or more, as needed. Possible modules for IPM training have been detailed in Table 1. These modules must be refined through further discussions with the crop protection and agricultural extension departments at MAF, The USP crop protection experts that should be involved in providing training and beneficiaries through structured PRAs.

Table 1: Proposed Tentative Training Modules for IPM

Training Module	Crop Stage	Activities
I	Pre-sowing	Farmer selection Farmers' meeting to explain FFS program Benchmark surveys
II	Germination	Group formation Leader farmer selection Pre-evaluation test Seed germination test

Training Module	Crop Stage	Activities
		Nursery bed preparation
III	Seedling/sowing	Seed treatment test Collection of field flora & fauna Sorting & identification Good message relay
IV	Seedling/vegetative	Sampling techniques Bio-ecology of major pests Demonstrating proper application of manure & fertilizer
V	Transplanting/vegetative	Agro-ecosystem analysis (AESA) Identification of diseases and their management Insect zoo
VI	Vegetative	Bio-ecology of major pests Predation experiments Installation pheromone traps IPM approach for major pests
VII	Vegetative/flowering	AESA Parasitic behavior study on eggs and larvae Installation of sticky traps Pesticide poisoning on natural enemies
VIII	Flowering	AESA of sprayed, unsprayed and field sprayed at economic threshold limit (ETL) Spraying of plants with and its comparative study with non sprayed field Pest population growth and its management Bio-ecology of major pests
IX	Fruiting	AESA of sprayed, unsprayed, and field sprayed at ETL IPM approaches for major crops Nematodes problem and its management Farmer presentation Yield comparison between IPM and non-IPM fields Post evaluation test Discussion on Post Harvest technologies

Currently the pesticide registration officer at quarantine department of MAF is assigned to register every agricultural chemical that enters the country. However, he is not providing any crop based information or advice on chemicals to be applied for particular weed/pest, active ingredients, formulation, dilution, dosage, and/or gestation period. The staff at the agricultural chemical stores, operated by the government, do provide some recommendations, but number of visits made by the consultant reveal that the level of knowledge of the staff on appropriate level of chemical application and the type of chemical suitable for different plant diseases were less than satisfactory. There is also a need to empower the quarantine officers and the department to enforce the quarantine (Biosecurity) bill (2003) more effectively to reduce import of highly toxic or banned agrochemicals to Samoa by developing an effective agrochemical registration system to minimize the levels of persistent organic pollutants (POPs) in the natural environment.

IPM demonstrations should be conducted, not only at Nu'u research station, but also in farmers' fields in both islands of Upolu and Savai'i. A minimum of 20 demonstrations should be conducted during the five years period. The number of demonstrations is only an indicative and actual number can only be determined after identifying the needs of the farmers through PRA and gap analysis by the agricultural extension workers.

In addition to the above the training strategy proposed for improving environment awareness proposes for two workshops for training of trainers in the first and second year respectively for the MAF agricultural extension employees. Further district level awareness training and workshops are proposed in each of the islands on a yearly basis by the trained MAF employees. IPM would be an integral part of curriculum of all trainings conducted by MAF staff.

The demonstration of IPM would be jointly organized to the extent possible and all kinds of convergence would be ensured. While organizing demonstration, quality would be emphasized rather than number of demonstration conducted. Demonstration would be organized keeping in view the need of the farmers and field days would be an integral part of each of the field demonstration. Success or failure of demonstration would be judged on the basis of acceptance of technology by nearby farmers. To monitor the effect of demonstration, impact evaluation would be made at periodic intervals. The selection of the demonstration plots would be through detailed study of its suitability and those that facilitate adoption of the technologies for which demonstration are being held. The project support for these demonstrations would be in the form of cost of inputs, field day and training, etc. The achievement and impact of these demonstrations would be evaluated in terms of adoption of demonstrated technologies by the direct beneficiaries and non-beneficiaries in project farmers and in the adjoining villages during the following years rather than in terms of physical numbers of demonstration. Proposed IPM related awareness and training needs during the life of project that are required for successful implementation of IPM principles by the project farmers are proposed and outlined in Table 2.

Table 2: Proposed IPM related awareness needs relevant to SACEP activities

Activity	Responsible agency	Schedule
Environmental awareness and training for trainers at Upolu	PCG at MAF, MNREM	Years 1 and 2
Environmental awareness training at district level for farmers, pesticide traders,	MAF extension officers trained on environmental principles	Yearly as needed
Farmer field school on IPM technologies	Crop protection and extension departments at MAF	Yearly at different project areas/villages

Apart from SACEP interventions following trainings/activities should be included as part of MAF responsibilities as a part of the effective pest management program:

- Training of extension officers and resource persons as trainers would be developed through season long training programs in proposed fruit and vegetable crop production. One such training would be held in wet and one in dry season. The program aims at training 16 agricultural extension officers over a period of two years.
- Though a training workshop for field supervisors they would be exposed to IPM principals in a five days period. The extension officers would be trained on a yearly basis, as needed, at South Pacific University.
- One Day Awareness Campaign to ensure mass awareness of the IPM concept would be taken up by each of the trained agricultural extension officers. 20 farmers would be trained in each of the campaigns. The program should be able to cover all farmers involved in fruit and vegetable production component activities.
- Pesticide, fertilizer, and seed dealers and extension agents play a pivotal role in the application of pesticides and fertilizers and their promotion to the farmers. To educate them a one-day training program would be conducted in each district. The program targets to educate all agrochemical dealers.

- Strengthening of existing crop protection department to empower them to provide pest surveillance and to survey pest and disease situation through rapid roving surveys at regular intervals to guide field functionaries in a timely manner.
- Pest and disease forecasting unit should be established within the crop protection department and their capacity should be strengthened with necessary material building to run these centers.
- Demonstrative use of Bio-Pesticides in FFS to popularize use of Bio-pesticides such as neem extract.
- Evaluation and adoption of Indigenous technical Know-how (ITK): Different IPM packages used by farmers would be evaluated for adoption through a participatory action research at the FFS for inclusion in the IPM program. One such method, use of boiling water to reduce the population of nematodes in tomato, cabbage, and other vegetable fields is already practiced at Aggie's farm in Upolu. Possibility of expanding such activities to other farms and demonstration of their effectiveness to other farmers fields should be an essential part of extension activities on IPM.

4 Pests and Diseases

Pests and diseases for F&V in Samoa are diverse and, depending on the weather pattern, can give rise to a variety of their populations.

Table 3 provides the information on currently known pests for fruits and vegetables in Samoa.

Table 3: Pests, Type of Damage and Diseases of F&V and fruit trees

Insect Pest	Type of Damage/Disease
Vegetables	
Diamondback moth	Feeds on outer pods of cabbage
Large cabbage moth	Feeds on outer/inner leaf of cabbage
Bacterial rot (tomatoes)	Cause the plant to wilt and die
Thrips and aphids	Stop tomatoes and capsicum from producing flowers
Giant African snails, scales, and mealy bugs	Soft rot, root rot
Fruit trees	
Fruit flies	Eggs laying in potential fruits, damaging the fruit
Fruit piercing moth	Sucking the juice from the fruit, causing damage to the fruit
Fruit flies, mealy bugs, thrips, aphids	Citrus canker, black spots
African giant snails	Black spots

4.1 General IPM principles

IPM consists of set of interventions that all together result in reduction of pest incidence to low and acceptable levels with minimal possible negative impact on natural ecosystems, non-targeted pests and the environment. Integrated Pest Management (IPM) is an effective tool to combat the negative effects of over application of pesticides that can potentially:

- destroy crop pollinators and lead to poor crop yields;
- eliminate the natural enemies of crop pests causing loss of natural pest control that keeps the populations of crop pests very low;
- cause development of pest resistance to pesticides;
- encouraging further increases in the use of chemical pesticides;

- contamination of the soil and water bodies;
- pesticide poisoning of farmers and deleterious effects on human health;
- unacceptable levels of pesticide residues in harvested produce and in the food chain; and
- loss of biodiversity in the environment.

Successful IPM is based on building sound farmer knowledge of the agro-ecological processes of the farming environment and empowering them to make informed decisions on the most appropriate management strategies to minimize crop loss due to pests, using economic threshold in pesticide application, and decide on best pest management practices to increase financial viability of their farming activity in an environmentally sustainable way.

Generally, The IPM components include:

- Cultural practices (good farm management);
 - ✓ Frequent, complete harvesting
 - ✓ Sanitation
 - ✓ Pruning of fruit trees, thinning of vegetable population
 - ✓ Weed management
- Planting materials resistant/tolerant to major pests and diseases;
- Biological control of pests and diseases if available; and
- Rational pesticide utilization (minimal, efficient and safe use of permitted pesticides).

Table 4 shows the typical results from the various IPM inputs where all these contribute to the health of the F&V.

Table 4: Results of various potential IPM Inputs

Results of inputs	Outputs or the results of the inputs
Sanitation	Reduce pests and diseases Improves general health of fruit trees and vegetable crops
Nitrogen Fertilizer Application	Increase vegetative growth Improves health and vigor
NPK	Induce flowering Promote growth
Weed control	Reserve plant nutrients Discourage pests and diseases Improve field and crop/tree sanitation
Shade control	Allow light penetration to dry moisture Discourage Pests and disease development
Tree pruning	Allow light penetration Provide uniform canopy Promote flowering Improves tree health, reduce pests and diseases Allows good plant husbandry and management as trees are small and accessible

SACEP would promote the use of IPM practices, in particular through the following measures where possible:

Major issues to be addressed through the use of IPM are

1. Increased use and reliance on chemical pesticides
 - ✓ Promote adoption of IPM on chemical pesticide practices through farmer education and training; and
 - ✓ Move farmers away from input-dependent crop/pest management practices and promote use of locally produced organic matter, botanical pesticides and biological control, use of economic threshold levels (ETL) for pesticide application.
2. Current pest management practices
 - ✓ Allocate adequate resources to implement National Plant Protection Policy;
 - ✓ Increase IPM awareness amongst policy maker, agricultural produce retailers, and farming community; and
 - ✓ Promote safe handling and application of pesticides.
3. Enforcement of quarantine requirement
 - ✓ Strengthen institutional capacity at MAF to effectively supervise compliance with agrochemical registration and pesticide legislation.
4. IPM research and extension
 - ✓ Strengthen IPM research;
 - ✓ Strengthen IPM extension;
 - ✓ Strengthen group efforts for field implementation of IPM.
5. Environmental hazards of pesticide misuse
 - ✓ Create public awareness of pesticide misuse hazards through public awareness campaigns;
 - ✓ Undertake regular assessment of pesticide residues in irrigated agricultural production systems and in harvested produce; and
 - ✓ Carry out monitoring of pesticide poisoning in the farming and rural communities.
6. Increased dependence on chemical control
 - ✓ Support mixed cropping and crop rotation systems to keep pest species from reaching economic damage levels.
 - ✓ Promote proper disposal of unused agricultural chemicals and packaging materials.

SACEP activities through training and capacity building of the crop protection and agricultural extension departments would include support for training of farmers and other stakeholders on IPM strategies for the control of the pest and diseases, as well as resources for the implementation of the response plan. This is in line with the needs expressed by communities during consultations carried out for the preparation of the ESMF report. Specific training should also be performed related to the safe, efficient and minimal utilization of pesticides, based on economic threshold levels for each major crop. It is proposed to develop a direct working relationship with the crop protection department at the USP so that proper structured and applied training modules can be developed for not only MAF's crop protection and extension staff, but also project farmers through FFS on implementation of IPM approach in F&V production.

5 IPM Action Plan under SACEP

It is essential that SACEP supports the development of knowledge and builds upon lessons already learned on IPM in GoS. Little work has been conducted concerning biological control methods for

F&V. This is something that could be supported by SACEP, being promoted by the MAF crop protection and agricultural extension departments.

The Pest Management Plan (PMP) within the project operational plan should be finalized by project appraisal and should be included in the Operational Manual (OM). The proposed IPM related activities include:

Phase I: Preliminary reconnaissance study to identify the major pest problems in the selected production chains for the selected fruit and vegetable crops, their contexts (ecological, agricultural, public health, economic, and institutional), and defining main parameters for evaluation.

Phase II: Within the context of the technical components of fruit and vegetable and animal feed production to develop operational plans to address the identified pest problems. The possible activities might include:

- Implementation and dissemination of the list of pest control products that are authorized by the project for procurement;
- Development of IPM approaches (biological control, cultural practices, use of resistant or tolerant varieties, reducing pesticide use to the minimum based on economic threshold limits and replacement of pesticides with other environmentally safe practices);
- Identification of actions that would be required and prioritize each of the selected production chains to:
 - ✓ improve the policy, economic, institutional, and legal framework for regulating, procuring, and managing the use of pesticides that are consistent with an IPM approach and are sustainable; and
 - ✓ the proposed mechanisms for financing, implementing, monitoring, and supervising components relating to pest management or pesticide use, including any role envisaged for the private sector including local nongovernmental organizations such as WIBDI, SBEC, and METI.
- Finalizing of the proposed training plan to develop the capacity of all who are involved in initiating IPM related research and agricultural extension activities within production chain approach to provide alternatives to undesirable pesticide use. Training activities should also include the various aspects related to the safe use of pesticides such as the use of protective gear and safe disposal of containers used, timing of application, etc.;
- Agree on a time-bound program to phase out the use of an undesirable and broad spectrum pesticide and properly dispose of any existing stocks, if applicable;
- Depending on the nature and complexity of the pest management and pesticide-related issues confirmed before project implementation, and in relation to the Pest Management and the Environmental Action Plans, the supervision missions might include appropriate technical specialists; and
- At the end of the project, the implementation completion report (ICR) should be prepared to evaluate the environmental impact of pest management practices supported or promoted by the project and institutional oversight capacity of the Ministry.

5.1 Pesticide Use

The following criteria apply to the selection and use of pesticides in activities under SACEP:

- They should have negligible adverse human health effects (Categories II and III, as per WHO categories, 2004);
- They should have shown through field studies that they are effective against the target species;

- They should not be broad-spectrum pesticides and should have minimal effect on non-target species and the natural environment. The methods, timing, and frequency of pesticide application must be aimed to minimize damage to natural enemies; and,
- Their use should take into account the need to prevent the development of resistance in pests.

Pesticide financed by SACEP should be packaged, labelled in both English and Samoan languages, handled, stored, disposed of, and applied according to standards that comply with the FAO's Pesticide storage and stock control manual (FAO, 1996), Revised guidelines on good labelling practice for pesticides (FAO, 1995), Guidelines for the management of small quantities of unwanted and obsolete pesticides (FAO, 1999), Guidelines on Management Options for Empty Pesticide Containers (FAO, 2008), and Guidelines on personal protection when using pesticides in hot climates (FAO, 1990).

SACEP financing would not be used for formulated products that fall in WHO classes Ia and Ib, or when they are likely to be used by farmers without training, equipment, and facilities to handle, store, and apply these products properly.

SACEP financing would not be used for any pesticide products that contain active ingredients that are listed on Annex III of the Rotterdam Convention (on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade), unless the Samoan Government has taken explicit legal or administrative measures to consent to import and use of that active ingredient.

SACEP financing would not be used on any pesticide products which contain active ingredients that are listed on Annex A & B of the Stockholm Convention on Persistent Organic Pollutants, unless for an acceptable purpose as defined by the Convention, or if an exemption has been obtained by the Samoan Government under this Convention.

5.2 Occupational and Health Risks and Mitigation Measures

IPM methods based on cultural practices normally do not involve the use of chemicals and is of no risk to farmers. However, modern agricultural practices and intensive crop production normally require adoption of agrochemicals use, such as would be the case for F&V production under SACEP. Therefore, it is essential to ensure that farmers involved in the project are made adequately aware and are taught proper procedures for the safe use, handling, application, storage and disposal of agrochemicals. The use of such gears as face and nose masks, eye and body protection and personal hygiene including thorough washing of hand and clothing after the application of the agrochemicals should be introduced and, as much as possible, enforced. Only permitted pesticides should be used in recommended quantity and frequency with appropriate application techniques and nozzles to make sure that the most efficient control of targeted insects, using narrow band and targeted pesticides with minimal quantity are used.

In addition, no pesticide, classified and listed as category I in the WHO Guidelines would be financed under SACEP and the project would assist MAF and other stakeholders in revisiting their recommendations in that area.

Training activities would be designed so as to maximize participation by women farmers since field observation indicated that most women are involved in day-to-day farming activities that include spraying of F&V crops with pesticides.

5.3 Implementation of IPM

5.3.1 Introduction

Integrated pest management is a decision-making process for the selection, implementation, and evaluation of pest management practices. It utilizes all available methods to achieve the most economically and environmentally sound management program. IPM is the integration of available techniques to reduce pest populations and maintain them below the levels causing economic injury in a way that avoids harmful side effects.

Specific pest management needs vary with the crop, cropping system, pest problems, pesticide use history, socio-economic conditions, and other factors. There are, however, well-defined principles that

guide the implementation of integrated pest management (IPM). Based on these principles, some guidelines can be offered for the development of and execution of IPM activities for F&V and cassava production subprojects. The implementers of the subprojects should adopt these guidelines to the conditions found in their subprojects.

IPM can decrease pest losses, lower pesticide use, and reduce overall operation costs, while increasing crop yield and stability. Successful IPM programs would be developed for pests on various crops to be promoted by SACEP.

5.3.2 Proposed steps for implementation of IPM approach

Step 1. Assess IPM needs and establish priorities

- Consider the relative importance of target crops and their need for pesticide application;
- Review pesticide use history, trends, availability and needs for development of IPM technology;
- Identify training needs for farmers and extension agents; and
- Respect and use local knowledge.

Step 2. Identify key pests for each target crop

- Become familiar with key pests of target crops and the damage they cause; and
- Correctly identify the common pest.

Step 3. Monitor the fields regularly

- Inspect crops regularly to determine the level of pests and natural enemies;
- Seek assistance of agricultural extension staff if necessary; and
- Determine when crop protection measures, including pesticides are necessary.

Step 4. Select appropriate mix of IPM kits

- Maximize the effectiveness of traditional and introduced non-chemical control techniques;
- Use targeted (not broad spectrum) pesticides when no other practical, effective and economic non-chemical control methods are available;
- Examples of Non-chemical Pest Management Techniques include:
 - ✓ Maintaining good soil fertility and a diverse agro-ecosystem;
 - ✓ Plant resistant crop varieties;
 - ✓ Selecting pest resistant plant varieties for location and season;
 - ✓ Rotating crops;
 - ✓ Planting clean seed;
 - ✓ Select correct planting and harvest periods to minimize pest population increase;
 - ✓ Proper irrigation methods;
 - ✓ Correct fertilizer, rates, and timing;
 - ✓ Good crop sanitation;
 - ✓ Hand picking of larger pests; and
 - ✓ Use of natural control agents (biological control).

Step 5. Develop education, training, and demonstration programs for extension workers

- ✓ Conduct hands-on training of farmers in farmers' field format as opposed to a classroom;
- ✓ Use the participatory "Farmers' Field School" approach; and

Conduct special training for extension workers, government officials, retailers, and the public.

5.4 Overview of Training and Human Resource Development

Training of small farmers on IPM would be an integral part of SACEP activities. Small farmers need to know and understand how they can produce quality fruits and vegetables while minimizing any negative impact on the environment.

5.5 Training of Farmers

Under SACEP, farmers would be trained on IPM principles as early as possible to ensure full implementation of research findings of MAF and USP scientists and to ensure optimal use of agrochemicals within project areas. In addition, modules emphasizing IPM should become a part of the regular agricultural extension activities of MAF staff based on the findings of the crop production scientist at Nu'u and USP. Crop protection and agricultural extension staff capacity should be improved through structured and applied training programs to be conducted by USP staff under SACEP.

All these would be delivered through the various productive partnerships within Components 1 and 2 of the SACEP. During consultation with USP, NGOs, and relevant MAF staff as well as some of the farmers, a number of responses were expressed about different ways or modalities for the delivery of the required training. Training on IPM would be conducted through a number of protocols, including structured and applied training by the USP staff, on farm training or "training by association", and farmer to farmer approaches as promoted by the WIBDI, and other proven approaches.

In addition, farmers could be trained on principles of IPM in a community setting at community halls. This would have the advantage of greater community involvement. Training in classrooms (structured training) is a more formal avenue of training which is often not popular with smallholder farmers who have various family and community obligations. It might be more appropriate for training of trainers.

A large number of NGO based activities such as activities by WIBDI and METI have been formed in the project islands and they could be also sources to draw farmers from to attend the training.

5.6 Public Awareness Raising

To inform the retailers and the public of the importance of IPM and to aware them of the benefits of using the IPM approach to food production in reduction of potential concentration of pesticides in the food and vegetable produce, it is proposed to develop an information campaign through public media such as newspapers, radio and television. Such awareness program should concentrate its efforts on informing the public that use of IPM approach reduces the need for application of pesticides, minimizing potential concentration of pesticides on fruits and vegetables and the possible presence of few blemishes on the vegetable does not only indicate poor quality, but that such blemishes might also be an indication that the produce has not been sprayed during its last stages of development, reducing the possibility of having pesticide residue in the produce.

6 Monitoring and Evaluation under SACEP

As is recommended in ESMF, MAF should train one of the senior staff as Environmental and Social Management Specialist (ESMS) to coordinate the ESMF and EMP related activities and be engaged as a member of PCG for the SACEP. It would be the responsibility of this person and international TA to train the relevant agricultural extension officers involved in PMP and other environment related activities of PCG and any other staff involved in monitoring activities and to routinely visit all the establishments of SACEP in the two target islands, and to report to the PCG on a semi- annual basis.

6.1 Activities Requiring Monitoring

The application of IPM measures are often done by the farmer as he/she is in control of his F&V garden, based on the training that has been given by the trained MAF staff. The uptake of IPM by

farmers would be confirmed through the project M&E activities, by observing a sample of farmers, who have attended the training and monitoring results from their F&V garden blocks.

The ESMS on the quarterly visits would need to visit selected blocks to observe the application of IPM measures. These sites and areas would need to be discussed with the relevant agricultural extension and other MAF staff involved in project coordination.

Appendix 1: Currently used pesticides in the GoS Agriculture sector

No	Chemical Trade Name	Active Ingredients	WHO Category
1	Banvine	200 g/l of 2,4-D + 100 g/l Dicamba, both as arvine salt	III
2	Blitzen pellets	15 g/kg Metaldehyde in pellet form	II
3	Claw PCO	30 g/l (10%) Bifenthrin	II
4	Conqueror	970 ml/l mineral oil in form of emulsified concentrate (Glyphosate)	U
5	Cusol	Copper ammonium complex equivalent to 400 g copper sulphate as water soluble concentrate	II
6	Dipel DF	<i>Bacillus thuringiensis</i> subsp. <i>kustaki</i>	U
7	Match	50 g/l Lufenuron 596 g/l hydrocarbon liquid	U
8	Orthene	970 g/kg Acephate	III
9	Prevathon	5% Chloranruniliprole	NL*
10	Shield	45 g/l Acephate or inhale	III
11	Stewart	150 g/l Indoracarb form of concentrate	NL

* Not listed

Appendix 2: List of chemicals under Stockholm & Rotterdam Conventions

Stockholm Convention	Rotterdam Convention
<p>Annex A:</p> <p>Aldrin</p> <p>Chlordane</p> <p>Dieldrin</p> <p>Endrin</p> <p>Heptachlor</p> <p>Hexachlorobenzene</p> <p>Mirex</p> <p>Toxaphene</p> <p>Polychlorinated biphenyls (PCB)</p>	<p>Pesticides:</p> <p>2,4,5-T</p> <p>Aldrin</p> <p>Benomyl (certain formulations)</p> <p>Binapacryl</p> <p>Captafol</p> <p>Carbofuran (certain formulation)</p> <p>Chlordane</p> <p>Chlordime</p> <p>Chlorobenzilate</p> <p>DDT</p> <p>Dieldrin</p> <p>Dinoseb and Dinoseb salts</p> <p>DNOC and its salts</p> <p>1,2-dibromoethane (EDB)</p> <p>Ethylene dichloride</p> <p>Ethylene oxide</p> <p>Fluroacetamide</p> <p>HCH (mixed isomers)</p> <p>Heptachlor</p> <p>Hexachlorobenzene</p> <p>Lindane</p> <p>Mercury compounds (certain formulations)</p> <p>Monocrotophos and parathion (all formulations)</p> <p>Pentachlorophenol</p> <p>Thiram (certain formulations)</p> <p>Toxaphene</p> <p>Certain hazardous pesticide formulations of:</p> <p>Methamidophos</p> <p>Methyl-parathion</p> <p>Monocrotophos</p> <p>Phosphamidon</p> <p>Parathion</p>

Stockholm Convention	Rotterdam Convention
	<p data-bbox="755 233 1003 260">Industrial chemicals:</p> <p data-bbox="755 279 1240 338">Asbestos (actinolite, amosite, anthophyllite, crocidolite, tremolite)</p> <p data-bbox="755 357 1133 384">Polybrominated biphenyls (PBBs)</p> <p data-bbox="755 403 1138 430">Polychlorinated biphenyls (PCBs)</p> <p data-bbox="755 449 1138 476">Polychlorinated terphenyls (PCTs)</p> <p data-bbox="755 495 1101 522">Tetraethyl and tetramethyl lead</p> <p data-bbox="755 541 1154 569">Tris (2,3-dibromopropyl) phosphate</p>